

all the essential elements for online discussions. Instructors can even assign students to separate discussion groups. Through the interactions with others from different geographical areas and with different life experiences, students are expected to find learning more interesting and thus can learn better about the scientific subject matters.

ED51A-0225 0830h POSTER

The Topography of Mars: Understanding the Surface of Mars Through the Mars Orbiter Laser Altimeter

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The Mars Orbiter Laser Altimeter has been orbiting Mars since 1997 and has measured the topography of Mars with a meter of vertical accuracy. This new information has improved our understanding of both the surface and the interior of Mars. The topographic globe and the labeled topographic map of Mars illustrate these new data in a format that can be used in a classroom setting. The map is color shaded to show differences in elevation on Mars, presenting Mars with a different perspective than traditional geological and geographic maps. Through the differences in color, students can see Mars as a three-dimensional surface and will be able to recognize features that are invisible in imagery.

The accompanying lesson plans are designed for middle school science students and can be used both to teach information about Mars as a planet and Mars in comparison to Earth, fitting both the solar system unit and the Earth science unit in a middle school curriculum. The lessons are referenced to the National Benchmark standards for students in grades 6-8 and cover topics such as Mars exploration, the Mars Orbiter Laser Altimeter, resolution and powers of 10, gravity, craters, seismic waves and the interior structure of a planet, isostasy, and volcanoes. Each lesson is written in the 5 E format and includes a student content activity and an extension showing current applications of Mars and MOLA data. These activities can be found at <http://ftpwww.gsfc.nasa.gov/education/resources.html>. Funding for this project was provided by the Maryland Space Grant Consortium and the MOLA Science Team, Goddard Space Flight Center.

ED51B MC: Hall D Friday 0830h

Approaches to Undergraduate Education in the Geophysical Sciences

Presiding: S Stockman,
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ED51B-0226 0830h POSTER

Going Beyond the Lecture Class - Is it Worth it?

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Lectures, labs, and seminars dominate the course offerings at most American universities. Students have been learning successfully from these teaching methods for hundreds of years. Alternatively, in order to provide

a more personally meaningful learning experience, educational researchers espouse a constructivist approach to learning. To demonstrate this approach, we will describe a case study of two courses, marine chemistry and biological oceanography, that were taught as a single interdisciplinary experience by Stanford University faculty. The courses incorporated an innovative curriculum using active learning methodologies including problem-based learning and teamwork, a set of interactive and facilitative teaching practices, customized technology that worked in the background to make the course effective and efficient, and a goal to reveal the interdisciplinary nature of the content in the two courses.

Videotapes of group problem solving revealed that students displayed higher order thinking skills. Students indicated in focus groups that teamwork provided a motivating, rich, learning environment. The communication technology supported both the faculty in the delivery and assessment of the course and the students in communicating with their teams. The technology was the glue that made the course work effectively and efficiently. The overall learning experience can be best expressed by the students themselves who said they felt like they were participating in real science for the first time.

ED51B-0227 0830h POSTER

Developing an Assessment Tool for Geology: Stage One, Student Interviews

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Questionnaires and targeted interviews were used to determine the extent of college student conceptual understanding in the geosciences. Specifically, introductory and non-major courses were targeted, with emphasis on three dimensions of Earth processes: Earths crust, Earths interior, and Earth through time. A review of the geoscience and education literature revealed only sixteen studies that are relevant to conceptual understanding in these three categories. A number of studies focus on definitions, such as the meaning of the term fossil. Some researchers also touch upon soil, water, and plate tectonics, and geologic time is the most closely considered concept. This study extends the available research, and reveals a number of preconceptions held by college-aged students. For instance, many students are unable to fully comprehend geologic time, have poor understanding of the causes of geologic events such as earthquakes and volcanoes, and have a non-scientific view of the interior of the Earth.

ED51B-0228 0830h POSTER

Integrating Real-time Earthquakes into Natural Hazard Courses

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Natural hazard courses are playing an increasingly important role in college and university earth science curricula. Students' intrinsic curiosity about the subject and the potential to make the course relevant to the interests of both science and non-science students make natural hazards courses popular additions to a department's offerings. However, one vital aspect of "real-life" natural hazard management that has not translated well into the classroom is the real-time nature of both events and response. The lack of a way to entrain students into the event/response mode has made implementing such real-time activities into classroom activities problematic. Although a variety of web sites provide near real-time postings of natural hazards, students essentially learn of the event after the fact. This is particularly true for earthquakes and other events with few precursors. As a result, the "time factor" and personal responsibility associated with natural hazard response is lost to the students. We have integrated

the real-time aspects of earthquake response into two natural hazard courses at Penn State (a 'general education' course for non-science majors, and an upper-level course for science majors) by implementing a modification of the USGS Earthworm system. The Earthworm Database Management System (E-DBMS) catalogs current global seismic activity. It provides earthquake professionals with real-time email/cell phone alerts of global seismic activity and access to their data for review/revision purposes. We have modified this system so that real-time response can be used to address specific scientific, policy, and social questions in our classes. As a prototype of using the E-DBMS in courses, we have established an Earthworm server at Penn State. This server receives national and global seismic network data and, in turn, transmits the tailored alerts to "on-duty" students (e-mail, pager/cell phone notification). These students are responsible to react to the alarm real-time, consulting other members of their class and accessing the E-DBMS server and other links to glean information that they will then use to make decisions. Students wrestle with the complications in interpreting natural hazard data, evaluating whether a response is needed, and problems such as those associated with communication between media and the public through these focused exercises. Although earthquakes are targeted at present, similar DBMS systems are envisioned for other natural hazards like flooding, volcanoes, and severe weather. We are testing this system as a prototype intended to be expanded to provide web-based access to classes at both the middle/high school and college/university levels.

ED51B-0229 0830h POSTER

An Earth Summit in a Large General Education Oceanography Class

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An Earth Summit approach in UCSBs undergraduate physical oceanography course has raised student interest level while it also supports the course goals of increased learner awareness of the process of science, and critical analysis of scientific claims. At the beginning of the quarter, each group of students chooses a country to represent in the Earth Summit. During the course of the quarter, these groups relate each of the class themes to their chosen country. Themes include 1) ocean basins and plate tectonics, 2) atmospheres, oceans and climate, and 3) fisheries. Students acquire and utilize Earth data to support their positions. Earth data sources include the "Our Dynamic Planet" CDROM (http://oceanography.geol.ucsb.edu/ODP_Advert/odp_onepage.htm), NOAAs ocean and climate database (<http://ferret.wrc.noaa.gov/las/>), World-Watcher CD (<http://www.worldwatcher.northwestern.edu/>) and JPLs Seawinds web site (<http://haifung.jpl.nasa.gov/index.html>).

During the atmospheres, oceans and climate theme, students choose from 12 mini-studies that use various kinds of on-line Earth data related to important global or regional phenomena relevant to the course. The Earth datasets that the students access for their analysis include: winds; atmospheric pressure; ocean chemistry; sea surface temperature; solar radiation; precipitation, etc The first group of 6 mini-studies focus on atmosphere and ocean, and are: 1) global winds and surface currents, 2) atmosphere and ocean interactions, 3) stratospheric ozone depletion, 4) El Nino, 5) Indian monsoon, and 6) deep ocean circulation. The second group focus on the Earths heat budget and climate and are: 1) influence of mans activities on the climate, 2) the greenhouse effect, 3) seasonal variation and the Earths heat budget, 4) global warming, 5) paleoclimate, and 6) volcanoes and climate. The students use what they have learned in these mini-studies to address atmospheric and climatic issues pertinent to their specific Earth Summit countries. For example, students representing the country of Chile might model their investigations after a)winds and surface currents, b)atmosphere and ocean interactions, c) stratospheric ozone depletion, d)El Nino; and/or e)volcanoes and climate.

Please join the "Oceanography" interest group of DLESE to discuss, develop, and access oceanography related mini-studies that use earth data (http://oceanography.geol.ucsb.edu/dlese/wg_oceanog/Index.html).

URL: <http://oceanography.geol.ucsb.edu/AWP/Class-Info/GS-4/Labs/Labs Index.html>

ED51B-0230 0830h POSTER

Using Planetary Science to Motivate the Introductory Science Curriculum; the Solar System Collaboratory

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For the past four years the Solar System Collaboratory has used Geoscience and Planetary Science to motivate the standard introductory curriculum in college Physics and Astronomy for non-majors. Extensive use of java-based simulations is being made to provide interactivity and facilitate the use of guided inquiry. Class management scripts are used to tailor the level of instruction to the appropriate level for each class, and to extend the use of the simulations to the high-school and elementary levels. Assessment and evaluation results including learning gains for three years of college level courses will be presented, and the challenges and opportunities of extending the work to elementary and high schools will be discussed.

ED51B-0231 0830h POSTER

Developing Online Oceanography at UCSB

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Oceanography at UCSB is an introductory general education science course taken by up to 200 students per quarter. The emphasis is on learning science process by engaging in authentic science activities that use real earth data. Recently, to increase student motivation, the course has been modified to include an Earth Summit framework.

The online support being developed for this course is the first step in the creation of a completely online oceanography class. Foundation software was first tested in the class during Spring 2001. Online activities that are supported are writing and instructor feedback, online threaded discussion with live chat and graphics, automatically graded homeworks and games, auto graded quizzes with questions randomly selected from a database, and thought problems graded by the instructor(s). Future plans include integration with commercial course management software.

To allow choice of assignments, all course activities totaled 110%. Since grades were based on A=90-100, B=80-90, C=70-80, etc, it was possible to get a better than A grade. Students see the effect (on their grade) of each assignment by calculating their current course grade. Course activities included (most of which are automatically graded): weekly lab homeworks, weekly mini-quizzes (10 multiple choice questions selected at random from a topic database), weekly thought questions (graded by the TA), 3 written assignments, and Question of the Day from lecture (credit given for handing it in). The online writing software allowed students to enter their writing, edit and link to graphic images, print the paper, and electronically hand it in. This has the enormous advantage of allowing the instructor and TAs convenient access to all student papers.

At the end of the course, students were asked how effective each of the course activities were in learning the course material. On a five point scale, ranging from highest contribution to lowest, the percentage of students giving ratings of 4 or 5 (highest) were: lectures: 27%, labs: 70%, earth summit activities: 57%, weekly thought questions: 36%. Questions of the day: 34%, weekly quizzes: 51%, weekly homeworks: 48%, writing assignments: 68%. Course difficulty responses were symmetrically peaked at a rating of 3, indicating that the course was taught at the right level. 64% of the students responded with 4 or 5 level to I worked very hard in this class.

Join the DLESE Oceanography interest group (www.dlese.org) to discuss and help develop oceanography course materials.

URL: <http://oceanography.geol.ucsb.edu/Support/CourseWare/Index.html>

ED51B-0232 0830h POSTER

Connecting Visualization to Physical Insight: Strategies from the Visual Geophysical Exploration Environment

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A key aspect of mature scientific understanding is the ability to connect direct observation of a natural system to fundamental theories: to connect the ideal to the real. Research suggests that novice learners have particular difficulty in making this transition. In undergraduate geoscience classes, this can lead to student understanding that is compartmentalized to a few specialized cases or examples, and not generally available to help interpret direct experience or inform personal or societal decisions.

The Visual Geophysical Exploration Environment (VGEE) includes a number of tools to help learners connect fundamental theories to complex geophysical phenomena. These are:

- a three-dimensional environment in which learners construct their own representations of phenomena
- data sets, adapted from research data, organized around specific geoscience phenomena
- concept models that learners can use to discover fundamental theories in idealized contexts
- the ability to use the concept models within the visualization environment as probes to explore the role of fundamental theories in realistic contexts
- an inquiry strategy that serves as a model for learners to construct and perform their own investigation

The 3d visualization of authentic data serves as an anchor for the VGEE: it motivates inquiry and provides a context for new knowledge. The inquiry strategy includes identifying and relating patterns in the visualization, explaining those patterns using idealized concept models, and integrating multiple explanations into a comprehensive understanding of the phenomena using the concept models as probes. A key innovation of the VGEE is the close connection between the ideal and the observable provided by using idealized concept models as probes within the visualization environment. Using the concept models in the visualization helps learners

determine the role of fundamental theories in observable phenomena and gives learners experience in applying theoretical understanding in practical contexts.

In addition to demonstrating the VGEE, our presentation will report on our initial use of the VGEE in an introductory meteorology laboratory class. We will also highlight the adaptability of the inquiry strategy and VGEE architecture to other geoscience disciplines. Finally, we will show how the VGEE contributes to, and benefits from, our ongoing research on learning using visualization in an inquiry-based curriculum.

URL: <http://www.dlese.org/vgee>

ED51B-0233 0830h POSTER

GeoWall: Stereo Projection Systems Designed for Earth Science Classrooms

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Within the past year, advances in projection technology and consumer-grade computer game technology have reduced the cost of stereo projection systems to a level that allows this technology to be used in the classroom. Stereo projection systems have remarkable potential for any educational discipline that deals with complex spatial relationships (engineering, physics, astronomy, etc.), but the implications for earth science education are particularly rich. The ability to visualize and interpret spatial relationships is a critical skill that many earth science students find difficult to master. Stereo projection can serve as a bridge to increase students' perception of maps, images and aerial views, or allow students to interactively manipulate three-dimensional, time-dependent visualizations of research data sets and mathematical models that move well beyond traditional education materials.

The GeoWall Project is an initiative to build low-cost, high-quality stereo projection systems at a number of research and education institutions. By standardizing the technical design of these systems, materials developed by one institution can be used by any of the other member institutions. This allows institutions to easily adopt materials that they could not produce in-house and fosters a community capable of generating curriculum materials that take advantage of stereo projection technology. Although not universally applicable across earth science education, stereo projection systems have the potential to transform the way that we teach many earth science concepts.