classroom sections, once the class is underway. However, student requests for incompletes tend to be somewhat higher in the online course, especially during the summer offerings.

Learning outcomes are reviewed at the beginning of the course and subsequent assessment on achieving each outcome is embedded in the graded assignments, which include a critical thinking essay on declining marine fisheries, one mid-term exam that emphasizes the application of basic math and the methods of scientific discovery in the context of ocean research; poster presentations in a symposium-style format, a course portfolio of web-based work, weekly discussions on an electronic bulletin board and a take-home final consisting of an original research grant proposal. The diverse nature of the graded assignments assures a comprehensive assessment of student learning from a number of perspectives, such as quantitative, qualitative, and analytical. Student learning compares favorably with classroom sections of the course, even though some students lack the discipline for self-paced learning. The distribution of the course grades in the online section typically differs from classroom sections by having higher percentages of both high and low performing students and fewer students clustered about the mean. Students strongly affirm that communication with the instructor in the online course is far greater, and of higher quality, than in classroom sections.

ED11B-0044 0830h POSTER

Evaluating Improvements to the Student Learning Experience in an Honours Earth and Environmental Sciences Program

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The School of Geography and Geology (SGG) at McMaster University recently received funding for a three-year project to apply new teaching strategies to enhance the undergraduate learning experience. A major focus of this project is to develop multiple opportunities for inquiry-based and experiential learning in the four-year Honours B.Sc program in Earth and Environmental Sciences. A second aim of the project is to enhance systematic personal transferable skills development in all students enrolled in this program.

The aims of the SGG educational project are being met through progressive revision and refinement of instructional methodologies and the introduction of increased opportunities for experimental lab work, fieldwork, co-op and volunteer placements. Introductory level laboratory assignments are now up to 70% inquiry-based and fieldwork opportunities exist for all students within the program. A major hurdle to assessing the success of the project is evaluation of the effectiveness of the educational changes made in the programs. To date, a number of evaluation tools have been used to assess improvements to the learning experience including formative and summative student feedback (both informal and formal), student performance evaluations (pre- and post-course), and surveys of program alumni and potential employers. A system for the evaluation of personal transferable skills development is currently being developed using a skills attainment grid. By comparing future student attainment and feedback with that documented in a baseline' survey carried out at the beginning of the project, it is hoped that assessment of improvements to the student learning experience can be made.

ED11B-0045 0830h POSTER

Designing and Evaluating a Climate Change Course for Upper-Division Engineers and Scientists

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AOSS 300, GLOBAL ENVIRONMENTAL IMPACT OF TECHNOLOGICAL CHANGE, was created to provide a mechanism for scientific exploration of the unexpected global environmental side effects of technological innovation with emphasis on issues of the atmosphere and oceans. The course is specifically designed to contribute to the desired Accreditation Board for Engineering and Technology (ABET) outcomes that engineering and science graduates possess "the broad education necessary to understand the impact of solutions in a global and societal context."

To facilitate this new course a new suite of coupled Flash/PHP/MySQL tools have been created that allow personalization of the students' learning space and interaction with faculty. Using these tools students are challenged to actively participate in the construction of knowledge through development of on-line portfolios that influence course content. This paper reports on lessons learned in the first semester that will guide further course development.

URL: http://www.engin.umich.edu/class/aoss300/

ED11B-0046 0830h POSTER

RESEARCH INTO STUDENTS PRE-INSTRUCTIONAL BELIEFS OF ASTROBIOLOGY RELATED SCIENCE CONCEPTS

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The purpose of this study was to identify and document student beliefs and reasoning difficulties concerning astrobiology related topics. This was accomplished by surveying over two thousand middle school, high school, and college (science and non-science majors) students. Students were surveyed utilizing student-supplied response questions focused on the definition of life and its limitations, evolution of Earth (biologically and geologically), and the role of water for life as we know it. Careful, inductive analysis of student responses revealed that the majority of students correctly identify that liquid water is necessary for life and that life forms can exist without sunlight. However, many students incorrectly state that life cannot survive without oxygen. Furthermore, when students are asked to reason about life in extreme environments, they most often cite complex organisms (such as plants, animals and humans) rather than the more ubiquitous microorganisms. Students also have well-established models of the relationship between the geologic and biologic evolution of Earth. Results of this study were used to guide the development of a set of inquiry-based activities, which will be highlighted.

ED11B-0047 0830h POSTER

The Geoscience Concept Test: A New Assessment Tool Based on Student Misconceptions

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We developed and began pilot testing of an earth science assessment tool called the geoscience concept test (GCT). The GCT uses student misconceptions as distractors in a 30 item multiple-choice instrument. Student misconceptions were first assessed through the analysis of nearly 300 questionnaires administered in introductory geology courses at three institutions. Results from the questionnaires guided the development of an interview protocol that was used by four interviewers at four different institutions. Over 100 in-depth student interviews lasting from 0.5 to 1 hour probed topics related to the Earth's interior, geologic time, and the formation of Earth surface features such as mountains and volcanoes to better define misconceptions. Thematic content analysis of the interviews identified a number of widely held misconceptions, which were then incorporated into the GCT as multiple-choice distractors (wrong answers). For content validity, the initial GCT was reviewed by seven experts (3 geoscientists and 4 science educators) and revised before pilot testing.

Approximately 100 introductory and non-science major college students from four institutions were assessed with the GCT pilot in the spring of 2002. Rasch model analysis of this data showed that students found the pilot test difficult, and the level of difficulty was consistent between the four institutions. Analysis of individual items showed that students had fewer misconceptions regarding the locations of earthquakes, and many misconceptions regarding the locations of volcanoes on the Earth's surface, suggesting a disconnect in their understanding of the role of plate tectonics in these phenomena. Analysis of the misfit statistic for each item showed that none of the questions misfit, although we dropped one question and modified the wording of another for clarity in the next round of piloting. A second round of piloting scheduled for the fall of 2002 includes nearly 3000 students from 34 institutions in 19 states.

ED11C MCC: 270 Monday 0830h

Evaluating Geoscience Education Projects I *(joint with OS, PA)*

Presiding: **S Buhr,** University of Colorado**; L Barker,** Alliance for Learning Technology and Society

ED11C-01 0830h INVITED

Using Project Evaluation to Focus and Improve Earth and Space Science Education and Public Outreach Projects

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It is becoming common for research geoscientists to become involved with, and often lead, earth and space science education projects for K-18 levels and outreach to the general public. Typically, these projects have three principle goals: (i) increase the general geosciences background knowledge of participants; (ii) enhance the participants' life-long attitudes toward geosciences, and science in general; and (iii) increase participants' skills toward using geoscience principles (high quality teaching by teachers, advanced fieldwork by amateurs, science-positive voting by legislators, etc.). As many financially sponsoring foundations or agencies now require a project evaluation, research scientists are being asked to document the effectiveness and impact of their activities. Evaluation plans are often presented in proposals as a matrix with rows indicating the specific project goals and outcomes with columns showing project activities, assessment data sources and analysis strategies, and performance indicators of success. Geoscience knowledge increases are commonly measured by pre- and posttests, enhanced attitudes with pre- and posttest Likert scale surveys with responses ranging from "(1) strongly agree" to "(5) strongly disagree," and improved skills by clinical interviews or observation checklists. Quantitative data can be validated qualitatively using individual or group interviews with participants; however, the evaluation results that are often the most convincing employ a triangulated, multi-data source approach to assessing stated project goals which use a combination both quantitative and qualitative data. This work supported in part by NSF TE 9731083 and NASA #NAG5-4576.

URL: http://shiraz.as.arizona.edu

ED11C-02 0850h INVITED

OERL: A Tool For Geoscience Education Evaluators

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The Online Evaluation Resource Library (OERL) is a Web-based set of resources for improving the evaluation of projects funded by the Directorate for Education and Human Resources (EHR) of the National Science Foundation (NSF). OERL provides prospective project developers and evaluators with material that they can use to design, conduct, document, and review evaluations. OERL helps evaluators tackle the challenges of seeing if a project is meeting its implementation and outcome-related goals.

Within OERL is a collection of exemplary plans, instruments, and reports from evaluations of EHR-funded projects in the geosciences and in other areas of science and mathematics. In addition, OERL contains criteria about good evaluation practices, professional development modules about evaluation design and questionnaire development, a dictionary of key evaluation terms, and links to evaluation standards. Scenarios illustrate how the resources can be used or adapted. Currently housed in OERL are 137 instruments, and full or excerpted versions of 38 plans and 60 reports. 143 science and math projects have contributed to the collection so far. OERL's search tool permits the launching of precise searches based on key attributes of resources such as their subject area and the name of the sponsoring university or research institute.

OERL's goals are to 1) meet the needs for continuous professional development of evaluators and principal investigators, 2) complement traditional vehicles of learning about evaluation, 3) utilize the affordances of current technologies (e.g., Web-based digital libraries,

relational databases, and electronic performance support systems) for improving evaluation practice, 4) provide anytime/anyplace access to update-able resources that support evaluators' needs, and 5) provide a forum by which professionals can interact on evaluation issues and practices.

Geoscientists can search the collection of resources from geoscience education projects that have been funded by NSF to carry out curriculum development, teacher education, faculty development, and increased access, retention, and preparation of under-represented student populations in science.

Over the next two years, additional plans, instruments, and reports from other projects will be added to the OERL collection. Also to be added are more professional development modules and online coaches for constructing key evaluation documents.

The presentation overviews the structure of OERL, describes some of the geoscience projects in the collection, and provides some examples of how its resources can be used and adapted for other geoscience education evaluations.

URL: http://oerl.sri.com

ED11C-03 0910h INVITED

Continuing Evaluation of S'COOL, an Educational Outreach Project Focused on NASA's CERES Program

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The Students' Cloud Observations On-Line (S'COOL) project began in early 1997 with 3 participating teachers acting as test sites. In the nearly 6 years since then, S'COOL has grown by leaps and bounds. Currently over 1250 sites in 61 countries are registered to participate. On the face of it, this seems like a huge success. However, to ensure that this effort continues to be useful to educators, we continue to use a variety of evaluation methods.

S'COOL is a modest outreach effort associated with the Clouds and the Earth's Radiant Energy System (CERES) instrument of NASA's Earth Observing System. For most of its existence S'COOL has been run on the part-time efforts of a couple of CERES scientists, one or two web and database specialists, and a teacher-in-residence. Total funding for the project has never exceeded $300,000 per year, including everyone's time.

Aside from the growth in registered participants, the number of cloud observations is also tracked. 6,500 were submitted in the past year, averaging about 20 per actively participating class, for a total of over 15,000 observations to date. S'COOL participation has always been at the discretion of the teacher; we do not require a set number of observations.

Due to various difficulties with CERES data processing, only about 1,000 satellite matches to the observations are currently in the S'COOL database. However, examination of these matches has already provided some useful information about the problem of cloud detection from space.

Less objective information is provided by extensive surveys of teachers attending our summer teacher workshops (run for 4 years and reaching 78 teachers so far), the on-line EDCATS survey run by NASA HQ which we ask our teachers to fill out annually, and day-to-day interaction with teachers - whether participants, conference attendees, or other interested educators. A new survey instrument is being designed (the last participant survey was in Fall 2000) and will be administered to participating and non-active teachers this fall.

This paper will report the results of all these evaluation methods and will draw conclusions about the success of the S'COOL project.

URL: http://scool.larc.nasa.gov

ED11C-04 0930h INVITED

Museum Exhibitions: Optimizing Development Using Evaluation

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The Space Science Institute (SSI) of Boulder, Colorado, has recently developed two museum exhibits called the Space Weather Center and MarsQuest. It is currently planning to develop a third exhibit called InterActive Earth. The Space Weather Center was developed in partnership with various research missions at NASAs Goddard Space Flight Center. The development of these exhibitions included a comprehensive evaluation plan. I will report on the important role evaluation plays in exhibit design and development using MarsQuest and InterActive Earth as models. The centerpiece of SSIs Mars Education Program is the 5,000-square-foot traveling exhibition, MarsQuest: Exploring the Red Planet, which was developed with support from the National Science Foundation (NSF), NASA, and several corporate donors. The MarsQuest exhibit is nearing the end of a highly successful, fully-booked three-year tour. The Institute plans to send an enhanced and updated MarsQuest on a second three-year tour and is also developing Destination: Mars, a mini-version of MarsQuest designed for smaller venues. They are designed to inspire and empower participants to extend the excitement and science content of the exhibitions into classrooms and museum-based education programs in an ongoing fashion. The centerpiece of the InterActive Earth project is a traveling exhibit that will cover about 4,000 square feet. The major goal of the proposed exhibit is to introduce students and the public to the complexity of the interconnections in the Earth system, and thereby, to inspire them to better understand planet Earth.

Evaluation must be an integral part of the exhibition development process. For MarsQuest, a 3-phase evaluation (front end, formative and summative) was conducted by Randi Korn & Associates in close association with the development team. Sampling procedures for all three evaluation phases ensured the participation of all audiences, including family groups, students, and adults. Each phase of evaluation focused on the goals and objectives of the MarsQuest project. For example, the front end evaluation focused on uncovering visitors misconceptions about the planets Mars and Earth and determining how the MarsQuest exhibit could address these. The formative evaluation focused on testing how well a selection of prototyped exhibition components followed through with creating quality intergenerational experiences and learning. The summative evaluation examined the quality of science learning and critical thinking that took place as a result of visiting the final MarsQuest exhibition. Results from RK&As evaluation of MarsQuest and their front end evaluation of InterActive Earth will be presented.