

## Education and Human Resources

**ED31A CC: 220 C-E Wednesday 0830h**

### Innovations in Earth and Space Science Education Posters

**Presiding: J Madsen, University of Delaware; C Manduca, Carleton College**

**ED31A-01 0830h POSTER**

#### Teaching Geoscience with Visualizations: Using Images, Animations and Models Effectively

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Visualizing the Earth, its processes, and its evolution through time is a fundamental aspect of geoscience. Geoscientists use a wide variety of tools to assist them in creating their own mental images. For example, we now use multilayered visualizations of geographically referenced data to analyze the relationships between different variables and we create animations to look at changes in data or model output through time. An NAGT On the Cutting Edge emerging theme workshop focused on the use of visualization tools in teaching geoscience by addressing the question "How do we teach geoscience with visualizations effectively?" The workshop held February 26-29 at Carleton College brought together geoscientists who are leaders in using visualizations in their teaching, learning scientists who study how we perceive and learn from visualizations, and creators of visualizations and visualization tools. Participants considered what we know about using visualizations effectively to teach geoscience, what important questions need to be answered to improve our ability to teach effectively, and what resources are needed to increase the capability of teaching with visualizations in the geosciences. Discussion focused on how we use visualizations in our teaching to describe and explain geoscience concepts and to explore and understand data. In addition, a section of the workshop focused on powerful emerging tools and technologies for visualization and their use in geoscience education. Workshop leaders and participants have created a web-site that includes visualizations useful in teaching, an annotated bibliography of research about teaching and learning with visualizations, essays by workshop participants about their work with visualizations, and information for visualization creators. Further information can be found at [serc.carleton.edu/NAGTWorkshops/visualize04](http://serc.carleton.edu/NAGTWorkshops/visualize04).

URL: <http://serc.carleton.edu/NAGTWorkshops/visualize04>

**ED31A-02 0830h POSTER**

#### Student Cognitive Difficulties and Mental Model Development of Complex Earth and Environmental Systems

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Students organize scientific knowledge and reason about environmental issues through manipulation of

mental models. The nature of the environmental sciences, which are focused on the study of complex, dynamic systems, may present cognitive difficulties to students in their development of authentic, accurate mental models of environmental systems. The inquiry project seeks to develop and assess the coupling of information technology (IT)-based learning with physical models in order to foster rich mental model development of environmental systems in geoscience undergraduate students. The manipulation of multiple representations, the development and testing of conceptual models based on available evidence, and exposure to authentic, complex and ill-constrained problems were the components of investigation utilized to reach the learning goals. Upper-level undergraduate students enrolled in an environmental geology course at Texas A&M University participated in this research which served as a pilot study. Data based on rubric evaluations interpreted by principal component analyses suggest students' understanding of the nature of scientific inquiry is limited and the ability to cross scales and link systems proved problematic. Results categorized into content knowledge and cognition processes where reasoning, critical thinking and cognitive load were driving factors behind difficulties in student learning. Student mental model development revealed multiple misconceptions and lacked complexity and completeness to represent the studied systems. Further, the positive learning impacts of the implemented modules favored the physical model over the IT-based learning projects, likely due to cognitive load issues. This study illustrates the need to better understand student difficulties in solving complex problems when using IT, where the appropriate scaffolding can then be implemented to enhance student learning of the earth system sciences.

URL: <http://its.tamu.edu/research/products/working%20papers/>

**ED31A-03 0830h POSTER**

#### Integration of Research Into Grade Nine-Graduate Level Curricula

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Research on the Kolb Learning Cycle, engineering education, and recent cognitive learning research indicates that learning occurs through knowledge application. Moreover, experts in a given discipline will differ from novices with regard to their ability to transfer their knowledge by application to new contexts. We have developed a suite of educational opportunities to bridge the gap between research and the classroom, with activities spanning the educational spectrum from high school through graduate school. One mechanism for transferring of research into undergraduate/graduate curricula is through our National Science Foundation (NSF) funded Combined Research-Curriculum Development (CRCD) project ("Environmental Informatics in Coastal Margins"). This project modifies engineering curricula to provide the nation with the next generation of engineers who can utilize the latest environmental modeling tools. The project revises/creates three undergraduate courses forming the environmental informatics (EI) track of the civil engineering curriculum and two graduate courses integrating GIS and environmental measurements. Curriculum development efforts are guided by an expert team drawn from nearby campuses and both regional and national industry, and includes an expert in assessing the pedagogical value of the curriculum and developing suitable metrics to evaluate student learning experiences. Another NSF-funded project integrating research into an undergraduate educational setting is our Research Experience for Undergraduates (REU) project ("Undergraduate Research in Biodiversity and Ecological Processes in Fluctuating Environments"). Research includes overlapping topics in environmental engineering and life sciences. The summer research experience provides students an opportunity to integrate engineering and life science technologies and to the study of ecological processes associated with biodiversity and environmental quality. Students orally present their project and submit in-depth papers. Over twenty publications/proceedings papers have been generated thus far. A third project involves our collaborations with the ITS Center ("Information Technology in Science Center for Teaching and Learning") on the A&M campus. As an investment in "project team growing", the Center is collaborating with us to collect data on implementation of an engineering science and math enhancement module in Hearne Independent School District. The specific activity involves a CRCD engineer-

ing class and an educational psychology undergraduate class. The engineering students give group presentations, where each presentation addresses a scenario that focuses on an environmental topic presented in the class. The students present the technical material to the education students who serve as a non-technical lay audience, emulating a city council, for example. The education students adapt the material for presentation to high school students, working with mentor teachers to enhance content, relevance and hands on experience while learning to apply teaching pedagogy.

**ED31A-04 0830h POSTER**

#### The Delaware Bay Estuary as a Classroom: A Research Experience for Future Elementary Grade-Level Teachers

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With supplemental funding from the National Science Foundation (NSF), students from the University of Delaware's Science Semester course took part in a two-day research cruise in the Delaware Bay Estuary. The Science Semester, an NSF-funded project, is an integrated 15-credit sequence that encompasses the entire course work for the spring semester for approximately 60 sophomore-level elementary education majors. The semester includes the earth, life, and physical science content courses and the education science methods course integrated into one curriculum. In this curriculum, problem-based learning and other inquiry-based approaches are applied to foster integrated understandings of science and pedagogy that future elementary teachers need to effectively use inquiry-based approaches in their classrooms. The research cruise was conducted as part of one of the four major investigations during the course. The investigation focused on Delaware's state marine animal, *Limulus polyphemus*. It is one of the four remaining species of horseshoe crabs; the largest spawning population of *Limulus* is found in Delaware Bay. Within the problem- and inquiry-based learning approaches of the Science Semester course, the students became aware that very little data exists on the benthic habitat of *Limulus polyphemus*. In order to learn more about this habitat, a cohort of seven students from the course was recruited as part of the scientific party to take part in the research cruise to collect data on the floor of Delaware Bay. The data included: multibeam bathymetry/backscatter data, grab samples of bay bottom sediments, and CTD profiles. Prior to the cruise, all students in the course took part in laboratory exercises to learn about topographic maps and navigation charts using the Delaware Bay area as the region of study. While "at-sea", the cruise participants sent the ship's latitude and longitude positions as a function of time. The positions were used by the on-land students to investigate motion and data representation (e.g., distance vs. time, velocity vs. time plots). After the at-sea experience, and using the data collected, all of the students plotted the sampling locations on their navigation charts and examined and quantitatively described the bottom sediments collected with the grab samples. The CTD data were used to investigate solutions, salinity, and conductivity. The ability to participate in, and use the data collected from, the two-day cruise provided an excellent opportunity for these future elementary teachers to experience real-time scientific research. The students onboard the ship were able to observe, and more importantly, engage in the collection of data from an oceanographic research vessel. All of the students in the course through hands-on laboratory exercises were able to see the link between data collection and analysis and its subsequent interpretation within the scope of a real scientific problem, namely the study of the benthic habitat of an important marine animal.

**ED31A-05 0830h POSTER**

#### Onondaga Lake: A Forsaken Superfund Site, or a Sampling Playground for Environmental Geochemistry Classes?

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Onondaga Lake, in Syracuse, NY, is described by the EPA as one of the most polluted lakes in the US. High levels of heavy metal and semi-volatile organic contamination provide an excellent case study that serves as the cornerstone for an environmental geochemistry course at Colgate University. Our course is designed to teach students basic environmental analysis skills including experimental design, sample preparation, analytical instrumentation operation, data processing and statistical analysis, and preparation of a collaborative scientific paper. Participating students generally have some background in environmental geology, but rarely more than one semester of chemistry. The Onondaga Lake project is the focus of the course for approximately half the semester. At the outset of the project, students are presented with a driving question that is answered through a series of guided field and lab investigations, such as an assessment of the environmental consequences of a proposed marina along the lakefront. The students' first task is to delve into the lake's environmental history, including identification of contaminants, location of point and non-point pollution sources, and clean-up efforts. Students then participate in 2 field trips to the site. First, students learn the geography of the lake system, collect sediment and water samples, and observe mitigation efforts at the wastewater treatment plant. The second trip is 2-3 weeks later, after students have assessed further sampling needs. Identification and quantification of organic compounds are accomplished by GC-MS, and heavy metal contents are determined by ICP-MS. Students compile their results, perform statistical analyses, and collaboratively draw their conclusions regarding the impact of the proposed project. The final product is a single report written by the entire class, an exercise in organization, cooperation, and planning that is usually the most challenging, but ultimately the most rewarding, aspect of the project. Basic laboratory and data processing skills are introduced to the class as they become necessary, but not before they are applied to the project. We have found that students find these very real environmental questions so compelling that they are motivated to learn the necessary skills when, in a more isolated laboratory setting, they would often otherwise be intimidated by them. Instead, the Onondaga Lake case study provides students with a powerful motivating force to learn both environmental geochemistry and the underlying chemical principles.

ED31A-06 0830h POSTER

Training Undergraduate Physics Peer Tutors

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The University of Wisconsin's Physics Peer Mentor Tutor Program matches upper level undergraduate physics students in small study groups with students studying introductory algebra-based physics. We work with students who are potentially at-risk for having academic trouble with the course. They include students with a low exam score, learning disabilities, no high school physics, weak math backgrounds, and/or on academic probation. We also work with students from groups under represented in the sciences and who may be feeling isolated or marginal on campus such as minority, returning adult, and international students. The tutors provide a supportive learning environment, extra practice problems, and an overview of key concepts. In so doing, they help our students to build confidence and problem solving skills applicable to physics and other areas of their academic careers. The Physics Peer Mentor Tutor Program is modeled after a similar program for chemistry created by the University of Wisconsin's Chemistry Learning Center. Both programs are now run in collaboration. The tutors are chosen for their academic strength and excellent communication skills. Our tutors are majoring in physics, math, and secondary-level science education. The tutors receive ongoing training and supervision throughout the year. They attend weekly discipline-specific meetings to discuss strategies for teaching the content currently being discussed in the physics course. They also participate in a weekly teaching seminar with science tutors from chemistry and biochemistry to discuss teaching methods, mentoring, and general information relating to the students with whom we work. We will describe an overview of the Physics Peer Mentor Tutor Program with a focus on the teacher training program for our undergraduate tutors.

ED31A-07 0830h POSTER

The Radio JOVE Project: A New Multi-channel Spectrum Analyzer

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A new radio spectrograph is now operational at the University of Florida Radio Observatory (UFRO) via the education and public outreach project called the Radio JOVE project (<http://radiojove.gsfc.nasa.gov>). The UFRO telescope is a 16-element 10-40 MHz log spiral array which is sensitive to both right-hand and left-hand circular polarization. Another spectrograph is connected to a 17-30 MHz log-periodic antenna located at Windward Community College in Hawaii (<http://jupiter.wcc.hawaii.edu>). Freely available software from Radio-Sky Publishing (<http://www.radiosky.com>) allows students, teachers, and radio astronomy enthusiasts to view the spectral data in real time via the Internet. Ultimately team members will be able to log on to the telescope and control the antenna and spectrometer's total sweep range, polarization, and calibrations. The software and telescope controls are discussed, and recent data results are shown. These data are of high quality and can lead to research applications.

ED31A-08 0830h POSTER

Modern Views of Ancient Solar Observatories

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The NASA Sun-Earth Connection Education Forum (SECEF) annually promotes an event called Sun-Earth Day. The event emphasizes the study of the Sun and its effects on the Earth and the rest of the Solar System. Sun-Earth Day 2004 will emphasize the June 8th Transit of Venus as a theme. For 2005 the highlight will be the study of the Sun by ancient cultures and how that relates to contemporary solar knowledge. There are many examples of ancient solar observatories around the world, but some of the best are found in National Parks. SECEF has been working with Chaco Culture National Historical Park in New Mexico to do a webcast showing knowledge about the Sun by the Chacoan people that is evident in the park. The Sun Dagger and other pictographs as well as Chaco building alignments indicate the influence of the Sun in the lives of this people. The cooperative planning for this event by NASA and the National Park Service (NPS) will be discussed. Other events emphasizing ancient observatories in other locations are also planned for the future. The partnership between SECEF and NPS is not limited to ancient observatories, however. The influence of the Sun on our daily lives is an appropriate topic for many parks and the possibilities for solar exhibits, daytime astronomy sessions, scientist lectures, etc. will be discussed as well.

URL: <http://sunearth.gsfc.nasa.gov>

ED33A CC: 518 C Wednesday 1330h

Communicating the Science of Climate Change to Teachers, Students, and the General Public (joint with A, GC)

Presiding: P Folger, American Geophysical Union; S Buhr, Cooperative Institute for Research in Environmental Sciences (CIRES); M A Geller, Institute for Terrestrial and Planetary Atmospheres, Stony Brook University

ED33A-01 1330h

Climate and Global Change Education and Outreach for Students, Teachers, and the Public at the National Center for Atmospheric Research, Boulder, Colorado

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The National Center for Atmospheric Research in Boulder Colorado is a leading research institution in the area of global and climate change research worldwide. As a component of NCAR's mission in research, education, and service, NCAR supports numerous programs designed to bring this science to different audiences in order to promote better understanding of climate and global change research as well as its relevance in learning contexts. Our climate and global change education and outreach effort targets several audiences, including professional development for middle and high school educators, exhibits, tours, websites, and development of educational resources on climate and global change topics. The design of our program intentionally leverages resources in support of multiple audiences in different settings. Over 80,000 visitors come to the NCAR Mesa Laboratory each year, and now have the opportunity to visit our new Climate Discovery exhibit unveiled in July 2003. This exhibit, which includes integrated curriculum resources addressing topics highlighted in the exhibit, will soon be extended to include an interactive Climate Future gallery. Our two-week summer professional development workshops - the NCAR Climate and Global Change Workshop and the NCAR Modeling in the Geosciences Workshop - provide extensive background information on the state-of-the-art of climate and global change research and modeling provided by leading researchers, training on computer- and non-computer based activities, field trips, project development, training for dissemination, and opportunities to share with their colleagues. Our education and outreach websites are now being expanded to include dedicated content and interactives addressing climate and global change topics, including the NCAR Education and Outreach website ([www.ncar.ucar.edu/eo](http://www.ncar.ucar.edu/eo)) and the Windows to the Universe website ([www.windows.ucar.edu](http://www.windows.ucar.edu)).

ED33A-02 1345h

Climate and Global Change: Programs and Services Reaching Public and K-12 Audiences at a National Research Laboratory

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The study of climate and global change is an important on-going focal area for scientists at the National Center for Atmospheric Research (NCAR). Programs overseen by the University Corporation for Atmospheric Research Office of Education and Outreach