Assessment

Assessing Student Understanding of Biological Concepts Using Simulation Software

Contributors: Eli Meir, SimBiotic Software; Judy Perry, Massacusetts Institute of Technology; Eric Klopfer, Massacusetts Institute of Technology

We'll show preliminary findings from a study we are conducting on using challenges posed to students in simulation environments as a means of discovering the students conceptual understanding of a subject in biology. To do this, we are recording all the students actions as they use the software, and attempting to correlate different sets of actions with different misconceptions. Along with our preliminary results, we'll also show a program we built for the study called OsmoBeaker which teaches diffusion and osmosis, and other teaching software we've made including EcoBeaker for teaching ecology, EvoBeaker for teaching evolution, and NerveWorks for teaching neurobiology.

Assessing the Influence of Curricular Change: Preliminary Problem-Based Assessments and Student Evaluations of Introductory Psychology

Contributors: Richard H. Ettinger, Eastern Oregon University; Marie Balaban, Eastern Oregon University; Charles Lyons, Eastern Oregon University

We are planning to change the Introductory Psychology sequence from a large lecture course to a course that combines lectures with inquiry-based lab activities. In order to evaluate changes in students' evaluations of the course and changes in their knowledge of basic experimental methodology, we collected baseline data from the lecture course during year one of this project. We will present the measures developed to examine students' reasons for enrolling in the course and their evaluation of the course, and will summarize the data collected during two terms of the baseline period. We will also present the problem-based assessment that we developed, and provide reliability for scoring this assessment and results from the two baseline terms.

Bringing Educational Relevancy to the First-Year College Experience by Bearing Witness to Social Issues

Contributors: Donald E. Stearns, Wagner College; Jonathan R. Peters, City University of New York, College of Staten Island

A working model is presented to meet a major academic challenge to educators of first-year college students: How can course content be shown to be of value to the student? The model presented consists of a learning community (LC) with an experiential component that clearly connects the student to the subject matter. The LC has an environmental theme and consists of a biology course and an economics course, coupled with an experience in the community (the Toms River Project), as well as a third course that is not taught using a traditional lecture format but instead is student interactive and allows for discussion and reflection regarding the LC theme and the experiential component associated with it. The effectiveness of the LC with and without the Toms River Project was analyzed using the same survey questions in 1998 (without the experience) and 1999 (with the experience). This LC was also compared with the other LCs presented in those years as part of the Wagner College First-Year Program. Results clearly show that the LC dramatically improved from 1998 to 1999. The 1999 environmental LC also stood out favorably when compared with the other LCs. We conclude that, when the experiential component of a learning community is relevant to the theme of the LC, project-based, and faculty-involved, the experience improves student interest, brings importance to the lecture material, stimulates critical thinking, and increases student understanding of civic responsibility.

Cohort and Problem-Based Learning in an Undergraduate Environmental Science and Policy Curriculum

Contributors: Travis Wagner, University of Southern Maine; Samantha Langley-Turnbaugh, University of Southern Maine; Merrie Cartwright, University of Southern Maine

The Environmental Science and Policy Program at the University of Southern Maine received a CCLI grant to increase environmental science and policy competency. The goal was to substantially increase the scientific literacy of students and create a working model for teaching undergraduates the process of scientific inquiry through involvement in scientific research on regional environmental problems. Our proposed approach was based on three major components. First, modify the curriculum by establishing a five-course sequence integrating problem-based cohort learning. The course sequence is Environmental Communication and Problem-Solving, Research and Analytical Methods, Environmental Statistics, Environmental Impact Assessment, and Senior Seminar. Second, select regional environmental problems for the problem-based learning component to enhance excitement of scientific research. Third, focus the curriculum around a grant-funded Inductively Coupled Plasma Emission Spectrometer. The outcomes from each course result in a comprehensive and evaluative student research portfolio to be presented during the senior seminar. The program is currently in its second year. The results thus far are mixed. First, there is difficulty in maintaining cohorts because of our unique student population, which is approximately 75% non-traditional students. These students tend to be part-time and have less flexible schedules. Second, state budgetary problems have presented substantial challenges to modifying program requirements to include the five-course sequence. Consequently, we have relied on persuasion of the program's benefits rather than by edict. Although, given our unique student population, the cohort aspect appears to be unattainable for the foreseeable future; we are convinced that the five-course problem-based sequence is invaluable. NSF Grant # DUE-0127017.

Implementation and Assessment of On-Line Gateway Testing

Contributors: Robert E. Megginson, Mathematical Sciences Research Institute; Gavin LaRose, University of Michigan

Gateway tests provide a means of assuring that students in reformed precalculus and calculus courses acquire the algebraic and computational skills needed in courses following these, while allowing the focus of the course to be on the conceptual under-

standing intrinsic to the reformed courses. However, logistical difficulties plague the pencil-and-paper administration of these tests, significantly decreasing their usefulness. To address these difficulties we have implemented an on-line version of the gateway tests that allows students to practice the skills on their own and take the test for a grade in a proctored environment. The development of this system was supported by the NSF CCLI Adaptation and Implementation program through grant #DUE-0088264.

LUCID: A Web-Based Learning and Assessment System

Contributors: David Hanson, Stony Brook University, SUNY; Troy Wolfskill, Stony Brook University, SUNY

The LUCID Project is developing a web-based learning and assessment system with curriculum materials for General Chemistry to assist students and teachers in improving student learning outcomes. The system provides guided-inquiry activities, a rich set of conceptual questions, exercises, and problems that can be used by students working individually or in teams. Team activities develop conceptual understanding and problem-solving strategies, and use a peer review process to assess open-ended responses. Responses to exercises and problems can be collected in a variety of formats, including multiple choice, multiple response, fill-in, and drag and drop, as well as discipline-specific responses such as chemical reaction equations and Lewis structures. These responses then are analyzed to identify competencies that students have and have not achieved. By tracking student learning in real time by both topic and level of mastery, feedback can be provided to help both students and teachers improve learning.

Novel Educational Materials and Assessment Tools for Undergraduate Quantum Mechanics Courses

Contributor: Richard W. Robinett, Pennsylvania State University

We present examples of some novel educational materials under development for use in undergraduate quantum mechanics courses, in conjunction with traditional textbooks. Included are samples of 1) animations, 2) worksheets for individual homework or collaborative projects, 3) a Resource Letter-type review of the pedagogical literature in quantum mechanics providing references taken from American Journal of Physics, European Journal of Physics, and the Journal of Chemical Education, 4) and a discussion of an assessment tool which has been developed to probe student understanding of quantum mechanical concepts, especially as elicited by visualization (the so-called Quantum Mechanics Visualization Instrument or QMVI) including data from sophomore-level modern physics classes, junior-senior level quantum courses for majors, and first semester graduate courses in quantum theory and quantum chemistry.

Separate Assessment of Problem-Solving Skills in General Chemistry

Contributor: Thomas Holme, University of Wisconsin, Milwaukee

While many chemical facts will be forgotten by the students who pass through the general chemistry classroom, the ability to approach problems from several perspectives represents an important skill that successful students gain. Despite this observation, the problem-solving skills are often assessed only implicitly, by determining if answers to assessment items are correct. This poster will involve attendees in identifying skills that are involved in general chemistry problems and then show strategies for devising assessment items that query them explicitly. The incorporation of this assessment strategy in general chemistry for engineering students will be noted as an example of the benefit derived from deconvoluting the skill assessment from the problem answer assessment.

Short-Term Pain for Long-Term Gain: Can One Semester of Inquiry-Based Study Have Sustained Impacts on Student Learning?

Contributors: Terry L. Derting, Murray State University; Claire Fuller, Murray State University

A nation-wide movement is underway to actively engage students in their learning. But what "amount" of active learning is needed to have a sustained impact on undergraduate students? Is one semester of intervention early in a student's academic program sufficient to affect learning two or three years later? During implementation of a new inquiry-based introductory biology curriculum, we compiled data to determine short- and long-term impacts on student performance in biology. Three areas of performance (i.e., knowledge gains, level of self-efficacy, and understanding of the process of science) were assessed in lower- and upper-level courses. Data from students who completed our two new first-semester courses are being compared with data for students enrolled in the old curriculum. Our results to date indicate that students who complete the new inquiry-based first semester courses have higher learning gains, greater self-efficacy, and a better understanding of science as a process compared with students in the old curriculum, including more senior students. A consistent positive relationship has been found between student performance on in-class assessments and student understanding of science as a process. In addition, increases in students' self-efficacy during the first semester have a synergistic effect on subsequent increases in self-efficacy. These results suggest that curriculum reforms in just a few courses can have a significant sustained impact on student learning. Although curriculum reform at the department or institution level is desirable, reform at smaller levels can be sufficient to significantly enhance learning.

The Geoscience Concept Test: Linking Grounded Theory, Scale Development, and Item Response Theory

Contributors: Julie Libarkin, Ohio University; Steven Anderson, Black Hills State University; William Boone, Indiana University, Bloomington

Over 5000 students from more than fifty universities and colleges nationwide participated in a study aimed at developing an assessment instrument for entry-level geoscience courses. Short, open-ended questionnaires from 1000 students and interviews with 200 students provided insight into ideas about the Earth held by entry-level students, and these ideas drove the development of test questions and answers. The test was created in two phases: a small, 29-item test was piloted in Fall 2002 and evaluated using item response theory and qualitative validation techniques. Based upon the success of this initial testing, a second set of 45 questions was

created for piloting in Fall 2003. Our experiences with the geoscience Concept Test indicate that 1) assessment questions created in direct response to student interviews are particularly useful in large-scale testing of student ideas; 2) a variety of qualitative and quantitative measures should be used when creating assessment instruments to ensure validity of the test design and application; and 3) many alternative ideas about the Earth are difficult to modify, as evidenced by small change between pre- and post-test scores nationwide.

Using the World Wide Web to Build Research Skills from Multiple Examples

Contributors: William S. Maki, Texas Tech University; Francis T. Durso, Texas Tech University; Sadie Alexander-Emery, Texas Tech University

Psychological research on learning and memory has long informed us that practice with multiple instances of structurally similar problems is beneficial to learning. However, psychological research methods textbooks show no signs of this understanding being put into common practice; important concepts often are reinforced with just a single example. As a remedy, our project was intended to develop evidence on the effectiveness of practice with multiple instances of similar problems related to concepts usually taught in a psychological research methods course and to use the web as a cost-effective means of delivering such problems. In two problem domains (identifying parts of research abstracts and identifying statistical interactions), we created short scenarios. The text for each scenario was linkable to terms in another text box. After completing matches, students could request feedback with which to evaluate their answers. Practice on several scenarios in each domain was rewarded with course credit. Learning was evaluated by comparing pre- and post-test scores for those students who did and did not work the practice problems. Scores significantly increased from pre- to post-test only for those students who worked the problems. Additional control procedures (including working the same problems as traditional paper homework) showed that the improvement was specific to the web-based treatment and was unlikely to be due to other uncontrolled factors (such as instructor or selection effects). Thus we have shown that it is possible to boost student learning of research methods skills by supplementing formal instruction with multiple examples delivered via the web.

Centers & Collaborations

Biologists — Are You Contributing to the Premier Clearinghouse of Biology Resources Sponsored by Professional Societies in the Life Sciences?

Contributors: Amy Chang, American Society for Microbiology; Yolanda George, AAAS; Marsha Matyas, American Physiological Society; Jason Taylor, Ecological Society for America

Do you know about the leading clearinghouse for peer-reviewed teaching and learning resources in the life sciences sponsored by leading professional societies in the life sciences? It's called Biosci Ed Net (BEN) and found at www.biosciednet.org/portal/. Do you know that you could submit your best works to BEN and have it reviewed by the community and published by the professional societies? Do you know that BEN was built for and by the community of undergraduate life science faculty? Do you know that BEN boasts more than 2500 peer-reviewed resources that can be downloaded and adapted for your students in your classroom?

Join me and learn more about how you can make this site work for you and your students. Find out why BEN and more than 21 professional society partners are committed to this resource. Learn how this collaborative effort was spearheaded by the American Association for the Advancement of Science (AAAS) and supported by professional society partners. The goals of BEN are to disseminate high quality, peer-reviewed materials, advance the scholarship of teaching and learning, and ensure excellence in life science education.

This presentation will be made by the American Society for Microbiology (ASM), one of the founding partners of BEN. The ASM sponsors MicrobeLibrary, (http://www.MicrobeLibrary.org) an online collection of peer-reviewed teaching resources for undergraduate microbiology education. MicrobeLibrary, established in 2000, contains still images, animations and video clippings; classroom activities and laboratory exercises that promote active learning; articles from Microbiology Education journal, Focus on Microbiology Education (quarterly magazine), ASM News; and reviews of books, multimedia programs and websites.

BEN and Microbelibrary are sponsored by the National Science Digital Library Initiative (DUE#00226185).

Building a GIScience Curriculum Integrating Five Disciplines Across Five Campuses in Maine

Contributors: Matthew Bampton, University of Southern Maine; Dave Hobbins, University of Maine, Fort Kent; Cathleen McAnneny, University of Maine, Famington; Joe Szakas, University of Maine, Augusta; Bill Wiegle, University of Maine, Machias

GIScience is a vital and rapidly growing field. As it is adopted as an essential skill in an increasing number of disciplines the need for well-equipped laboratories and high-quality training grows. Our project addresses this need. We are now half-way through a three-year CCLI-funded project in which we have built comparable laboratories and developed a consistent set of teaching materials to serve the needs of five CO-PIs working at five different campuses. Our original aim was to work within curriculum guidelines established by the National Council for Geographic Information and Analysis (NCGIA). However, developments in the field, challenges that have emerged in the course of implementation, and our formative evaluation process all indicate that a more flexible approach to developing GIScience curriculum produces better results. Each discipline, campus, and student constituency requires a significantly different approach to teaching GIScience. Balancing the benefits of curricular consistency with this diversity of needs is encouraging us to develop a teaching model based more on outcomes. We are not alone in reaching this conclusion, as is indicated in the Strawman report, published by the University Consortium for GIS in 2003 (http://www.ucgis.org/priorities/education/strawmanreport.htm).

Center for the Advancement of Engineering Education

Contributors: Cindy Atman, University of Washington; Robin Adams, University of Washington; Lorraine Fleming, Howard University; Larry Leifer, Stanford University; Sheri Sheppard, Stanford University; Karl Smith, University of Minnesota; Reed Stevens, University of Washington; Ruth Streveler, Colorado School of Mines; Jennifer Turns, University of Washington

The Center for the Advancement of Engineering Education (CAEE) addresses the critical national need to advance scholarship in engineering teaching and learning, increase the use of effective pedagogies in engineering classrooms, and strengthen the research and leadership skills of the engineering faculty and graduate student community. The specific goals of the Center are to understand and enhance the engineering student learning experience; integrate the needs of diverse faculty and diverse students into engineering education; strengthen the engineering education research base; expand the community of leaders in engineering education; and promote effective teaching for current and future faculty.

The core team consists of five partner universities: Colorado School of Mines, Howard University, Stanford University, and University of Minnesota, and University of Washington (lead).

Three major outcomes include: People: CAEE activities to build human resources in engineering education focus on advancing the scholarship of engineering education and on enhancing the engineering teaching skills of present and future faculty. Ideas: CAEE research activities will provide a strong base for understanding the engineering student learning experience of diverse groups. The Academic Pathways Study (APS) is studying engineering students at four of the partner schools and will be extended to a wider range of campuses in the last two years of the grant. Descriptions of student experiences ranging from entry level freshman contemplating engineering as a major to those in transition to a first engineering job will result. In addition to the APS, three smaller scale targeted studies are examining 1) the importance of difficult concepts in engineering learning, 2) the influence of technological fluencies in becoming an engineer and 3) the role of mathematics in engineering education and practice. Tools: CAEE will generate tools and resources for use in enhancing engineering education and the scholarship of engineering teaching. The research methodologies, instruments and results of the Academic Pathways Study will provide a basis for understanding the engineering student learning experience, improving engineering teaching, and generating further research activity. An Engineering Teaching Portfolio Program for graduate students will serve as a model for thinking about teaching decision making in the early stages of the engineering teaching experience. Three year-long Engineering Education Institutes will establish methodologies and processes for further collaborations of engineering educators to advance the scholarship of engineering teaching.

Computer Graphics Education and Collaboration

Contributor: Judith R. Brown, University of Iowa

A workshop supported by NSF DUE 99-06124 was held in Coimbra, Portugal in 1999 with outcomes ranging from recommendations for teaching computer graphics in computer science, discussion of the use of computer graphics to teach other disciplines, and discussion of the value of visualization for collaborations. A paper on "Enabling Educational Collaboration – a New Shared Reality" discussed national and international collaborations through networked virtual environments, featuring collaborations at The University of Iowa. This project was supported by NSF DUE 97-50537, "ENVISAGE: Environmental Visualization and Geographic Exploration." The Computer Graphics Educational Materials Source (CGEMS), an emerging online refereed repository for curricular materials related to computer graphics was a successful result of this workshop and is co-sponsored by ACM SIGGRAPH and Eurographics. Also, the discussion of the use of computer graphics for learning led to a workshop on Visual Learning in Snowbird, Utah, in 2002 and will be followed by a track on Visual Learning in the ACM SIGGRAPH/Eurographics Computer Graphics Education workshop in Hangzhou, China in June, 2004. In this workshop, we strive to gain Chinese input on visual learning and to recommend how to implement the ideas of visual learning into computer science and engineering curricula.

Developing a New Undergraduate Science Course Focused on Hispanic Students at the University of Texas at Dallas: Geography, Resources, and Environment of Latin America

Contributors: I. Pujana, University of Texas, Dallas; R.J. Stern, University of Texas, Dallas; C. Ledbetter, University of Texas, Dallas

This is a new lower-division science course entitled "Geography, Resources, and Environment of Hispanic America". It is an adaptation of a similar course "Geology & Development of Modern Africa" developed by Barbara Tewksbury, in 1995 at Hamilton College. The main objective of Tewksbury's course was to attract African American students to science, highlighting the cultural connection with their ancestral land. The fundamental assumption of our course is that a similar approach will work with Hispanics and other ethnic groups. Today Hispanics are the minority group lagging behind in educational achievement; but also the fastest growing segment of the U.S. population, with particularly rapid growth in the southwest U.S. and Florida. The Hispanic population in the U.S. is a heterogeneous group that shares a common language and historical roots. This group values their language and keeps very strong ties with the ancestral land, even after several generations. It is our opinion that this introductory science course related to issues facing Latin America in general, and Mexico in particular will appeal to Hispanics students, a group which is traditionally more interested in humanistic courses at the university level.

Geography, Resources, and Environment of Latin America is an interdisciplinary exploration of how the geologic evolution of Mexico, Central America, and South America has influenced the prehistory, history, culture, and economy of Latin America.

The course consists of 20 lectures ordered in modules and requires the student to present a report partnering with correspondents in Latin American universities.

The course begins with an overview of Latin American geography and geologic evolution followed by a series of modules that relate the natural resources and environment to the history, economy, and

culture of the region. Because the majority of Hispanics in the U.S and Texas (58 % and 85% respectively- U.S. Census Bureau 2001c) have roots in Mexico, this country is emphasized in our lectures, but it may be easily focused to other particular Hispanics subgroups as Puerto Ricans, Haitians, Cubans, or Brazilians.

Emphasis in Computational Science at Wofford College

Contributor: Angela Shiflet, Wofford College

Computational Science is a fast-growing field at the intersection of the sciences, computer science, and mathematics. Many interesting and important scientific problems require its interdisciplinary approaches. The field combines simulation, visualization, mathematical modeling, programming, data structures, networking, database design, symbolic computation, and high performance computing with various scientific disciplines. Despite the critical need for computational scientists, few programs and computational science textbooks appropriate for undergraduates exist. However, computers have become fast and cheap enough; networks have become sophisticated enough; scientific visualization has become mature enough; and the Internet has become pervasive and friendly enough so that a meaningful undergraduate computational science program is not only desirable but now possible.

Responding to the need and with the help of a National Science Foundation CCLI Proof-of-Concept Grant (0087979), Wofford College developed an Emphasis in Computational Science for interested science and mathematics majors. A student electing this program completes a Bachelor of Science, three existing courses (C++ Programming, Data Structures, Calculus I), two new computational science courses (Scientific Programming, Data and Visualization), and a summer internship. Interactive online modules (http://www.wofford.edu/ecs/) comprise the textbooks for the computational science courses. Along with algorithms and techniques, modules emphasize applications, such as predator-prey, rocket motion, enzyme kinetics, spreading of fire, and genomic sequence comparison. Students have been successful in applying what they have learned in internships at national laboratories, graduate school, and scientific positions. As Wofford's experiences demonstrate, schools can develop effective undergraduate computational science programs that can provide meaningful and needed educational opportunities for students.

Engineering Education Programs at NSF

Contributors: Sue Kemnitzer, National Science Foundation

The Engineering Education Program — an unsolicited program — has the goal to increase the quantity and quality of U.S. citizens who earn BS degrees in engineering. We welcome unsolicited proposals from faculty with cutting edge new ideas for undergraduate engineering education improvements. Target Dates for submission of proposals to this program are January 9 and July 9 of each year.

Grants for Department-Level Reform of Undergraduate Engineering Education (http://www.eng.nsf.gov/eec/funding/pgm_display.cfm?pub_id=5703&div=eec) support departmental and larger units to reformulate, streamline, and update engineering and engineering technology degree programs; develop new curriculums for emerging engineering disciplines; and meet the emerging workforce and educational needs of U.S. industry. These efforts should increase the relevance of undergraduate engineering curriculum to modern engineering practice and induce an increased proportion of students who enroll to complete engineering degree programs. The deadline for submitting proposals to this program is March 12 of each year.

Establishing a Community to Develop Engineering Courseware

Contributors: Joseph G. Tront, Virginia Polytechnic Institute and State University; Brandon Muramatsu, University of California, Berkeley; Flora McMartin, California State University

Faculty members attempting to create materials for collections of engineering education content in a digital library face several challenges. Lack of training in sound pedagogical practices, a shortage of training in the effective use of educational technology, short supply of required resources and time to produce completed and tested works, and a lack of emphasis on improved teaching in the university faculty rewards systems are the major obstacles to materials development. To remedy this situation, this project endeavors to create an active, engaged, and sustained virtual community of engineering educators who energetically contribute to and share materials from a common collection of courseware.

The virtual community is taking the form of an incubator in which faculty are trained in sound pedagogical practices e.g., developing learning goals and assessment techniques. Next, participants are being schooled in the effective use of technology in many different teaching/learning situations including: classroom presentation, self-study, distance and distributed learning, experiential learning, etc. Once trained, faculty will then develop a portion of a collection of courseware modules in their area of expertise. Guidelines will be provided so that modules can be integrated with one another from both the standpoint of technology as well as the pedagogical approach being used. Members of the virtual community of contributors subsequently become the testers of the courseware modules with each of the contributors using a subset of modules to conduct courses back at their home campuses. As soon as a baseline collection in a topic area is established we will present national workshops on how to adopt and adapt the materials in the collection. NEEDS and MERLOT will be used to catalog and make the collections available as well as provide broader peer reviews by a broader group of engineering faculty. This paper describes the first year of this research effort including the challenges encountered in this difficult enterprise.

Inquiry-Based Learning Modules for Conservation Biology Education

Contributors: Nora Bynum, American Museum of Natural History; Eleanor Sterling, American Museum of Natural History; James Gibbs, State University of New York, Syracuse; Malcolm Hunter, University of Maine; Ian Harrison, American Museum of Natural History

The world is facing a 'biodiversity crisis' — the loss of plant and animal species brought about by human activity. Despite recent increased attention to conservation biology training, there are widespread misgivings about the ability of current university curricula to prepare students to face the real-life problems they will encounter

routinely, or to integrate the goals of conservation biology with other, sometimes conflicting, goals of society. The Network of Conservation Educators and Practitioners (NCEP), a cooperative effort of the American Museum of Natural History and other institutions, addresses this challenge through the development of student-active teaching and learning modules that emphasize the application of critical thinking to conservation problems. The modules, intended as resources for undergraduate teachers, are a flexible resource rather than a rigid curriculum. Each module includes an expert synthesis of a key topic in biodiversity conservation, an easily modified classroom presentation, accompanying practical problem-solving exercises for the field and classroom, a teacher's guide to module use, and a collection of original scientific literature. Interdisciplinary case studies will also be included to highlight key topics and issues. The module topics fall under the following principal headings: Understanding Biological Diversity, The Biodiversity Crisis, The Human Context for Conservation, Tools and Strategies for Assessing, Managing, and Restoring Biodiversity, and Skills in Communication, Teaching, Research and Organizational Development. All materials will be disseminated for educational use at no cost <http://cbc.amnh.org/ncep>. A total of 50 NCEP modules are being developed under the auspices of CCLI (DUE-0127506).

Just-in-Time Teaching (JiTT) Across the Country: The Spread of a Strategy to Improve Student Engagement, Interaction, and Learning via Coordinated Web/Classroom Activities

Contributor: Evelyn Patterson, U.S. Air Force Academy

Just-in-Time Teaching (JiTT) is a pedagogical strategy that provides web support to students and instructors in active learning classroom environments. JiTT instructors adjust the daily classroom activity after reading student responses to strategically constructed web assignments which are due just hours before class. JiTT is now used in over 300 STEM and humanities courses at over 100 institutions across the U.S. and abroad.

This poster offers a glimpse of the current status of JiTT across the country. Examples of JiTT implementations by the CCLI grantees will illustrate the essence of JiTT. Sample web materials, student responses, in-class follow up activities, and student and faculty reflections on JiTT will be included.

The poster also introduces the next growth phase for the JiTT initiative – JiTTDL, the Just-in-Time Teaching Digital Library. The JiTTDL project will create a shareable collection of JiTT resources and materials and interconnect and grow the multidisciplinary JiTT community.

LabWrite: Students Learning Science through Writing Better Lab Reports

Contributors: Michael Carter, North Carolina State University; Eric Wiebe, North Carolina State University; Miriam Ferzli, North Carolina State University

The laboratory report, which is the predominant form of extended writing in lab science classes, offers the potential for learning science. Research in writing to learn science suggests that lab reports encourage learning not only by inviting students to reflect on what they have done in the lab but also, through the format of the report itself, by guiding students in thinking scientifically about the lab experience. The problem, though, is how to take advantage of the potential of writing to learn in the laboratory setting. The obstacles are many: labs are frequently run by teaching assistants and other instructors who have little training or investment in writing to learn; introductory chemistry labs often rely on fill-in-the-blank reports; even when students write lab reports, the only instruction they receive is a list of the parts of the report; and evaluation of reports typically focuses on right answers rather than guiding the scientific thinking embodied in the report.

This poster presents one solution to this problem: LabWrite (http://labwrite.ncsu.edu), a set of online, just-in-time instructional materials that have been shown to significantly enhance science learning, both learning the scientific concept of labs and learning to think scientifically about labs. The poster describes the LabWrite project, presents data from a control-group study, and offers the opportunity to explore the LabWrite site. LabWrite is free and universally accessible online.

Leadership in Transforming Undergraduate STEM: The PKAL Experience

Contributor: Jeanne L. Narum, Project Kaleidoscope

PROJECT KALEIDOSCOPE—PKAL—is an informal alliance taking a lead in the national effort to transform the undergraduate STEM learning environment. PKAL's vision is of an environment "...in which all American undergraduates have access to learning experiences that motivate them to persist in their studies and consider careers in these fields; it is of an environment that brings undergraduates to an understanding of the role of science and technology in their world. It is vision that calls for attention to practices and policies that affect shaping the curriculum and building the human and physical infrastructure to sustain strong programs. It is a vision that calls for collective action" (PKAL 2002). Thus, PKAL focuses on developing leaders for this collective action, by providing easy access to the ideas, insights and experiences of leading agents of change through the weekly PKAL web publication: what works, what matters, what lasts; hosting workshops and seminars through which leadership teams from campuses around the country analyze their current circumstances and set an agenda for future action; supporting leaders implementing those agendas for action; establishing regional, topical and virtual networks through which the work of leaders can be enhanced and sustained. For more information, please visit: http://www.pkal.org.

Mathematical Biology Course for a Mixed Audience

Contributor: Janet Andersen, Hope College

Mathematical Biology is an ever-expanding field that benefits greatly from its interdisciplinary nature. At Hope College, we have created a mathematical biology course co-taught to a mixed audience of biology and mathematics students. The course is based on biology research papers and includes wet labs. We will discuss the format of the class, details of research papers and labs, student reactions, and outcomes from the course. The biology topics include Ecology and Neuroscience. The mathematical topics include Linear Algebra and Differential Equations.

Mathematics Throughout the Curriculum

Contributors: Marc Frantz, Indiana University; Daniel P. Maki, Indiana University; Bart S. Ng, Indiana University-Purdue University Indianapolis

The Indiana University Mathematics Throughout the Curriculum Project (MTC) is an NSF-sponsored curriculum development initiative. MTC involves faculty from all eight Indiana University campuses, as well as Franklin & Marshall College in Pennsylvania and the University at Buffalo (SUNY). To date, MTC participants have developed and taught 24 interdisciplinary courses, most of which were developed by two-member teams consisting of a mathematician and a faculty member from another discipline. The goal of these courses is to change students' attitudes towards mathematics by having them experience it in the context of solving and understanding authentic problems from disciplines close to their own lives and interests. MTC is now in the third year of a three-year, no-cost extension of our grant, and we continue to disseminate our courses and materials through national meetings and residential workshops for teachers. Assistant Director Marc Frantz will be present to answer questions and provide written information on workshops for summer 2004. (NSF-DUE 95-55408.)

Multithreaded Instruction: Forming Multi-Disciplinary Research Groups to Improve Undergraduate Education

Contributor: Chris Rogers, Tufts University; Caroline Cao, Tufts University; Doug Matson, Tufts University; Judith Stafford, Tufts University; Marina Bers, Tufts University; Eric Wang, University of Nevada, Reno

The Idea: Building a team of students to solve an engineering problem typically only has engineers. Our goal is to have more than engineers; include human factors students, computer scientists, and child development majors. These new members of the team do not have many of the preconceptions of the engineers and require the engineers to learn better communication skills. At the same time, they learn confidence in engineering from the engineering students.

Outcomes: After the first year, the 10 students found the interdisciplinary aspect of the program to be its greatest highlight. They liked working on something new and unknown, and found they developed better relationships with faculty. Overall they rated the Academy experience between very good and excellent and all said they would definitely recommend the Academy to their peers. They thought that the main limitation of the Academy was it should include more than just seniors, and should emphasize communication across disciplines earlier on in the year.

Associated Web Links:

- http://www.tuftl.tufts.edu/users/EngEdu/robotics_academy
  The Academy page with project descriptions.
- http://www.ceeo.tufts.edu/robolabatceeo
  The teacher support material for lego engineering in the classroom.

POGIL - Combining Process Skill Development with Guided Inquiry to Strengthen Student Learning

Contributors: David Hanson, Stony Brook University; Rick Moog, Franklin & Marshall College; Jim Spencer, Franklin & Marshall College; Frank Creegan, Washington College; Andrei Straumanis, College of Charleston; Diane Bunce, Catholic University of America

We have developed an instructional strategy that we call POGIL (Process-Oriented Guided-Inquiry Learning) that provides opportunities to teach both content and key process skills simultaneously. In a POGIL classroom or laboratory, students work in small self-managed groups on specially designed guided-inquiry materials. The instructor serves as a facilitator of learning rather than a source of information. POGIL materials include printed full-course and modular activities as well as web and CD-based deliverables, and are based on research that reveals how students learn most effectively. Activities guide students through an exploration to construct understanding while developing higher-order thinking skills. The NSF-supported POGIL National Dissemination Project provides regional one-day and three-day, in-depth faculty development workshops, on-site consultancies by experienced POGIL users, and opportunities for on-line chats. This poster presentation will provide details on POGIL pedagogy and materials, assessment, and faculty workshops and mentoring.

Politics and Public Perceptions of Prescribed Fires for Endangered Species Management

Contributors: Diana Marti, Florida Atlantic University; Hank Smith, Florida Park Service; Brady Harrison, Florida Park Service

Savannas Preserve State Park in Florida is experiencing an environmental crisis due to anthropogenic fire suppression. Many threatened and endangered species of plants and animals are losing more of their habitat year after year. Contrary to a frequent public misperception, the lack of fires in scrub habitats is the reason Savannas is in such turmoil. Scrub habitats are pyrogenic, meaning they are adapted to, and need, seasonal fires to maintain natural species diversity.

Fire suppression has been the dominating policy in Savannas and in the United States for many years. However, after much research, wildland scientists have realized that fire is necessary in many forests. Laws such as the Endangered Species Act provide funding for species protection. The Florida Prescribed Burning Act authorizes and promotes the use of prescribed fire for wildlife/wildland management.

Savannas Preserve lies on what is normally called a "wildland/urban interface". Homes and other suburban infrastructure come dangerously close to the fire-suppressed, heavy fuel loads in the Preserve. If and when a natural catastrophic fire occurs, these properties will be in great danger of being consumed by fire.

In order to conserve the rapidly disappearing scrub-adapted wildlife, the Florida Park Service plans to reduce fuel loads by conducting small, low-level, prescribed fires, which will restore the scrub habitat to an earlier successional stage, and thereby reduce the danger of a catastrophic fire in the Preserve, and in the neighboring communities.

The poster will include a PowerPoint laptop presentation, GIS maps, photographs of the Savannas wildland/urban interface, and information researched during the course of my study.

Preparing Women for the Technological World

Contributors: Glenn W. Ellis, Smith College; Baaba B. Andam, Smith College; Susan Etheredge, Smith College; Thomas Gralinski, Amherst Public Schools; Alan Rudnitsky, Smith College; Gail Scordilis, Smith College

The Smith College engineering and education departments have formed a partnership with the goal of educating women to succeed in our modern technology-oriented society. Through an NSF BEE program grant and private support, the partnership has focused its efforts in two areas. The first is designing our undergraduate engineering curriculum in a way that is consistent with the research on how people learn and the research on attracting and retaining women in science and engineering. An important component of this curriculum is helping students appreciate the human condition and humanity's relationship to the environment. Technical content is taught with an emphasis on understanding and applying fundamental principles to a range of topics. The delivery of the curriculum is based upon learner-centered principles. These include helping students take control of their learning by developing learning goals, reflecting and evaluating their progress towards these goals, and organizing their knowledge in ways that support understanding and transference. Continuum Mechanics I—a required, sophomore-level course—is presented to illustrate our approach.

The second focus area is including engineering as a fundamental element of our teacher education curriculum. To help teachers integrate engineering into the K-12 classroom, we have developed a technology/engineering certification program, integrated engineering into our education methods courses, developed an engineering education workshop for pre-service and in-service teachers and developed K-12 engineering learning modules.

Science Education for New Civic Engagements and Responsibilities (SENCER)

Contributors: William David Burns, Association of American Colleges and Universities; Karen Kashmanian Oates, Association of American Colleges and Universities; Eliza Reilly, Association of American Colleges and Universities; Patti Simon, Association of American Colleges and Universities

SENCER stands for Science Education for New Civic Engagements and Responsibilities, a comprehensive, national dissemination project funded by the National Science Foundation.

SENCER aims to improve undergraduate science education and stimulate civic engagement through the design and development of courses that teach "to" basic science "through" complex, capacious, and unsolved public issues.

The SENCER Summer Institute (SSI) strengthens faculty leadership and institutional capacity through a team-based, intensive, residential development program for faculty, administrators, and graduate students from institutions who wish to initiate SENCER approaches or improve and expand SENCER activities already underway at their institutions.

Each year, the SENCER Summer Institute brings together teams from about 30 U.S. colleges and universities, along with a cohort of Institute alumni, advance representatives, and international delegates who are implementing SENCER projects in their own institutions and countries. Invited institutions receive grant awards to support their teams' attendance and the achievement of SENCER goals on their campus. Nearly 130 colleges and universities have participated in the SENCER Summer Institute since 2001.

The next Summer Institute will be held at Santa Clara University, August 6-10, 2004.

StatCrunch.com: Web-Based Data Analysis for Education

Contributor: Webster West, Integrated Analytics LLC

StatCrunch is an easy-to use data analysis package that is freely available via the Web at http://www.statcrunch.com. Providing students with access to affordable statistics software has long been a challenge. StatCrunch was created so that students might have better access to this type of software both while taking a Statistics course and afterwards. A complete description of the numerical and graphical analysis procedures available in StatCrunch will be presented with special emphasis placed on the user interface, which was constructed so that students can easily generate analysis results. A number of unique StatCrunch features that highlight the educational use of the product will also be discussed.

The Impact of an Undergraduate Research Experience at Murray State University

Contributor: Kelly Jo Boarman, Murray State University

Before starting my undergraduate research project, I did not know what scientific research had to offer. After several semesters and a summer of working in an organic chemistry laboratory, I am now aware of the endless opportunities available to those who choose a research-based career. My experience in an organic chemistry research lab has enabled me to learn research techniques, using equipment like that made available to universities through the CCLI program for advanced laboratories, that one simply cannot learn in a classroom setting or from a standard "cookbook-like" laboratory. My project involves the preparation of various butadienes and the study of the photochemistry of these compounds. My faculty mentor and I have published our results in a peer-reviewed journal. The most significant outcome from my experience, however, is that my career plans have changed. At one point, I had intended to be a druggist at a loc al drug store. Today, because of the opportunity I had to engage in research as an undergraduate, I intend to pursue a graduate degree that will enable me to actively engage in pharmaceutical research.

The Mathematical Sciences Digital Library

Contributors: Lawrence Moore, Duke University; Frank Wattenberg, United States Military Academy

The Mathematical Sciences Digital Library (MathDL) is the Mathematical Association of America's collection in the National Stem Digital Library Program. Current features of MathDL include the Journal of Online Mathematics and Its Applications

(www.joma.org), a refereed online journal with emphasis on online interactive learning materials in mathematics, and Digital Classroom Resources, the Association's collection of reviewed online resources in mathematics. This poster features:

- MathDL Books Online: These are interactive online course materials. Currently under development are materials for a mathematical modeling course and materials for a single variable calculus course.
- MathDL's collection of Lite Applets created by Frank Wattenberg and his colleagues at The United States Military Academy. These are short interactive online materials that can easily be repurposed for a variety of uses.

The Mind Project®: A Student-Faculty Research and Curriculum Project in the Cognitive and Learning Sciences

Contributors: David L. Anderson, Illinois State University; Robert Stufflebeam, University of New Orleans

The Mind Project® (http://www.mind.ilstu.edu) is a web-based interdisciplinary curriculum in the cognitive and learning sciences (primarily for undergraduates). The emphasis is upon interdisciplinary modules, active learning and assessment, interactive presentation of content, and online experiments. Although the curriculum is being used by faculty across the country (partners in our Consortium on Cognitive Science Instruction), most of the content modules are being developed by cognitive science experts at Illinois State University, Indiana University, and the University of New Orleans. The curriculum includes introductions to fundamental concepts and research methods in neuroscience, psychology, linguistics, anthropology, computer science, robotics, as well as the philosophy of cognitive science. Here are some of the more prominent examples: interactive introductions to neurons, neurotransmission, LTP, neuroimaging, computer modeling, computation, connectionism, dynamical systems, and consciousness; virtual labs for conducting experiments in neuroscience, anthropology, and robots; Smarts software for conducting studies in artificial life, reinforcement learning, and interactions between organism and environment; software for studying and building Turing machines; software for completing visual search experiments, experiments in signal detection theory, EEG experiments, apparent motion experiments, and memory scanning experiments. One module is a Virtual Neuroscience Lab where students implant microsensors in a rat-brain, gather data on the rat's behavior caused by the presence of various neurotransmitters, and interpret the data concluding with the virtual "publication" of a journal article. In addition to curriculum, The Mind Project® is a Learning Community of scientists, educators, K-12 teachers and students working to develop a comprehensive archive of downloadable cognitive science content.

Undergraduate Learning through Research: Lessons Learned from CCLI Grants to Primarily Undergraduate Institutions

Contributors: Jill Singer, Buffalo College; Lori Bettison-Varga, College of Wooster; Elaine Hoagland, Council on Undergraduate Research

The Council on Undergraduate Research has monitored the NSF CCLI program through its changes over the years. We have observed the impact of CCLI on Primarily Undergraduate Institutions (PUIs) and have made recommendations to NSF based upon our observations. This poster will review some indications of improvement in undergraduate learning attributable to the CCLI Program, including use of CCLI funds as a catalyst for undergraduate research and other forms of experiential learning. Evidence comes from articles in the CUR Quarterly, presentations at CUR conferences, and a survey of CUR members who have applied for CCLI grants.

Writing Peer-led Team Learning Workshops

Contributor: David K. Gosser, City College of New York

The Peer-led Team Learning model of undergraduate science instruction offers new dimensions in student participation and faculty involvement. Writing a good PLTL workshop requires faculty to shift their instructional thinking from an expository model to an inquiry model. Workshops make use of a variety of different learning styles, and utilize model building, practical simulations, problem-solving flowcharts, and simple pedagogical methods to engage students with the subject and with each other.

A Collaborative Computational Sciences Program

Contributors: Jim Sochacki, James Madison University; Alade Tokuta, North Carolina Central University; Bill Ingham, James Madison University; Dorn Peterson, James Madison University; Dave Pruett, James Madison University; Debra Warne, James Madison University; Paul Warne, James Madison University

The Departments of Mathematics & Statistics and Physics at James Madison University (JMU) and the Department of Mathematics & Computer Science at North Carolina Central University (NCCU) developed a joint program in Computational Science. Several courses have been created and enhanced by our "A Collaborative Computational Sciences Program" award. The award allowed us to obtain and build state of the art computing facilities.

At JMU the two departments have created a joint concentration in Computational Sciences that now has two tracks; one in Fluid Mechanics and the other in Solid Mechanics. A track in Acoustics is currently being developed. Our presentation will discuss our origins in 1999, our curricular expansion in 2003, and exciting recent developments that hold considerable promise for involving diverse facets of the University and greater community in aspects of computational science. The motivation for the latter was a highly successful student-faculty initiative in summer 2003—a 48-node video center—which is in the process of evolving into a state-of-the-art 72-node Computation and Visualization Center.

At NCCU the Department of Mathematics & Computer Science has built a state of the art scientific visualization room and has

enhanced and created several courses. The department has also been working with faculty in several other departments to incorporate scientific computing in their undergraduate courses.

This presentation will consist of learning modules, software tools, course outlines, web pages and videos showing the different ideas and tools that have been an outcome from the "A Collaborative Computational Sciences Program" award.

Faculty & Teacher Development

A Problem- and Reasoning-Based Curriculum for Preservice Elementary Educators: Understanding Mathematics Deeply for Teaching

Contributors: Judith Flowers, University of Michigan, Dearborn; Rheta Rubenstein, University of Michigan, Dearborn; Angela Krebs, University of Michigan, Dearborn

The Understanding Mathematics Deeply for Teaching (UMDT) Project addresses the need for improved mathematics courses for future elementary teachers. The project will create four instructional units on CDs each with detailed lesson guides and an assessment package constituting the core of an exemplary, replicable model for teacher education. The poster will describe this curriculum project.

The units are constructed from exemplary problem- and reasoning-based elementary and middle school curricula and from research on mathematics learning. Samples of adapted activities will be posted illustrating how the school curricula are being modified: (1) the level of challenge of activities is scaled up, (2) activities focus on major ideas that are highly connected to many other fundamental ideas, and (3) relationships among ideas are being emphasized. The poster describes the well-documented difficulties experienced by future elementary teachers who enroll in these courses as well as the difficulties experienced by their instructors.

The poster will present samples of adapted activities, student work, and student responses on assessment items. The preliminary results of a pre-post survey designed to gather data about students' experiences, perceptions, and suggestions will be displayed.

An Ecosystem-Based Biology Teaching Methods Course

Contributors: Rosemary J. Smith, Idaho State University; Sharolyn J. Belzer, Idaho State University

This project adapts elements of two funded CCLI projects to improve the preparation of biological sciences teachers. The goal is to locally address a national need: better preparation of pre-service K-12 science teachers in inquiry-based instruction. Pre-service teachers learn how to increase their students' perceived relevance of science by basing lesson plans on the local Idaho ecosystem. The project provides equipment loans and other support services, designed to help students implement the inquiry-based lessons during their student teaching at regional K-12 schools. The target course, Biology Teaching Methods, enrolls 20 students per offering. It is usually taken just before students enter student-teaching positions at regional schools. The 3-year project has four outcome-based objectives: a) develop and test 30 inquiry-based lesson plans focused on the regional ecosystem, b) redesign the course, ensuring all students have at least 3 opportunities to individually practice inquiry-based teaching, c) provide students practice setting up, using and troubleshooting modern laboratory equipment suitable for K-12 instruction, and d) create a resource center that provides loan equipment, lesson plans and other support. The equipment-loan component is vital, as many regional schools are rural and lack resources. Several students have already availed themselves of the equipment loans. In the first year, there were measurable improvements in teacher content knowledge, technological skills, and teaching skills. Five new inquiry-based lessons are in development and the native plant garden and resources are expanding. Lesson plans and the project components are disseminated on the web and have broad application throughout the western U.S.

GridForce: A Comprehensive Educational Framework for Preparing our Workforce for Grid Technology

Contributor: B. Ramamurthy, University at Buffalo, SUNY

Our project began as a simple adaptation of grid technology in CS-based undergraduate curriculum. It has evolved into a comprehensive framework GridForce (Grid For Research, Collaboration and Education) encompassing (i) curricula for a sequence of courses, (ii) laboratory exercises supporting the courses, (iii) grid hardware infrastructure to support the labs, (iv) research work to collaborate with the grid community, and (v) seminars to industry and peer educators. In this poster we present details of the GridForce framework. For the courses and labs we provide the grid-based curriculum, syllabus and schedules used, descriptions of sample lab exercises, outcome assessment questionnaires, lectures slides and code sources. To support grid-based labs we have assembled two lab infrastructures: one reusing old Sparc4s and another with newer Dell Blades. The hardware and software required for the infrastructures and instruction for their implementation will be discussed. We have planned a seminar on grid technology to local industry. The Center for Industrial Effectiveness at University at Buffalo is a collaborator in this venture. We will share with peer educators, the resources for organizing such seminars. Our exploration of grid for educational purposes has resulted in innovative research projects such as resilient grid and grid-based high trust computing, the details of which will be outlined in our poster. We will also discuss our experience in overcoming difficulties we faced during the implementation of this project. In summary, our poster will lay out a complete suite of resources for people who want to introduce grid technology in their environment. This project is partially supported by the grant NSF DUE CCLI A&I: 0311473

Implementing WeBWorK™ In the CSULB Teacher Training Curriculum

Contributors: Angelo Segalla, California State University, Long Beach; Alan Safer, California State University, Long Beach

The overarching goal of this project is to adapt and embed WeBWorK™ in the mathematics pre-service teacher training curriculum. With the addition of WeBWorK™ to the existing teacher training curriculum, we aspire to create exemplary educational support materials for the mathematics curriculum in the middle, high school and community college.

We focus on training future teachers to use this successful web-based homework tool as well as training working teachers already in the field. Shown by recent research to be an effective homework tool, and that WeBWorK™ increases the consistency and completion rates of mathematics homework at the university level, we wish to transport this effectiveness and success to the K-14 system, where because of exogenous demands on teachers' time, less attention may be given to good homework habits. WeBWorK™ requires some attention to detail on the part of the teacher, but in return it pays big dividends on less time spent on grading (or even just checking) homework. Its use as a quiz checker is especially successful.

Thus far in this project we were able to initiate WeBWorK™ training sessions in six teachers training classes at CSULB. In addition, we presented workshops at several K-12 districts. In both cases, WeBWorK™ was seen as having the potential to improve the learning of mathematics by encouraging students to complete their homework.

We will share some the materials we have developed thus far, the type of classes we are addressing, and we will report some pre-service teacher comments about WeBWorK™. We believe this project exemplifies NSF's philosophy of STEM education.

Knot Theory for Preservice and Practicing Secondary Mathematics Teachers

Contributors: Neil Portnoy, Stony Brook University, SUNY; Thomas Mattman, California State University, Chico

This two-week curriculum module focuses on the problem of classification of knots with particular attention to the knot invariant, the Jones polynomial. A mathlet, based on the state-sum, or "lake and island" picture of knots proposed by Kauffman (1988), illustrates the Jones polynomial in a dynamic, visual context.

Since knot theory draws on connections with diverse types of mathematics, this module will integrate well into undergraduate courses such as geometry, topology, combinatorics, discrete mathematics, or graph theory.

Preservice and practicing teachers will learn mathematics in a coherent fashion that emphasizes the interconnections among theory, procedures and applications; experience mathematics as a (product of) human endeavor instead of as a fixed body of knowledge understandable (or creatable) only by a few experts; develop the habits of mind of a mathematical thinker by having opportunities to generate and explore conjectures.

Please consult our web page for up to date information about our project: http://www.csuchico.edu/math/mattman/NSF.html

Mathematics Across the Curriculum: A Statewide Project

Contributors: Rebecca Hartzler, Edmonds Community College; Deann Leoni, Edmonds Community College

In 1999, Rebecca Hartzler and Deann Leoni began the Mathematics Across the Curriculum project at Edmonds Community College. The project quickly expanded beyond the College and now involves over eighty faculty from high schools and two- and four- year colleges throughout Washington State. Participants in the MAC project represent a variety of disciplines which include Anthropology, Art, Art History, Biology, English, Health, History, Physics, Political Science, Social Services, Sociology, Spanish and Theater.

The purpose of MAC is to support faculty as they develop curricula that integrates mathematics and/or quantitative reasoning into existing courses. Some faculty are merely making the mathematical dimensions of their disciplines more explicit for their students, some are creating projects and assignments for an existing course, and others are creating entirely new courses or learning communities that integrate quantitative skills throughout. Four-day summer institutes are the center of the project where faculty are given time and resources to create classroom-ready materials. Resources include an on-site library and computer lab with web access; consultants from other MAC projects around the country; workshops on topics such as statistics, graphing using Excel, and Ethnomathematics; and examples of assignments and projects from experienced MAC participants.

In this poster presentation, handouts will be provided with examples of classroom-ready materials that are also available online at http://mac.edcc.edu. Also available will be results from student attitudinal surveys, student interviews, and faculty interviews which are being used to assess the success of the MAC project.

Moving Bioinformatics into Mainstream Biology

Contributor: Sandra Porter, Geospiza Inc.

Bioinformatics tools and resources have become essential for many types of biological research. These tools are starting to enter the classroom at many different levels, but have yet to become widely used in undergraduate biology. We have developed animated tutorials, along with data sets and laboratory activities, that empower students and teachers to engage in biological research with bioinformatics resources, in a time-efficient way. The tutorials enhance the usability of the resources and allow teachers to assign activities without having to explain every step that students must follow. Many of the tutorials and supplementary materials are available online at http://www.geospiza.com. Data will be presented on behavioral changes in teachers who have used these materials in workshops.

On the Cutting Edge: Supporting Communities of Scholars in the Geosciences Using Topical Workshops and Web-Mediated Resources and Services

Contributors: David W. Mogk, Montana State University; Cathryn A. Manduca, Carleton College; R. Heather Macdonald, College of William and Mary; Barbara J. Tewksbury, Hamilton College

A combination of face-to-face workshops and web-mediated resources and services has proven to be an effective way to create and support communities of scholars to improve STEM education in both emerging and well-established disciplinary fields. A workshop on the emerging topic "Teaching Biocomplexity in the Geosciences" brought together early leaders in the field to explore the questions: what do we mean by biocomplexity, how and where are we teaching biocomplexity in the geosciences today, and what are the connec-

tions between biocomplexity and Earth system science? Other activities included demonstrations of successful biocomplexity teaching programs, a poster session, creation of an action plan for future development, use of a listserv for continued networking, and development of a collection of digital resources to support instruction (e.g. resources on complex systems, ecology, diversity and evolution, coupled human-natural systems, coupled biogeochemical cycles that can be accessed through the NSDL and DLESE). A topical workshop on one of the "core" disciplines of the geosciences, "Teaching Petrology in the 21st Century," has helped to reinvigorate instruction in this field through community-wide discussions of learning goals, current practice, examples of "what works" and alternate pedagogies, and a review of the relationship of petrology to the rest of the geoscience curriculum. Supporting web-mediated resources and services include: collections of activities, examples and related digital resources (e.g. PowerPoints maps, images) that support learning in petrology, a syllabus posting tool, a registry of analytical instruments, and continued support for working groups via the web and listservs.

Face-to-face workshops help to develop a critical mass of dedicated and connected instructors. The web-mediated resources support pre-workshop preparation, activities at the workshops, continued support for the attendees, as well as mechanisms to recruit and support additional contributing members. The websites host all workshop materials and resources and continue to grow in content and use (e.g. 2000 visits/month for Petrology).

Related URLs:
- http://serc.carleton.edu/NAGTWorkshops/index.html
- http://serc.carleton.edu/NAGTWorkshops/biocomplexity/index.html
- http://serc.carleton.edu/NAGTWorkshops/petrology/index.html

On the Cutting Edge: Improving Faculty Ability to Design Innovative Courses

Contributors: Barbara J. Tewksbury, Hamilton College; R. Heather Macdonald, College of William and Mary; Cathryn A. Manduca, Carleton College; David W. Mogk, Montana State University

The method that faculty use most commonly for designing courses and developing course syllabi involves making a list of the most important topics in a discipline, culling topics until the list is of reasonable length, arranging the topics in a logical order, and developing syllabus, lectures, labs, assignments and exams around the list of topics. While this produces a course with thoughtful topical coverage, the approach lacks introspection in terms of what goals a faculty member has for students in the course beyond mastery of content.

As part of a workshop program for faculty development in the geosciences, the NSF-funded program On the Cutting Edge has developed and offered workshops for geoscience faculty that guide participants through a stimulating process designed to help faculty members articulate goals and design effective and innovative courses that both meet those goals and assess outcomes. The process begins, not with a list of content items, but with setting goals by answering the question, "What do I want my students to be able to do on their own when they are done with my class?", rather than the question, "What do I want my students to know in this subject?" Choosing content items follows, as does selection of specific teaching, assignment, and assessment strategies to accomplish the goals. Participants leave the workshop with concrete plans for designing or redesigning a course and indicate enthusiastically that the process helped them completely rethink the course design process. Our poster will illustrate examples of the impact of the workshop on participants' courses.

The process is not geoscience specific and can be applied readily for designing courses in other disciplines. At our poster, we will provide guidelines for faculty who are interested in trying the process for designing their own courses.

On the Cutting Edge: Preparing the Next Generation of Geoscience Faculty

Contributors: R. Heather Macdonald, College of William and Mary; Barbara J. Tewksbury, Hamilton College; Cathryn A. Manduca, Carleton College; David W. Mogk, Montana State University

Many faculty arrive at their first faculty positions with little preparation for teaching and for working with undergraduate and/or graduate research students. The NSF-funded program On the Cutting Edge has offered annual four-day workshops that provide an opportunity for early career geoscience faculty to learn about a variety of teaching approaches, assessment techniques, successful strategies for developing and maintaining an active research program in their current setting, and various approaches for advising/supervising undergraduate and graduate research students. Workshop participants also leave with examples of assignments and activities for various courses, strategies for balancing competing demands, a support network of other early career faculty, and a plan for managing their early career as an academic. Most participants also attend a one-day visit to the National Science Foundation. On the Cutting Edge offered the first in a series of annual workshops for geoscience graduate students and post-doctoral fellows on preparing for an academic career in August 2003. The workshop included sessions designed to help participants become more effective teachers, stronger candidates for academic jobs, and better prepared for a quick start to teaching and research in the next stage of their career. It also included a panel of early career faculty from a variety of institutions. Participants from each of the workshops left with an expanded base of ideas and strategies, a network of new colleagues, and a specific action plan for the coming year. These workshops have been highly successful based on participant evaluations.

For more information, please visit:
- http://serc.carleton.edu/NAGTWorkshops/earlycareer03/
- http://serc.carleton.edu/NAGTWorkshops/careerprep03/

On the Cutting Edge: Web Resources Helping Faculty Improve their Teaching

Contributors: Cathryn A. Manduca, Carleton College; David W. Mogk, Montana State University; R. Heather Macdonald, College of William and Mary; Barbara J. Tewksbury, Hamilton College; Robert Mackay, Clark College; Dorothy Merritts, Franklin & Marshall College; Rebecca Teed, Carleton College

The web provides new opportunities for faculty to share materials and expertise that can improve their teaching. On the Cutting Edge (http://serc.carleton.edu/NAGTWorkshops/) is one of several NSF

funded projects at the Science Education Resource Center (http://serc.carleton.edu) that is developing on-line resources to assist faculty. Resources include:

- Exercises, labs, and activities for use in courses supplemented with notes for faculty that can be searched by scientific topic.
- Information about teaching methods with associated examples ready for classroom use.
- Course goals, syllabi and supplementary material to assist faculty in designing courses.
- Topical collections of resources addressing both content areas (e.g. biocomplexity) and pedagogical issues (e.g. designing web-based learning resources; using data to teach science; teaching quantitative skills in the geosciences, assessment).
- A discussion of the application of research on learning to the geosciences with essays by leading researchers, and a bibliography.

While the materials are directed primarily at geoscientists, the discussions of pedagogic methods are equally applicable in all scientific fields. Methods include setting goals, role playing, using interactive cases, Socratic questioning, and teaching with models. Teaching materials include examples of principles from biology, chemistry, physics, and mathematicians applied to real-world problems.

The SERC site currently receives 14,000 visitors per month with more than 2,000 visiting five or more pages. Evaluation indicates that faculty value the strong link between information about teaching and useable examples. A strength of the collections is the involvement of workshop participants and other leaders in education in development and review.

Preparing Future Teachers to Teach an Interdisciplinary View of Biology with Evolution as a Theme

Contributors: Katrina Mangin, University of Arizona; Lisa Elfring, University of Arizona

Biology Teaching Methods, BIOC 434, at the University of Arizona, prepares future high school biology teachers by using evolution as a theme, adapting exemplary materials from diverse sources, and having students conduct a long-term experiment. The course is taught as a collaboration between an experienced high school biology teacher and a University science educator. The one-semester course covers units typically covered in a one-year high school biology course. Evolution is addressed first and forms the foundation for the rest of the content. Student misconceptions and learning are addressed for each of the "big topics" in the course with pre- and post-tests. Among our findings: Collaboration with a practiced secondary teacher in the design and teaching of the course was very effective. Using the organizational scheme of the high school biology text grounded students in the material they would teach and provided ideas for activities in the classroom. Students had more misconceptions in their understanding of evolution than any other topic. Implementing complex technology requires considerable pre-course time for instructor training. Vernier probeware is good for a classroom laboratory and poorly suited for field trip use. Curriculum adapted in the course includes 1) GEMS guides (Global Warming, Discovering Density), 2) Biology: A Human Approach (BSCS, Kendall Hunt), 3) Teaching about Evolution and the Nature of Science (NAP, 1998), 4) The Private Eye, Technology adapted in the course includes Vernier sensors used with Palm Pilots and Vernier interfaces.

Problem-Based Learning in an Integrated Geosciences Course for Future K-8 Teachers

Contributors: Dave Dempsey, San Francisco State University; Isabel Quita, San Francisco State University

We have created a course for future K-8 teachers that attempts to meet the following objectives:

1 Meet the National Research Council's National Science Education Standards for science teaching (pedagogy), assessment, and geosciences content (including integration across geoscience disciplines).
2 Meet new California state preK-8 teacher preparation standards for science skills and abilities, earth and space sciences content, and use of instructional technology.
3 Help students learn to use computer-based instructional and information technologies and to evaluate WWWeb materials critically.
4 Using a problem based learning approach, help students learn to work collaboratively to tackle real-world geoscience problems, especially those with social implications, and to communicate their findings to others.
5 Help several Department of Geosciences faculty members learn to apply student-centered pedagogical strategies such as problem-based and inquiry-based learning, and to assess the results.

The course content is organized around several real-world, ongoing, geoscience-related problems in the San Francisco Bay area that require perspectives from geology, meteorology, oceanography, and even astronomy to address. Students work on these problems in permanent, collaborative groups of three or four. Much of our subject-matter instruction supports the real-world problem-solving assignments, and often employs small-group collaborative activities, computer-based exercises, and the internet. Three field trips also support the students' problem-solving efforts.

Science That Matters — A Standards-Based, Interdisciplinary Course Sequence and Materials for Non-science Majors and Future Teachers

Contributors: Robert Potter, University of South Florida; Gerry Meisels, University of South Florida; Teresa Flateby, University of South Florida; Donald Trisel, Fairmont State College

Improving science education is essential for a society with increasing reliance on technology. A new, two-semester science course sequence has been designed to address this need for non-science majors and future teachers at the University of South Florida and several partner institutions. The courses, Science That Matters I & II, fulfill general education requirements and provide a strong grounding in the National Science Education Standards. The course content is constructed from modules that are completed within approximately three to four weeks, and that contain interesting and relevant topics focusing on major science concepts. Inquiry approaches, critical thinking and student's ability to formulate rational arguments and explanations are emphasized throughout the courses. Each module includes lesson plans with clear learning

outcomes, background materials selected from existing textbooks, explicit active-learning strategies and suggested assessments. Three years of piloting multiple sections of this course have revealed positive impacts on student's attitudes about science and on their degree of scientific literacy. We use student focus groups a modified SALG, (Student Assessment of Learning Gains) survey and ACT (Test of Science Reasoning) to evaluate students. Volumes I & II, containing selected modules, are available from Kendall/ Hunt Publishers and the courses are part of the AACU/NSF sponsored SENCER program. Similar courses based on this model were implemented and evaluated in fall 2003 at St. Petersburg College, Hillsborough and Manatee Community College in Florida, Middlesex Community College in Massachusetts and at Fairmont State College in West Virginia.

Sustainable Scalable Systemic Faculty Development

Contributors: John R. Jungck, Beloit College; Ethel Stanley, BioQUEST Curriculum Consortium

The BioQUEST Curriculum Consortium has organized and led over a hundred Faculty Development workshops for groups of ten to forty STEM faculty from around the U.S. and about two dozen foreign countries. Workshops last from four days to two weeks and have been offered for the past eighteen years. Participants are challenged to experience science curriculum reform that requires investigative, collaborative, quantitative, and communicative skills. Over the course of a workshop, they spend roughly one third of their time working as a student, a professor of a single course, and a curriculum developer. Each professor/participant is asked to peer review curricular materials (simulations, problems, investigative cases) that have been designed through research and vetted in multiple classrooms and laboratories around the nation. We believe that networking, collaboration, and peer review are crucial to faculty development, to the development of materials that are transferable, scalable across different class and institutional size with students from diverse age, class, and ethnic backgrounds, sustainable for many years, and capable of achieving systematic reform at the national level.

Most science faculty find classroom and laboratory education very different from their research lab experiences and culture; therefore, we invoke a similar environment of shared, collective work which is actively debated, reviewed, and published in peer communities. We focus on the development of materials that are designed to help students learn long-term strategies of research, rigorous quantitative skills, and an understanding of cultural values of publication, priority, and peer review. While we share a common pedagogical philosophy based on problem posing, problem-solving and peer persuasion, we encourage participants to develop distinct approaches to instantiating such learner-centered curricula relevant and appropriate to their contexts. We deliberately recruit and select participants from the beginning, middle, and senior periods of their teaching/scientific careers so that mentoring and cross-cohort exchange is encouraged. Finally, the network is maintained by actively writing letters of recommendation for retention, tenure, promotion, awards, mobility, and grants. The perseverance of the Consortium is crucial to community members who are taking considerable risks when they experiment extensively in their teaching; the presence of colleagues who are supportive is important. Sustainability is not just a matter of maintaining a good working relationship with funders, but is also a function of providing a viable, valuable service that continues to be germane to the needs of participants as they progress through their career, that sustains peer support, and empowers them as future leaders in curriculum development.

The Center for Workshops in the Chemical Sciences (CWCS): An Overview

Contributors: Jerry C. Smith, Georgia State University; Emelita Breyer, Georgia State University; David Collard, Georgia Institute of Technology; Lawrence Kaplan, Williams College

The Center for Workshops in the Chemical Sciences (CWCS), http://chemistry.gsu.edu/cwcs, offers intensive, five-day workshops on diverse topics in the chemical sciences (broadly defined) with the goal of enhancing chemical education primarily at the undergraduate level. The target audience is faculty specifically involved in undergraduate instruction in two-year, four-year, or research institutions. Postdoctorals and advanced graduate student committed to teaching at the undergraduate level may also attend these workshops. The workshops consist of lectures and some form of hands-on activity; participants are also provided with tested materials that may be readily incorporated into their teaching activities. There are no costs to attend these workshops. Thus far in the initial funding cycle, the CWCS program has offered 31 workshops; 16 workshop sites have been utilized. Some 457 participants from 282 institutions representing 45 states plus the District of Columbia, Guam and Puerto Rico have been served by the program. Activities supported by a second funding cycle will resume in the spring of 2004; a schedule is available on the CWCS website. An overview of the program and results from an ongoing long-term evaluation of the impact of this program will be presented in our poster.

The Impact of NSF Support on Professional Activity at a Liberal Arts College

Contributors: Mario Belloni, Davidson College; Wolfgang Christian, Davidson College

The NSF CCLI-EMD program funded the Open Source Physics Education project in 2002. This project's goal is to create new open source applets as well as to nationally disseminate curricular material based on these applets. The material we are developing as part of this grant encompasses a wide variety of topics: introductory physics, computational physics and upper-level physics. This, however, was not the first NSF grant we received. Early cost-sharing grants had tremendous local impact and led directly to the goals that are being realized in the current grant. At Davidson College, NSF programs have been essential in supporting professional development and in supporting the development, dissemination, and assessment of curricular materials.

This poster will describe the past, present, and future of curriculum development at Davidson College focusing on the unique local and national deliverables that were created as a direct result of NSF support.

This work has been supported by the National Science Foundation under: USE-9050438, USE-9054144, DUE-9752365, and DUE-0126439.

Laboratories

16S rRNA: Molecular Methods in Environmental Systems

Contributor: Daniel B. Oerther, University of Cincinnati

Increasingly, environmental engineers use molecular biology tools in research projects to track microorganisms. To teach molecular biology skills to undergraduate and graduate engineering students as well as practitioners, we developed a novel learner-centered, hands-on lab course where participants perform step-wise procedures to identify individual phylogenetically-defined microbial populations in an environmental sample. Following self-paced video exercises, students work in teams to extract genomic DNA, conduct PCR amplification of 16S ribosomal RNA genes, clone and sequence 16S rRNA genes, and develop fluorescently labeled oligonucleotides to perform fluorescence in situ hybridizations. Grading is based upon the preparation of a peer-review quality manuscript by each team, short recall-based quizzes for individuals, and a one-on-one oral final examination with the instructor. This course has been successfully taught for four years to approximately 35 undergraduate and graduate students in Civil and Environmental engineering as well as 15 graduate students in Biomedical engineering, Electrical engineering, and Medicine. A one-day version of the course has been successfully delivered to 40 adult practitioners of environmental engineering. In the near future, our expectation is to expand this course beyond the University of Cincinnati and to demonstrate that this course can be successfully transferred and taught at a beta-test site. Financial support for this project comes from NSF CCLI DUE-0127279, NSF CAREER BES-0238858, and the Ohio Environmental Protection Agency.

A Laboratory for Studies in Reliable Electric Power Delivery

Contributors: Xiaoguang Yang, Drexel University; Anthony Madonna, Drexel University; Karen Miu, Drexel University; Chika Nwankpa, Drexel University

With recent power outages, a renewed focus on the reliable delivery of electric power has emerged. In addition, the restructuring of the electric utilities and the rapid installation of new automated components has created the need for engineers with formal knowledge about electric power distribution automation and control. In response, at Drexel, we have developed a power distribution systems curriculum centered on a Reconfigurable Distribution Automation and Control laboratory, RDAC. This poster will present (i) the hardware design and capabilities of RDAC [ASEE2002] and (ii) educational laboratory experiments designed to restore electric power in case of faults.

Advanced Laboratory for Lightwave Communication

Contributors: Judith Donnelly, Three Rivers Community College; Randall Seebeck, Three Rivers Community College

Wavelength division multiplexing (WDM) revolutionized the fiber optic industry, resulting in a demand for technicians with experience not only in fiber installation but also in using high end instrumentation to test passive and active optical components. The Advanced Lightwave Laboratory project builds upon the earlier Lightwave Communication Laboratory (NSF-ILI) by creating a hands-on curriculum where students learn the use of sophisticated test and measurement equipment and then use the equipment to investigate commercially important WDM devices and systems. Adapting the exemplary curriculum for advanced lightwave technology developed by the National Center for Telecommunications Technologies (NCTT), we have developed laboratory experiences to enrich five separate courses.

An Integrated Internet-Accessible Embedded Systems Laboratory

Contributors: David Jeff Jackson, University of Alabama; Kenneth G. Ricks, University of Alabama; William A. Stapleton, University of Alabama

This project seeks to develop, evaluate, and disseminate an integrated Internet-accessible embedded systems laboratory and associated instructional materials. Development of this laboratory will involve the adaptation and implementation of four key ideas from several prestigious institutions. The laboratory will rely on new educational pedagogies to enhance the learning experience of our students in three degree programs – Computer Engineering, Electrical Engineering, and Computer Science.

The project describes clear objectives, outcomes, rationale, and plans that are based on (a) published work describing the need for an increased emphasis on embedded systems, (b) other successful educational programs in this area, and (c) new pedagogies (e.g. teaming) in engineering education. The evaluation plan is multifaceted with both formative and summative processes and includes input from students, other educators, and industrial representatives.

The project will develop and disseminate a substantial amount of instructional material on embedded systems – an important, emerging educational area. It also will provide complete documentation on the design and use of an Internet–accessible laboratory model. This model, applicable to other disciplines, provides students access to expensive, sophisticated equipment either remotely or in a hands-on mode, as appropriate to the educational goals. The dissemination plan outlines specific strategies for involving a group of interested faculty at other institutions and for promoting the ideas and materials through a website, conference and journal publications, and faculty workshops.

An Integrated Signals and Systems Laboratory Using TIMS

Contributors: Lance C. Perez, University of Nebraska; Robert D. Palmer, University of Nebraska; Jerald L. Varner, University of Nebraska

The Department of Electrical Engineering at the University of Nebraska, Lincoln (UNL), is implementing an integrated signals and systems laboratory experience in its undergraduate curriculum. The laboratory experience uses a common experimental platform, the Telecommunications Instructional Modeling Systems (TIMS), throughout a sequence of four courses at the junior and senior levels. The four courses are in systems area with an emphasis on communications systems. The TIMS platform consists of a basic

system unit and card modules that implement components of analog and digital communications systems as well as ancillary functions, such as amplification, filtering and interfacing to external test and measurement equipment. By combining modules, virtually any basic analog or digital communication system may be realized. The modular design of the TIMS unit makes it extremely flexible and allows new functions to be added as communications technology advances. Each TIMS unit is supplemented with a multichannel digital oscilloscope, an arbitrary waveform signal generator and a spectrum analyzer. All of the test and measurement equipment is connected to a PC that enables real time screen captures and electronic laboratory notebook and report preparation. In this poster we present examples of experiments designed using TIMS and study results concerning the impact of the laboratory on student outcomes.

An Integration of Chemistry, Biology, and Physics: The Interdisciplinary Laboratory

Contributors: Gerald R. Van Hecke, Harvey Mudd College; Kerry K. Karukstis, Harvey Mudd College; Richard C. Haskell, Harvey Mudd College; Catherine S. McFadden, Harvey Mudd College; F. Sheldon Wettack, Harvey Mudd College

As a new venture to integrate research and education, a section of the first-year laboratory sequence known as the Interdisciplinary Laboratory was introduced to the Harvey Mudd curriculum during the 1999-2000 academic year and continues to be offered. The Interdisciplinary Laboratory or "ID Lab" brings together laboratory experiences from Biology, Chemistry, and Physics for the first-year student. Taught by a team of faculty from each of these disciplines, the course further seeks to illustrate commonality of investigative methods and laboratory techniques in these sciences in addition to introducing discipline-specific principles. This poster will describe the eight experiments performed over the year long laboratory course giving details on the nature of the experiments conducted and illustrating how the three disciplines are connected in each experiment. In addition this poster will provide further information on the course philosophy and mechanics as well as student reactions to this innovative and novel laboratory course that were derived from a variety of assessment tools.

An Introductory Physics Workshop for Engineering Students

Contributor: Stephen Thornton, University of Virginia

In 1998-99 a joint University of Virginia physics-engineering task force recommended, on the basis of the ABET 2000 criteria, a restructuring of the two-semester problem session/labs for 500 engineering students. The results of physics education research in the 1990s suggested a stronger reliance on computer-based tools and new methods of instruction and grading. We adopted a revised Real Time Physics curriculum as the basis for our new two-hour per week workshop/laboratory in introductory physics. We placed computers, interfaces, and probes on tables for three-student teams to work together collaboratively. Some of our most popular and successful labs are those we used previously that were adapted to computer control and/or analysis. In keeping with the NSF CCLI - A&I philosophy, we utilized as many exemplary commercial products as possible, including PASCO's Data Studio software and probes. WebAssign is used for pre-workshop student preparation and for post-workshop evaluation. The pre-workshop assignment, similar to the Just-in-Time Teaching philosophy, has been successful in having students come to the workshop more prepared. Students, working in groups of three during the workshop, do not write lab reports, but make individual predictions, answer questions, and submit group experimental results. Both students and faculty are more pleased with the current workshop/lab than the previous cookbook labs. Both pre- and post-course evaluations have been done using well-known diagnostic instruments, but because the post-course evaluations have not counted towards any part of the grade, the students have rushed through them, and the results are suspect.

Applications of Spectroscopy in Problem-Based Laboratories

Contributors: Houston Byrd, University of Montevallo; Stephen O'Donnell, University of Montevallo

One goal of our CCLI-A&I grant was to enable students to expand their knowledge base from learning concepts to solving problems through the application of modern instrumentation. We upgraded a CW-NMR to a FT-NMR and then developed our students' analysis and instrumentation skills by the introduction of project-based laboratories. We implemented a series of spectroscopic labs in the second semester of general chemistry. Students synthesize aspirin, characterize their products by FTIR and FT-NMR and analyze commercial aspirin using AA, HPLC, and UV-vis. This process introduces them to capabilities of modern instrumentation and teaches them important laboratory techniques. This exposure lays a foundation upon which we can build our higher-level courses. In the junior year, the experiments become more sophisticated with open-ended questions for them to answer in a project-based laboratory. In this type of lab, students are presented with a question about the mechanism for a well-studied reaction between and alcohol and an acid. Students search the literature, find a mechanism and experimentally validate their proposed mechanism. They present their result and defend their conclusions. This poster will demonstrate these methods by focusing on the use of the FT-NMR in general chemistry and will track a student's project-based lab on the kinetics of the esterification of trifluoroacetic acid with a series of alcohols, XCH2CH2OH, with X = H, Me I, F, etc. This lab goes beyond the traditional esterification experiment by investigating the relationship between the inductive effects of X, the rate of the esterification and Quantum Mechanical calculations.

Archaeology and Technology: Hands on the Past to Build Skills for the Future

Contributors: Kelley Hays-Gilpin, Northern Arizona University; Francis E. Smiley IV, Northern Arizona University; George J. Gumerman, Northern Arizona University

An NSF undergraduate science education instrumentation and laboratory improvement grant provides the nucleus of Northern Arizona University's archaeology program. We founded the new Centennial Undergraduate Materials and Imaging Laboratory in 1998 to house new equipment, teaching collections, and lab facilities. The program continues to grow and ramify. NAU anthropology students conduct research, give professional quality presentations, produce posters and websites in their new laboratory/classroom, and take their skills

and equipment to field schools in Northern Arizona and Peru. Our "corporate partners," local cultural resource management firms, and tribal cultural preservation firms work with student employees here. Electronic media interns from the communications college work with anthropology faculty to develop an interactive K-12 media based on native cultures of the Grand Canyon. We work with the National Park Service to train employees, many of whom are former NAU students. To satisfy students' natural curiosity about the past and Native cultures, they must engage in critical thinking about time, spatial patterns, materials, and cultures. We promote investigative skills in physical sciences, quantitative methods, microscopy, and mapping/Geographic Information Systems. We encourage visual, written, and verbal communication skills through electronic media.

CALISYS - Delivering Experiential Laboratory Exercises with Reduced Resources

Contributors: Scott A. Morton, University of Wyoming; Donald A. Smith, University of Wyoming; Robin K. Hill, University of Wyoming

CALISYS (computer aided laboratory instruction system) combines hands-on experiential discovery laboratory exercises with computer-aided instruction. The system, currently under development, is expected to enhance laboratory learning and understanding while significantly reducing the time, equipment, staffing and space requirements. CALISYS is composed of two generalized, interactive software modules. The first presents the selected laboratory problem through initial questioning and then assesses the student's learning of the experimental concepts after completion of the experiment. The second module guides the student through setup of the experiment with onscreen experimental design and setup, monitors the experimental effort, provides feedback during the laboratory exercise, and grades the student's performance. This poster shows a spring deflection experiment embodiment of a CALISYS experiment and shows initial results from a CALISYS fluid flow experiment.

Calvin-Rehoboth Robotic Twin Telescopes

Contributors: Lawrence Molnar, Calvin College; Deborah Haarsma, Calvin College; David Van Baak, Calvin College

With partial funding from a CCLI Adaptation and Implementation grant, Calvin College has purchased two robotic telescopes for use with all levels of undergraduate instruction. The first is located on campus, affording students hands-on experience, while the second is at a dark sky site in New Mexico, and is run remotely by student observers. Our poster will illustrate:

1) the equipment challenges presented by the requirement of reliable, unattended, remote observing. For example, software upgrades are installed and tested from out of state (not entirely unlike the process of reprogramming the Mars' rovers from Earth).

2) the wide range of experimental opportunities offered by such equipment. For example, students can apply Kepler's laws to determine the orbits of asteroids they discover!

3) the pedagogical and practical benefits of having an accessible duplicate system. For example, modifications needed on the remote system may be more conveniently developed and tested on the local system.

4) our curricular plans both for use by undergraduates and high school students. For example, the efficient nature of unattended observing makes it possible to offer significant observing time to teachers in feeder high schools, as a way to enhance interest in science among those students.

Chemical Structure and its Importance in the Environment: An Alternative Introductory Course for Chemistry Majors at Bates College

Contributor: Thomas J. Wenzel, Bates College

The first half of a two-semester introductory general chemistry course that relates fundamental chemical concepts to the study of the environment will be described. The two-course sequence satisfies the general chemistry prerequisite for all upper-level chemistry courses and the chemistry requirement for the B.S. degree. In addition to presenting general chemistry in the context of a relevant theme, the course emphasizes the process of how chemists conduct scientific investigations. In the lab, students undertake a semester-long laboratory project in which they investigate whether plants grown in lead-contaminated soil take up more lead than those grown in uncontaminated soil, and whether the lead uptake is a function of the acidity of the rain water. Working in teams, the students are given considerable autonomy over the design and execution of the investigation. Once the plants are growing, other experiments are integrated into the laboratory experience until harvest time. The difficulty of obtaining definitive answers, when studying something as complex as the environment, is demonstrated throughout classroom and laboratory activities. The course also emphasizes the connection of chemistry to other scientific disciplines such as biology and geology. Lastly, the course examines how scientific investigations simultaneously influence, and are influenced by, social forces. Whenever possible, the classroom portion of the course is taught using cooperative, group learning methods. The emphasis on group methods in the class and lab is designed to show how chemists typically work with others in investigating and solving problems, and to give students experience working with others in a professional setting.

CLICS: A Computational Laboratory for Information and Computer Security

Contributors: Andrew T. Phillips, University of Wisconsin, Eau Claire; Paul J. Wagner, University of Wisconsin, Eau Claire

In recent years, computer and information security issues have become increasingly significant for business, industry, and government, leading to an immediate need for increased computer security education through undergraduate level computer science curricula. To this end, the CLICS: Computational Laboratory for Information and Computer Security project at the University of Wisconsin – Eau Claire seeks to help through four specific objectives. These objectives are:

1. to develop a sophisticated heterogeneous computer and information security laboratory that adapts and extends a laboratory model already in place at the Indiana University of PA. A key feature of this laboratory is that during the computer security course scheduled instruction periods, it will be structured to simulate a typical corporate computing environment connected

to the Internet; at other times it will be fully functional for use in more general courses in computer science.
2. to adapt and develop computer and information security curriculum (both stand-alone courses as well as separate course modules) to better educate and train students in this area. The first of the courses will adapt and extend a pair of existing courses, Cybersecurity Basics (COSC316) and Network Security (COSC356), already offered at the Indiana University of PA. The second of the courses will adapt and further develop a Cryptography course (COSC427) soon to be offered for the first time at the Indiana University of PA.
3. to use this adapted laboratory and curriculum as the foundation for a formal application by UW – Eau Claire to become a Center for Academic Excellence in Information Assurance Education, as certified by the National Security Agency (NSA).
4. to make optimal use of university, department, and both federal and private grant resources by adapting and implementing this laboratory and curriculum in a way that builds on current resources at our university, as well as by using ideas and work done at other universities.

This poster will provide specific details on the completed implementation of both stand-alone courses (Computer Security, Cryptography and Network Security) as well as a variety of separate and independent course modules. In addition, specific details will be provided on the successes and challenges of creating and administering the heterogeneous "dual-purpose" computer security laboratory.

Collaborative Investigation of Mechanical Chaos and Electron Optics in the Advanced Physics Laboratory

Contributor: Marty Johnston, University of St. Thomas

Recent physics education research has emphasized the success of collaborative approaches in teaching introductory physics. The aim of this project is to expand this model of instruction to teaching and learning advanced experimental techniques. Working collaboratively, as they would in many technical job environments, students learn and develop hands-on skills and knowledge in an equipment-intensive course. The course is centered on two experimental problems: detecting and measuring signatures of chaos in a driven, mechanical oscillator and designing and characterizing a simple, low energy electron gun housed in a small vacuum system. These problems were chosen because of the breadth of instrumentation they involve and the skills students will acquire. In the process of conducting the two experiments, students work with computer interfacing and modeling, modular instrumentation, vacuum techniques, and instrument design. By working together on the same problem and discussing the experimental techniques presented in a closely coordinated lecture, students develop both individual competence in a variety of laboratory skills and the ability to work productively in a group. The course has been offered twice, with excellent results, particularly in terms of increased student readiness for independent research projects and internships. Work funded by the University of St. Thomas and NSF grant DUE-0126849.

Converting Cookbook Laboratories into Inquiry

Contributors: Frank Schmidt, University of Missouri, Columbia; Sandra Abell, University of Missouri, Columbia; John Adams, University of Missouri, Columbia; Jim Carrel, University of Missouri, Columbia; Jan Weaver, University of Missouri, Columbia

We are developing laboratory exercises to support a novel inquiry-based course for undergraduates who are not STEM majors. The course models the activities of professional scientists as a means of teaching scientific method and content. We present student laboratories that model the professional literature, albeit within a defined context, reasoning that students exposed to laboratory material in this manner are able to translate this introductory material into their own experiments. The material consists of a set of experiments presented in literature format and a guidebook for faculty to adapt their own experiments to this format.

Creating Laboratory Access for Science Students

Contributors: Michele Wheatly, Wright State University; Holly Slack, Wright State University

Wright State University was built to be architecturally barrier-free, and enjoys educating a large population of students with physical disabilities. The CLASS project is an interdisciplinary initiative that aims to create universally accessible science laboratory and field exercises. Activities have included a workshop to train educators on issues of accessibility; creation of a Source Book for science educators; production of training videos to raise consciousness among large groups of educators at professional meetings; development of an on-line course; a summer science camp for students with disabilities; and resources for regional museums/aquaria on issues of access. In addition to the deliverables available to the education community, the CLASS project has engaged in a research piece through studying the training of pre- and in-service educators in issues relating to disability. Attitudes toward teaching science to students with disabilities can be significantly changed through involvement with the CLASS project. Many of the adaptations that we recommend for use in labs are not costly! Further, they benefit ALL learners in the course. Individuals with disabilities remain significantly underrepresented in the sciences and the associated professions. Please join our efforts to reverse this trend.

Developing and Disseminating New Laboratories on Plant Molecular Genetics and Genomics

Contributors: David A. Micklos, Dolan DNA Learning Center; David Jackson, Cold Spring Harbor Laboratory

A comprehensive set of plant genetics and genomics laboratories, based on rapid and reproducible PCR chemistry, has been developed. Using the model plant Arabidopsis and important food crops, the laboratories illustrate key concepts of gene and genome analysis, including: the relationship between phenotype and molecular genotype, genetic modification of plants and detection of transgenes in foods, and linkage and bioinformatic methods for gene mapping. Students will also have the unique opportunity to explore functional genomics by assisting CSHL researchers with the cellular analysis of Arabidopsis genes of unknown function. An Internet "super site" will

support the laboratories with online protocols, custom analysis tools, shared databases, and collaborative bulletin boards and chat systems.

The proposal is comprised of an initial development phase (Year 1), culminating in a focus workshop of faculty advisors drawn from two- and four-year colleges representing six regions of the United States. During the dissemination phase (Years 2 and 3), faculty advisors will organize weeklong training workshops to reach 144 instructors. Applied Biosystems, Bio-Link National Center for Advanced Technological Training in Biotechnology, Carolina Biological Supply Company, and Cold Spring Harbor Laboratory Press have committed to provide key assistance to the project.

Equipment for an Undergraduate Microfabrication Laboratory

Contributors: David J. Lawrence, James Madison University; Brian H. Augustine, James Madison University; William C. Hughes, James Madison University; Gerald R. Taylor Jr., James Madison University

The objective of this project is to expand the capabilities and utilization of our Microfabrication Laboratory to enhance student instruction and undergraduate research. This cleanroom laboratory is used to give undergraduate students hands-on experience with microfabrication technology and reinforces the fundamental understanding provided through classroom instruction. The CCLI grant enabled the purchase of a three-source magnetron sputtering system capable of both dc and rf operation, which was received and installed in June 2002. This system, and other equipment in the Microfabrication Laboratory, has been used extensively by students in courses offered by the JMU Center for Materials Science and three academic departments (Chemistry, Physics, and Integrated Science and Technology). During the summer of 2002 and the summer of 2003, twenty one undergraduate students from JMU and other institutions, one high school student, one high school teacher, and four JMU faculty members used the Microfabrication Laboratory for research projects that were sponsored by the National Science Foundation (Materials Science REU Program, NSF DMR 00-97449) and by the JMU Center for Materials Science. Students used the new multi-target deposition system to deposit metals (aluminum, titanium, nickel, chromium, vanadium, and gold) and dielectrics (SiO2 , HfO2 , and VOx) for their projects, which involved materials characterization, sensor fabrication, light emitting diode fabrication, microfluidic device fabrication, dielectric studies, self-assembled monolayer studies, and other topics. Several presentations and publications have resulted from this work. This poster presentation will describe how the multi-target sputter deposition system has enhanced undergraduate instruction and undergraduate research at JMU.

Experiments with Single Photons

Contributor: Matthew Pysher, Colgate University

I present experiments that investigate the properties of light at the single photon level. According to the laws of quantum mechanics, when a photon is given a choice between two indistinguishable paths, the probabilities of the photon taking each path combine to form an interference pattern. By sending single photons through an interferometer with two identical paths, such that it is impossible to determine the path taken by the photons, we observe photons interfering with themselves. In an experiment known as the quantum eraser, we destroy this interference by introducing a distinguishable characteristic in one of the interferometer's paths. We then show that this distinguishing information can be erased through optical manipulation, thereby restoring our original interference pattern. These experiments were conducted as a part of my junior research seminar at Colgate University.

Experiments with Single Photons for Undergraduates

Contributors: Enrique J. Galvez, Colgate University; Charles H. Holbrow, Colgate University

We have developed a set of laboratories for undergraduates that underscore the quantum nature of light. Advances in the field of Quantum Information have led to the development of affordable equipment and simple techniques for doing experiments with single photons. These developments make it feasible to do experiments on the fundamentals of quantum mechanics in the undergraduate setting. Our experiments fit in a 2x4 ft optical breadboard, and once aligned, produce beautiful data very easily. These experiments can be used in conjunction with an introductory course in quantum mechanics, where laboratory experiments or even demonstrations are scarce. Some of the experiments address fundamental issues of quantum mechanics, such as quantum superposition, locality and quantum interference. This work was funded by NSF grant DUE-9952626.

Extremely Halophilic Microorganisms as Models for Teaching Molecular Microbiology and Bioinformatics

Contributor: Richard F. Shand, Northern Arizona University

Extremely halophilic (salt-loving) microorganisms are found in all three domains (Archaea, Bacteria and Eucarya) and thrive in hypersaline environments that are saturated or nearly saturated with salt (e.g., the Dead Sea and the Great Salt Lake). Moreover, they have been shown to survive inside salt crystals that are dated to 250 million years! Haloarchaeons (extreme halophiles from the domain Archaea) are excellent models for teaching molecular microbiology and bioinformatics as (i) they are interesting to students as "extremeophiles" (ii) they are easy to culture; (iii) cultures are not easily contaminated; (iv) cells are easily lysed liberating DNA, RNA and proteins; (v) mRNA half-lives are much longer than bacterial mRNA half-lives; (vi) they produce small, robust protein antibiotics (called "microhalocins") that have been well characterized; (vii) they are easily recovered from surface salt deposits or from hypersaline brines; and (viii) the Halobacterium NRC-1 genome has been sequenced and microarrays have been made. An entire Molecular Techniques Laboratory course has been designed around haloarchaeons. Some of the laboratory experiments include: (i) resuscitation of novel extreme halophiles from samples from a nearby open-pit salt mine and characterization by amplification of 16S rDNA by PCR; (ii) partial purification of a microhalocin by gel filtration chromatography; (iii) cloning a microhalocin gene; (iv) correlation of microhalocin production and microhalocin transcript levels with growth physiology; and (v) designing and executing an experiment that compares two different physiological conditions or states

(e.g., exponential growth vs. stationary phase) and comparing gene expression using DNA microarrays.

Facilitating the Integration of Biotechnology Laboratory Experiences into Diverse Undergraduate Courses

Contributor: Peter Jankay, California Polytechnic Institute

A novel four-component approach has been successfully implemented that over comes common resource limitations and greatly increases the number of undergraduates provided with meaningful course specific hands-on biotech experiences. First, staffed by undergraduate technicians, the Undergraduate Biotechnology Laboratory (UBL) http://www.bio.calpoly.edu/ubl develops course specific exercises where students use biotech tools to address concepts important to the course. Our weed science course, for example, now asks "Did the Round-Up Ready transgene enter a weed population now resistant to Round-Up?" Second, highly resource efficient mobile modules make equipment readily available to any course anywhere on campus. A module consists of all equipment, solutions, and other required items for a given step, e.g., DNA isolation, that are placed on a cart. The user course does not even need a sink. Third, UBL trains faculty and teaching associates so they can teach the exercises, and helps undergraduates with protocols and equipment needed for their research projects. Fourth, UBL supports a fully equipped stationary lab necessary for exercise development, training, and undergraduate research. Costs of expendables are covered by course lab fees. Furthermore, through successfully integrating the Alu polymorphism exercise into introductory biology courses, UBL has shown that a university can meet its obligation to help prepare large numbers (2,000 annually at Cal Poly) of non-science oriented students to enter a society where biotechnology is having an ever increasing importance. Finally, we have successfully used a limited participation approach of the Alu exercise to engage a lecture only class of over 80 students. UBL was funded by an NSFCCLI grant, and continues to receive Cal Poly support.

Flow Cytometry for Undergraduate Students and Teachers

Contributors: John T. Boothby, San Jose State University; Sabine Rech, San Jose State University; Ruthann Kibler, San Jose State University

Investigative biology on protists in a basic teaching laboratory environment is limited by student skill level, ease of microbial culture and manipulation, instrumentation, time, and instructor expertise. The flow cytometer is gaining use as a mainstream instrument in research and clinical laboratories, but has had minimal application in teaching laboratories. Although the cost of a flow cytometer is currently prohibitive for most microbiology teaching environments and the number of trained instructors and teaching materials is limited, the flow cytometer is an ideal instrument for teaching basic microbiology in many ways. We report here on a laboratory module to study phagocytosis in Tetrahymena sp. using flow cytometry in a basic microbiology teaching laboratory, and workshops for teachers in implementing flow cytometry in their curricula.

GPS Tools for Geographers

Contributors: Michael D. Myers, Oklahoma State University; Thomas A. Wikle, Oklahoma State University

The GPS Tools for Geographers project is currently under NSF funding within the Course, Curriculum, and Laboratory Improvement (NSF-CCLI) program. Nearing completion, GPS Tools provides web-based instructional materials that address theory, operation, and applications of global positioning system (GPS) technology and its integration with Geographic Information Systems (GIS). Increasing use of GPS within agriculture, transportation, natural resource management, and other fields highlights the importance of understanding GPS principles and application. GPS Tools can be used within undergraduate geography (or related) courses that emphasize basic navigation and positioning, spatial data capture, data management and integration, or the analysis of geographic information. The website has presentation materials for instructors, interactive web-based testing for students, an illustrated overview on GPS theory with numerous links to additional websites, and "hands-on" field and lab exercises. GPS Tools for Geographers is located at www.osu-gps-tools.org. Key words: Global Positioning System (GPS), geographic education, Geographic Information Science (GIS).

Implementation of Field Laboratory and Fieldwork Curriculum in Physical Geography and Geotechniques

Contributors: Aondover Tarhule, University of Oklahoma; Bruce W. Hoagland, University of Oklahoma; May Yuan, University of Oklahoma; Hans-Joachim Spaeth, University of Oklahoma; Roosmarijn Tarhule-Lips, University of Oklahoma; Sally Gros, University of Oklahoma

We report preliminary activities and results of our project on the implementation of a field laboratory and fieldwork curriculum in physical geography and geotechniques at the University of Oklahoma. This project was predicated on the idea that fieldwork experience is critical for developing effective practitioners in all areas of geography. The opportunity for investigating real world phenomena fosters deeper appreciations for the objects of the study. Utilizing funding provided by NSF-DUE CCLI-A&I (#0127130) we created a field laboratory for physical geography, based on the inquiry-guided approach (http://geosciences.ou.edu/~pgfl/). The "laboratory" is a portion of a 330-acre piece of land belonging to the university and about 30 miles away from campus. We installed several instruments commonly used in geographic field research including an ET106 environmental monitoring station. In terms of the curriculum we introduced a new junior level field techniques course. Participating faculty also incorporated new, specially designed fieldwork modules in four courses based on the equipment and range of processes available at the field laboratory. These courses collectively enrolled about 90 students. The 16 students enrolled in the course developed their own research topics and worked with faculty in their areas of interest to collect primary data, process and analyze the data, prepare reports and present their results in a seminar and poster session. About a third of the projects were done jointly by two students while the rest were single inves-

tigator projects. All data collected by the students is being organized into a database that will be updated with each new set of students. The best project judged by all faculty as worthy of presentation at a national conference was selected and funded to be presented at the AAG in Philadelphia. Despite success in terms of our goals, the project encountered several difficulties including navigating complex legal issues associated with student fieldwork. Additionally, while some students thrived under the freedom to investigate issues of their choosing, others drifted. As a result about a quarter of the students did not complete the course. It is concluded that the inquiry-guided approach works best only for fully motivated students. Subsequent course offering will experiment with problem based learning techniques as a complement to inquiry guided learning.

Integrating Investigation across the Geology and Physics Curricula Using the Cullowhee Creek Environmental Field Station, Western Carolina University

Contributors: Ginny Peterson, Grand Valley State University; Mark Lord, Western Carolina University; Kurt Vandervoort, California State Polytechnic University

The Cullowhee Creek Environmental Field Station (CCEFS), a part of the Western Carolina University campus, is a NSF-CCLI-funded project that provides opportunities for undergraduate students in introductory to advanced geology and physics courses to participate in investigative experiences involving quantitative data collection and analysis. Cullowhee Creek drains a 62 sq. km watershed in the Blue Ridge Mountains of western North Carolina; the lower reach flows through campus. The field station includes three groundwater wells, a gaging station, a weather station, and areas to investigate the physical, hydrological, and environmental systems on campus. Hydrological measurements are made using continuously monitored loggers and probes, hand-held instruments, and flow meters. Shallow subsurface characteristics are evaluated through surface material observations, shallow soil probes, and geophysical (seismic, resistivity, magnetic and ground-penetrating radar) surveys. Curricular reforms using the CCEFS have emphasized development of investigative projects related to the campus geological environment in several introductory through advanced courses in geology and physics, as well as an interdisciplinary geophysics course. Our intent has been to integrate research design and data collection by undergraduate students into all levels of the geology and physics curricula. Students learn research skills early by exposure to concrete applications of theoretical concepts. Also, using geophysics helps geology and physics students make links between concepts of physics and environmental applications. Project assessment indicates that early and persistent student involvement in investigations has increased student understanding and ability to do science. The interdisciplinary field station activities have helped students recognize the importance and relevance of physics to geological and environmental problems.

Integrating Service Learning in the Environmental Chemistry Laboratory

Contributors: Anna G. Cavinato, Eastern Oregon University; Ronald B. Kelley, Eastern Oregon University

Creating research opportunities that extend beyond the local campus and that connect undergraduate students to the surrounding environment is an important step in attracting and retaining students interested in the chemical sciences. With support from NSF CCLI-A&I and MRI grants, we have developed an environmental chemistry laboratory curriculum which incorporates a service learning component in collaboration with scientists of the Confederated Tribes of the Umatilla Indian Reservation in Pendleton, Oregon. Students have an opportunity to learn about environmental issues of interest to the tribe and are given the choice of pursuing specific research projects. Some of these include investigating the snow pack composition of a commercial area within the reservation, analyzing moss used for ceremonial practices for possible PCBs contamination, and examining steelhead liver from the Columbia River. The collaboration with the tribe not only creates opportunities for interdisciplinary projects that engage students to solve real-world problems, but also provides them with a realistic appreciation of the Native American culture and values. In exchange tribal members gain access to expertise and instrumentation that may answer some of the pressing questions they have about the safety of their environment. Students' reflections on their service learning experience and overall assessment of the course will be presented.

Integration of Digital Field Mapping into a Summer Field Geology Course

Contributors: Joseph Frizado, Bowling Green State University; Charles Onasch, Bowling Green State University; Kurt Panter, Bowling Green State University

Digital Field Mapping has grown from a convenience to a necessity and it is imperative that students be exposed to this technology at an early stage of their education. We are in the process of enhancing our GIS/GPS-based summer field geology course by using handheld Pocket PCs. Using Compaq iPAQ computers with integrated GPS receiver, ESRI's Pocket PC GIS software- Arc Pad, Microsoft's Media Player, Word, Excel, and other common software, we have created a series of instructional exercises to introduce digital mapping and enhance student learning in the field. Using this system, students can create digital geologic maps, record field notes and sketches, and perform certain types of data analysis in the field directly on their Pocket PCs. We have developed an eBook format for our field course guidebook and other references that the students take into the field with them on their Pocket PC. Using MediaPlayer, short video clips of simple field techniques can also be carried in the PocketPC as a "refresher" when students don't have access to faculty or graduate assistants. As with many field camps, we utilize vans to get our students to the field taking up large amounts of travel time. Maps tied to highway mileage markers or UTM coordinates within ArcPad with additional references and exercises have been developed as 'on-the-road' geology exercises to convert long drives into educational opportunities. Overall, this system is inexpensive, highly portable, uses widely available software, and easily adaptable to a wide variety of learning strategies.

Laboratory Techniques in Behavioral Neuroscience: An Interdisciplinary Course

Contributors: John G. McCoy, University of Southern Mississippi; Dante Picchioni, University of Southern Mississippi; Yuan Luo, University of Southern Mississippi

This project addressed the need for an interdisciplinary laboratory course to prepare students for graduate programs and careers in behavioral neuroscience. The course continues to give students with majors from a number of different departments an opportunity to gain "hands-on" experience with both behavioral and neurophysiological techniques. The techniques are taught by instructors from both the Departments of Psychology and Biological Sciences, and has been offered on alternate years since receiving the Award. Laboratory exercises include: review of ethical prinicples and guidelines for conducting research with animals, electrophysiological analysis of nerve impulse conduction in frog sciatic nerve, neuroanatomy exercises using both computer-assisted tutorials as well as human and sheep brain dissection, administration of drugs by peripheral routes, stereotaxic surgical procedures, histological analysis, and Morris water maze behavioral testing. The behavioral neuroscience laboratory supported by the equipment continues to serve both as a teaching and research laboratory, with faculty research projects involving undergraduate assistants. Students who have taken the course or worked in the laboratory have co-authored presentations and peer-reviewed publications and are now in neuroscience graduate programs at top-ranked institutions. The information derived from this NSF-supported initiative has also been disseminated to other four year undergraduate institutions through workshops and student presentations held at the annual state psychological convention.

Modeling, Simulation, and Control of a Real System

Contributor: Robert Throne, Rose-Hulman Institute of Technology

We have developed a preliminary laboratory sequence in our introductory linear control systems class that combines modeling a real system, developing a control system design based on this model, and then implementing the designed controller on the real system. After our first time through this new sequence we have found three educational benefits: the students realize that (1) their models are only approximate descriptions of the real systems, (2) even though the models are only approximate, feedback control can compensate for these modeling errors, and (3) real motors have limits on gains, which must be included in their design.

Non-Traditional Laboratory Experiments: Olive Oil Manufacturing and Testing

Contributors: Mariano J. Savelski, Rowan University; Stephanie Farrell, Rowan University; Robert P. Hesketh, Rowan University; C. Stewart Slater, Rowan University

The primary objective of this project was to develop new laboratory experiments that utilize a series of chemical processes and analytical techniques that are not traditionally covered in chemical engineering and/or chemistry curricula, but that are commonly encountered in industry. Using chemicals derived from food grade raw materials, intrinsically safe new laboratory experiments will be created for Chemical Engineering courses.

In this project we created laboratory modules based on each step of the olive oil manufacturing process. These modules range in complexity from fundamental engineering and science principles shown in gravity decantation of immiscible liquids to more complex principles required to describe filtration theory. Within these experiments, students relate product qualities of flavor and aroma with chemical components. Advanced technology is integrated into the project by using HPLC, Gas Chromatography and Nuclear Magnetic Resonance spectroscopy to identify these compounds. The biomedical focus of these laboratories will be to identify and quantify the presence of oleic and linoleic acids. These unsaturated fatty acids have been linked to potential health benefits. Replacing dietary saturated fat with oleic acid is reported to lower levels of total plasma cholesterol and low-density lipoproteins (LDL, also known as "bad cholesterol") without substantially reducing levels of high-density lipoproteins (HDL, "good cholesterol"). Oleic acid was also featured in the recent Hollywood film "Lorenzo's Oil" (Universal Studios, 1992) as a means of relieving the effects of a rare genetic illness called adrenoleukodystophy (ALD). Students conducting these laboratories develop high level thinking skills by having them identify the relationship between the process variables and the resulting oil properties. This final outcome also contribute to bridge the gap between pure science and engineering practice.

Nuts And Volts: A Web-Based Hands-On Electrical And Electronics Laboratory (Remote Wiring And Measurement Lab (RwmLAB))

Contributors: Johnson Asumadu, Western Michigan University; Ralph Tanner, Western Michigan University

The Web is used to remotely and physically wire up electrical and electronics circuits in a real laboratory and also to perform real data measurements in real-time. RwmLAB is a hands-on experience intended to address real data acquisition over the Internet instead of using simulated data. A switching matrix board (with nodes) has been developed. Components and instruments are connected to the nodes and they can be remotely switched together physically to wire up the electrical and electronics circuits. A graphical interface "virtual breadboard" on the Web serves as the medium for a student to interact with the real laboratory components and instruments. The Web interface has components (resistors are color-coded, capacitors have values on them, and transistors and diodes have type stamps on them), Web-cam buttons, a box containing colored wires, and instruments that appear as buttons. The "virtual breadboard" allows a student to physically wire remotely an electrical/electronics circuit in the laboratory over the Internet. Real data and waveforms can also be obtained instantly. This approach gives the student a real-time hands-on experience in graphical mode. This is another tool to allow students to probe further what they are learning in lectures and in the laboratory. It is flexible, allows for spontaneous delivery of real-data for learning and for laboratory verification, and it is another tool to enhance learning.

This Web-based instrument allows for flexibility and the spontaneous delivery of laboratory material, to enhance undergraduate learning, and ensures a global access to a worldwide audience.

Pervasive Computing

Contributor: Mark Burge, Armstrong Atlantic State University

How do we prepare our students today to develop applications for tomorrow's most widely available computing platforms? In fact, pervasive computing devices like cell phones and personal digital assistants (PDAs) are now more numerous then PCs. Cheap and ubiquitous, these compact mobile devices are the computing platforms of tomorrow. During the last four years, with the support of IBM, Motorola, and the NSF, we have started to address the unique software engineering challenges (e.g., small memory models, cross-platform development, and wireless networking) of these platforms in our curriculum. We have developed course and lab materials, which can be used to easily introduce pervasive computing into existing Java based CS1 and CS2 courses. Our labs use arcade and logic games to motivate and excite students while teaching them important concepts like state machines, threading and cryptography. To ease their adoption by new institutes, our CS1 and CS2 materials purposefully make use of only freely available software and hardware emulators (i.e., Java Micro Edition (J2ME), Eclipse, and POSE). Our capstone course prepares students to develop sophisticated pervasive computing solutions for a variety of devices through hands-on-labs including: secure computing using Java Card smartcards, wireless Personal Area Networks (PANs) using Bluetooth, and advanced J2ME application development using real hardware.

Practicing Science in the General Psychology Laboratory

Contributors: E. G. Clary, College of St. Catherine; Andrea M. Olson, College of St. Catherine; Thomas J. Thieman, College of St. Catherine; David T. Schmit, College of St. Catherine; Lynda A. Szymanski, College of St. Catherine; Joanne Q. Floyd, College of St. Catherine

This report discusses a project designed to enrich the scientific experience of all students in General Psychology at the College of St. Catherine (St. Paul campus), a liberal arts college for women. The centerpiece of our work is presenting science as a means of seeking answers to important questions that can be pursued with an array of methods and strategies. Each of five laboratories, presented in two to three weekly sessions and taught by upper division psychology students, provide students with experience in scientific inquiry and use current instrumentation and generally involve adapting existing materials. The five research strategies included in the laboratory experience are: literature review (a brief review of the empirical literature on a student-chosen topic using PsycINFO); naturalistic observation (structured observation of six preschool children's videotaped interactions with the curiosity box), experimentation (lab sections design an experiment on memory, conduct it with another lab section, and analyze the data), correlation research (life stress, reaction to a mild stressor and physiological reactivity are correlated), and archival analyses (relations of attitudes and behaviors, among other topics, are explored with 1971- 1999 St. Catherine students' responses to the CIRP freshman survey). Moreover, each of the laboratory experiences are fully integrated into lecture portion of the course, in part by utilizing classic studies in psychology. Finally, evaluations of the laboratory via surveys of students' comfort level, experience and interest in several content and skills areas targeted by the labs, along with pre- and post-tests of knowledge of research, indicates positive gains.

Project-Based Labs in Physical Chemistry: Physical Characterization of Sulfonamide Polymorphs

Contributors: Marcy Hamby Towns, Ball State University; Zachary L. Hart, Ball State University

The original goals of our CCLI proposal included the development of guided-inquiry collaborative physical chemistry laboratory projects. At this time we have developed two projects for use in the course. The first focuses on polymorph characterization.

Polymorphism refers to the ability of a compound to crystallize into more than one unit cell. Polymorphs are of particular concern to pharmaceutical companies since the crystalline form of an active ingredient impacts its physical properties and subsequent therapeutic performance. This project focused on preparing and characterizing the polymorphs of sulfonamides such as sulfathiazole or sulfanilamide. The goal is for the students to prepare and to characterize the polymorphs using DSC. Student data for these projects will be presented.

The second project focuses on the kinetics of a substitution reaction of sulfitopentaaminecobalt (III). The students experimentally determine the rate law of the substitution reaction between $Co(NH_3)_5SO_3^+$ and NO_2^-. Once the rate law is established, then mechanisms for the reaction can be explored. The data analysis lends itself to a collaborative approach amongst groups of three to four students. Upon determining the rate law, the students who have completed our inorganic course are encouraged to lead a discussion where differing mechanisms are proposed and compared to the experimental results. The collaboration amongst students leads to a deeper understanding of reaction mechanisms by all students, even those who have not taken inorganic.

ReactorLab.net Laboratory Simulations

Contributor: Richard K. Herz, University of California, San Diego

ReactorLab.net provides simulations of a variety of chemical reactors for use in chemistry and chemical engineering education. The overall software framework is field-independent; only individual lab modules are field-specific. The software framework is that of a "rich client" or "Internet application," with full Internet communication capabilities. The software was created using a very-high-level scripting tool, Runtime Revolution.

A student initially downloads the core software – platform-specific engine file and platform-independent script files – from ReactorLab.net . Students have the option of working on- or off-line. Whenever a student goes on-line, the software on the student's computer automatically updates itself when new versions of files are available on the server. Lab modules accessed on the net are saved locally so that the student can work off-line. When they go back on-line and new versions of a lab are available, the local copy is automatically updated.

Students can perform experiments, view results, and save data for analysis with commercial data analysis software such as Excel or Matlab. Many labs have quizzes in which each student gets a unique set of unknowns, with student responses being scored automatically with virtual $. The Lab's "conference room" allows students to post messages to a bulletin board and "chat" with others

on-line. Non-networked versions of the Lab are available in Spanish and Portuguese.

Partial support provided by NSF grant DUE-0125076.

Shared Development and Implementation of Lab-Based Educational Engineering Tools

Contributors: Shirley J. Dyke, Washington University; Juan M. Caicedo, Washington University; Manuel Soto-Fournier, Washington University

This poster focuses on the development, implementation, and impact of a unique cooperative educational effort including over sixty universities in the U.S. and abroad. The University Consortium on Instructional Shake Tables (UCIST) was developed in 1999 to foster collaborative teaching and learning at the university level. This consortium, headquartered at Washington University in St. Louis, originally consisting of 23 universities associated with the three U.S. national earthquake centers, has expanded to more than two times its original size. UCIST has endeavored to enhance the education of civil engineering undergraduates through the procurement of instructional shake tables and the development of curricular materials. UCIST serves as a national, and international, model for integrating structural dynamics and earthquake engineering into the undergraduate curriculum. Additionally, this program may be an attractive model for other engineering disciplines interested in sharing resources and expertise for the mutual benefit of their students. The website (http://ucist.cive.wustl.edu/) provides information on the program and is also a repository for the tools and exercises developed and is averaging approximately 10,000 hits per month, an exciting amount of activity. New members are always welcome. Membership requires new member institutions obtain an instructional shake table, use at least one experiment from the web page, and submit surveys online when they are requested. All members are encouraged to submit newly developed projects to the web page. Additionally, outreach activities and undergraduate research opportunities are encouraged. The program is funded in part by the National Science Foundation (CCLI Grant No. DUE–9950340).

The Molecules of Life: A Lecture and Laboratory Course for Non-Majors at New York University

Contributors: Trace Jordan, New York University; Neville R. Kallenbach, New York University

The scientific investigation of biomolecular structure and function occurs at the intersection of chemistry, biology, and medicine. We have developed a course curriculum that introduces undergraduate non-majors to this interdisciplinary venture within the general education curriculum at New York University. The pedagogical strategy is to engage students' interest by using examples that are prevalent in current news stories, such as the effect of specific pharmaceuticals or the function of anabolic steroids. Using this context, we then introduce the chemical and biological principles on a "need to know" basis. Major scientific themes in the curriculum include the principles of chemical bonding, water and solutions, amino acids and protein structure, the catalytic function of enzymes, cell membranes, and the expression of genetic information. An important component of the course is a weekly laboratory session. Some laboratory projects employ computer-based graphics that enable students to interactively explore important aspect of molecular structure, whereas other projects are hands-on experiments that are based on inquiry questions. As one component of the course assessment, students investigate a pharmaceutical of their own choosing and give a presentation to their peers. We have now offered the course seven times and will provide extensive evaluation data, along with a summary of the educational challenges that still remain to be solved.

The Use of GC/MS to Promote Learning in Undergraduate Organic Chemistry Laboratory

Contributor: S. Jane Myong, Sinclair Community College

In our undergraduate organic chemistry laboratory, students are asked to analyze their reaction products by using GC/MS. GC/MS analyses of the products are simple and provide in-depth information about the reactions. The results and the conditions of GC/MS analyses of Dehydration of 2-Butanol and Synthesis of n-Butyl Bromide will be presented.

Transforming the Organic Chemistry Laboratory Experience with a Green (Environmentally-Friendly) Curriculum

Contributors: James E. Hutchison, University of Oregon; Kenneth M. Doxsee, University of Oregon

Green chemistry, the (re)design of chemical products and processes to eliminate hazards to human health and the environment, provides unique opportunities for innovation in the undergraduate chemistry curriculum. In the laboratory curriculum, specifically, one can convey the important fundamental chemistry concepts and techniques, introduce state-of-the-art strategies and methods and provide a safer learning environment. In this CCLI project, we seized the opportunity to develop a new, greener curriculum for the organic chemistry teaching laboratory. More than 30 new laboratory experiments have been developed, tested and fully implemented, many of which are included in our recently published laboratory text. The experiments highlight the important chemical concepts and techniques that are traditionally taught while introducing new green chemical concepts and recently developed experimental techniques. Practical advantages of the curriculum are that it minimizes the production of chemical waste and provides a safer working environment (nearly eliminating the need for expensive fume hoods). Additional benefits of the curriculum are that it has resulted in renewed student enthusiasm for chemistry (up to a 30% increase in enrollments for organic chemistry lab) and is a good recruiting tool for undergraduate and graduate students. At the UO, this curriculum has been fully adopted, replacing the traditional laboratory curriculum. These materials are now being evaluated and implemented by more than 50 institutions that have participated in workshops during the last three summers. This poster will explain the rationale for development of these educational materials, highlight the new lab experiments and describe the numerous benefits of the greener curriculum.

Tunable Diode Lasers in the Undergraduate Laboratory

Contributor: Kenneth G. Libbrecht, Caltech

Tunable semiconductor diode lasers are excellent tools for use in advanced undergraduate physics teaching labs. The physics that can be demonstrated with tunable diode lasers includes many sophisticated and generally interesting topics that have broad student appeal. The technology is new and exciting, but at the same time laser-based optics experiments are very hands-on. The students set up the various components themselves, align the optics themselves, hunt for a signal, optimize it, and throughout the lab they are very much in control of most aspects of the experiments.

Tunable diode lasers have only recently crossed an important cost threshold, so they are now cheap enough to be incorporated in many advanced teaching labs. In this poster I describe our ongoing efforts to develop a commercial teaching lab using tunable semiconductor diode lasers.

Undergraduate Education and Research Training Through Radio Astronomy

Contributor: Preethi Pratap, Massachusetts Institute of Technology Haystack Observatory, Joseph Salah, Massachusetts Institute of Technology Haystack Observatory

MIT Haystack Observatory has been involved in an effort to introduce radio astronomy into the undergraduate program. Through this effort we have developed and commercialized a small radio telescope (SRT), provided undergraduate students and faculty nationwide with remote access to a 37-m research grade radio telescope, and provided tutorials, projects and other materials on the web to facilitate the introduction of radio astronomy into an undergraduate curriculum.

The current phase of the project explores the concepts of radio interferometry. We are developing a radio interferometer using two SRTs and will provide materials for students and faculty to incorporate these concepts into their classroom. The multi-disciplinary aspects of radio astronomy have allowed our facilities to be used in physics, engineering and chemistry classrooms. The poster will detail the past accomplishments of the program and lay out the future plans.

Using the Laboratory as a Learning Factory

Contributors: Mukasa E. Ssemakula, Wayne State University; Gene Y. Liao, Wayne State University

The Learning Factory (LF) concept was first developed as part of the TRP/NSF funded Manufacturing Engineering Education Partnership (MEEP). The objective of the LF is to integrate a practice-based engineering curriculum that balances analytical and theoretical knowledge with physical facilities for product realization in an industrial-like setting. This poster describes a project whose goal is to adapt the LF model for implementation in regular academic programs oriented to practical applications without having to build an actual factory. This work is being accomplished by modifying five carefully selected courses in our programs, leading to the use of coordinated projects across those courses. The projects focus on the making of functional model engines. In the various courses, students will generate CAD drawings of all the engine components, produce process plans for and make those components, and assemble and test the engines. This will afford students a good understanding and experience of the full range of issues involved in product design, manufacturing planning, fabrication, assembly and testing of functional products.

Virtual Labs and Scenario Based Learning for Introductory Chemistry

Contributors: David Yaron, Carnegie-Mellon University; Gaea Leinhardt, University of Pittsburgh; Mike Karabinos, Carnegie-Mellon University; Jordi Cuadros, Carnegie-Mellon University; Rea Freeland, Carnegie-Mellon University; Emma Rehm, Carnegie-Mellon University; D. Jeff Milton, Carnegie-Mellon University; Tim Palucka, Carnegie-Mellon University; Karen Evans, University of Pittsburgh

We will present learning technologies that address two main learning challenges in introductory chemistry (http://ir.chem.cmu.edu/). Our virtual laboratory addresses the first challenge, that of helping students connect the algebraic manipulations of the current course with authentic chemistry. This is done through our virtual lab, a flexible Java applet that allows students to choose from hundreds of standard reagents and manipulate them in a manner that resembles that of a real lab. The student activities couple the paper-and-pencil manipulations of the current course with chemical manipulations and experimental design. By allowing students to see the species and concentrations present in their solution, the lab bridges laboratory manipulations with the numbers that are the focus of the algebraic manipulations of the course. The lab has been used for online homework, in class experimentation, and prelabs/postlabs. Tools are also provided to allow instructors to create their own lab activities. The other major learning challenge in introductory chemistry is coupling chemical knowledge with the real world. Our CreateStudio authoring tools allow non-programmers to create scenarios that embed chemical manipulations in contexts that highlight their utility. By comparing textbooks with the NY Times' Science Times and Scientific American, we have identified and characterized a misalignment between chemistry instruction and the demands of chemical literacy. We will use our Mixed Reception murder mystery activity to illustrate how embedding current course concepts in scenarios can address this misalignment, while requiring only minor changes to current course structures. We will present our experiences and results obtained while using these materials in introductory college and high school courses.

Virtual Labs, Real Data for Statics and Mechanics of Materials

Contributors: Alan Zehnder, Cornell University; Peeyush Bhargava, Cornell University

Hands-on laboratory experience is a key element of learning the concepts of engineering mechanics. Laboratory sessions provide examples that students can see, feel and hear, and provide an alternate mode of learning to those for whom reading the textbook or hearing lecture is insufficient. Labs are also used to introduce data analysis, report writing, finding empirical correlations between experimental variables and data, and to validate theory.

However, hands-on laboratories are not always an option due to

space, cost and time constraints. Thus there are currently a number of projects to develop virtual laboratories. These can be classified broadly into three categories. (1) Simulation-based virtual labs that provide a software mockup of an experiment, sometimes including controls, meters and such to emulate the physical lab. (2) Remote but physical labs in which students view, control and acquire data from a physical experiment through a web-based interface. (3) Recorded experiments where students can view actual experiments, and work with real data.

The virtual lab we are developing is of category (3), recorded data and videos of experiments. Our lab focuses on torsion or circular and non-circular shafts made of engineered (metals and plastics) and biological (turkey bone) materials. The lab is web-based and consists of (a) narrated chalk talks on basic theory, test equipment, and data reduction procedures, (b) virtual experiments, videos of the tests, including live plotting of twist-torque data, (c) extensive sets of data, and (d) a lab manual with suggested exercises and questions. The lab is designed to be modular so that instructors can pick and choose from elements that suit their own curriculum, perhaps writing their own manual to direct students to specific aspects of the lab and to specific tasks.

ZAP! Adapted: An Introductory Electromagnetism Laboratory Incorporating Design

Contributor: James A. McNeil, Colorado School of Mines

In the last decade the Accreditation Board for Engineering and Technology (ABET) significantly reformed the criteria (EC200) by which engineering programs are accredited. Not surprisingly, engineering design constitutes an essential component of these criteria. The Engineering Physics program at the Colorado School of Mines (CSM) underwent an ABET general review and site visit in the fall of 2000. In preparation for this review and as part of a campus-wide curriculum reform the Physics Department was challenged to include elements of design in its introductory electromagnetism laboratory. The new laboratory forms an important component of the redesigned course that respects the psychological principles of learner-based education. As part of the background research for this reform, several laboratory programs were reviewed including traditional and studio modes as well as a novel laboratory used by Cal Tech and MIT called "ZAP!" which incorporates design activities well-aligned with the EC2000 criteria but in a nontraditional delivery mode. We adapted several ZAP! experiments to incorporate significant design experiences but delivered in a standard laboratory format. This poster outlines the reformed introductory electromagnetism course and how the laboratories are integrated into the pedagogy along with design activities. In their new form the laboratories can be readily adopted by physics departments using traditional delivery formats.

Pedagogy & Teaching

$(CL)^2$: Computer-Led Cooperative Learning

Contributor: Victor J. Montemayor, Middle Tennessee State University

This poster presentation will describe the major components of an integrated approach to teaching the algebra-based College Physics sequence at Middle Tennessee State University. In particular, the general purpose and modus operandi of the sequence will be described, including very focused lecture web sites that serve as the course text, and in-class interactive EXCEL spreadsheets and hands-on activities that were all specifically developed for this sequence. The spreadsheets and activities are performed in groups in a self (group)-paced cooperative-learning environment. The lecture web sites can be viewed at http://physics.mtus.edu/~phys2010 and http://physics.mtus.edu/~phys2020 . (Supported in part by NSF-CCLI grant #DUE-9981015.)

A Discovery Approach to Teaching College Geometry

Contributor: Michael Hvidsten, Gustavus Adolphus College

There is currently a movement in the college community toward a discovery-based approach to the teaching of geometry. Most students taking college geometry are those who will be future teachers of mathematics at the high school level. These teachers will be expected to integrate the active-learning recommendations of the National Council of Teachers of Mathematics (NCTM) into their own classrooms. To effectively do this they need good models of such teaching practices at the college level.

The objective of this proposal is to develop an integrated textbook/software environment for the teaching of college geometry that uses discovery-learning and computer laboratory projects as fundamental techniques for the exploration of concepts. Publication of project materials will support faculty in their efforts to move to an open-ended, discovery-based pedagogical approach to the teaching of geometry.

This project builds on five years of experience teaching discovery-based geometry at Gustavus Adolphus College. A draft of the proposed textbook and software are currently being field-tested at a diverse set of colleges and universities to produce a bundled textbook/software product for national distribution.

The project addresses three of the four main themes that NSF has identified for DUE programs: Preparation of Future Teachers, Integration of Technology, and Faculty Development.

A Seamless Classroom Approach to the Instruction of Botany and Zoology

Contributors: Patricia A. Burrowes, University of Puerto Rico, Rio Piedras; Gladys M. Nazario, University of Puerto Rico, Rio Piedras

Teaching science by inquiry, hands-on activities, and experimentation has proven to be an effective tool to promote learning with the excitement of discovery. This project's goal is to improve learning of biology concepts and process skills through the integration of labo-

ratory and lecture in the Botany and Zoology courses at the UPR-RP. When students inquire about factors that maximize photosynthetic rate, they immediately proceed to test hypotheses on the effect of light intensity, wavelength, or increased CO_2, on the oxygen production of plants. When studying animal development, students hypothesize on the patterns of cleavage and early stages of development across phylogenetic lineages, and make direct observations through in vitro fertilization of protostome and deuterostome eggs. By implementing new instructional materials for the integration of lab and lecture in Zoology and Botany we expect to help students understand the correlation between theory and research, enhance conceptual understanding, develop laboratory skills, and increase their motivation towards learning biology. Summer workshops, a website and publications serve to disseminate materials and model teaching strategies to teachers, graduate students and colleagues at our institution. We anticipate that learning science through experimentation will help more Hispanic students to succeed in research careers.

Activities for Introducing Students to Statistics

Contributors: Allan Rossman, California Polytechnic Institute, San Luis Obispo; Nicole Walterman, California Polytechnic Institute, San Luis Obispo

We present examples of learning activities for introducing students to statistical concepts, applications, and theory. One specific goal of our project is to attract more students into the study of statistics through these curricular materials, and another is to better prepare future teachers of statistics by modeling pedagogy that implements active learning. The activities build on genuine data collected in scientific studies, in an effort to highlight for students the inter-disciplinary nature of statistics. Specific activities to be presented include: simulating a randomization test applied to the results of a psychology experiment on the effect of an observer with a vested interest, sampling words from the Gettysburg Address in order to introduce the concept of sampling bias and to indicate the virtues of random sampling, and simulating repeated samples in order to explore the interpretation of confidence intervals and to compare newly proposed procedures to standard ones. Applets that have been developed to accompany the activities will also be presented.

An Integrated Engineering Curriculum for Freshman and Sophomore Students at Louisiana Tech University: An Emerging Success

Contributors: James Nelson, Louisiana Tech University; Kelly Crittendon, Louisiana Tech University; Stan Cronk, Louisiana Tech University

The College of Engineering and Science at Louisiana Tech University has established an integrated curriculum for engineering students for all engineering, math, and science courses taken in the freshman and sophomore years. Established as a pilot program in 1997, the curriculum was developed to help students see the connections among the material taught in all of their early STEM courses. The curriculum is now used to educate students in each of the six engineering degree programs offered by the college. Because the curriculum has been fully implemented since 1999, its full impact on graduation rates cannot be determined. However, initial data indicates that our goals of 50% retention of engineering students from the freshman to sophomore years, as well as 90% retention of students from the sophomore year to graduation, are being met or exceeded. The success of this curriculum has led to the development of an integrated science curriculum for other students within the college, including students majoring in chemistry, computer science, geology, math, and physics.

An Interdisciplinary, Inquiry-Based Physics of Music Course

Contributors: Jane Flood, Muhlenberg College; Diane Follet, Muhlenberg College

The National Research Council calls for all students to learn science "through methods and processes of inquiry" (Transforming Undergraduate Education in SMET, National Academy Press, Washington DC 1999). To meet this challenge, we have developed an interdisciplinary, inquiry-based course, The Physics of Music, to serve humanities and social science students. The course is designed and taught by professors from the two disciplines of physics and music.

By providing an attractive entry point to exploring rigorous scientific principles, we hope to spark student curiosity and encourage a scientific approach to problem-solving. The active-learning approach of this inquiry-based course develops technological literacy through use of current technology for experimental observation.

The Physics of Music is currently being offered for the first time at Muhlenberg College. We will describe our course design, selected exercises and assessments, and our progress to date.

Applied Drug Delivery throughout the Engineering Curriculum

Contributors: Stephanie Farrell, Rowan University; Robert Hesketh, Rowan University; Mariano Savelski, Rowan University; C. Stewart Slater, Rowan University

Drug Delivery is a burgeoning field that represents one of the major research and development focus areas of pharmaceutical industry today, with new drug delivery system sales exceeding 10 billion dollars per year[1]. Chemical Engineers play an important and expanding role in this exciting field, yet undergraduate chemical engineering students are rarely exposed to drug delivery through their coursework. To provide students with the skills directly relevant to the evolving needs of the pharmaceutical industry, this project will develop and integrate applied drug delivery coursework and experiments throughout the Rowan Engineering curriculum.

To design and produce a new drug delivery system, an engineer must fully understand the drug and material properties and the processing variables that affect the release of the drug from the system. This requires a solid grasp of the fundamentals of mass transfer, reaction kinetics, thermodynamics and transport phenomena. He or she must also be skilled in characterization techniques and physical property testing of the delivery system, and practiced in the analysis of the drug release data.

This project comprises seven modules that introduce students to multidisciplinary engineering principles through application to drug

delivery systems. Each module comprises experiments for the design, preparation, characterization, and analysis of a variety of drug delivery systems. This paper focuses on experiments developed to investigate tablets, transdermal patch systems, drug stability and supercritical fluid applications. The experimental methods and engineering concepts used to analyze drug delivery systems are presented, and the role of the engineer in this field is explored.

[1] Langer, R., Foreword to Encyclopedia of Controlled Drug Delivery, Volume 1, Edith Mathiowitz (ed.), John Wiley and Sons, NY 1999.

Beyond LEGOs®: Hardware, Software and Curriculum for the Next Generation Robot Laboratory

Contributors: Douglas S. Blank, Bryn Mawr College; Deepak Kumar, Bryn Mawr College; Lisa A. Meeden, Swarthmore College; Holly A. Yanco, University of Massachusetts, Lowell

As educators, we are often faced with the paradox of having to create simplified examples in order to demonstrate complicated ideas. The trick is in finding the right kinds of simplifications — ones that will scale up to the full range of possible complexities we eventually would like our students to tackle. Low-cost robots have been a useful first step, but are now becoming a dead end because they do not allow our students to explore more sophisticated robotics methods. It is time to shift our focus from low-cost robots to creating software tools with the right kinds of abstractions that will make it easier for our students to learn the fundamental issues relevant to robot programming, artificial intelligence and computer science.

Every robot platform comes with its own, often proprietary, development tools that are substantially different from other platforms. Often the primary programming languages used are different as well. More problematic may be a complete change in paradigm from one robot to another. We have developed a programming framework called Pyro (Python robotics) that provides a set of abstractions for writing platform-independent robot programs. Pyro has been implemented for several types of robots as well as several simulators. We have also developed a set of course modules that can be assembled in different ways for courses in robotics, artificial intelligence, introductory computer science, and cognitive science. The materials have been tested at the PIs' institutions and are currently being pilot tested at other schools.

Biology Interest Groups (BIGs): A Chemistry, Math, Biology Learning Community of Freshmen and Faculty making Connections through Cases

Contributor: Lillian Tong, Center for Biology Education, University of Wisconsin, Madison

Biology Interest Groups (BIGs), for first semester students at UW-Madison who are interested in the biological sciences, were created to help students integrate math and chemistry around biology problems, take ownership of their learning, learn to work effectively in groups, and think critically about complex problems. Twenty students, as a cohort, take three linked courses: math (calculus), chemistry, and the BIG seminar. The BIG seminar focuses on a topic in biological sciences and is taught using cases/Problem Based Learning problems which are worked on in small groups. Biology faculty develop the cases in their own disciplinary area with input from other BIGs seminar instructors and the chemistry and math instructors in the linked courses. They, together with graduate TA's, constitute the BIGs instructional community which provides ideas, feedback, and support as they develop ways to meet the BIGs objectives.

Four BIGs seminars have been offered: "Issues in Ecology and Environmental Sciences," "Infectious Diseases," "Physiology of Human Behavior," and "Energy, the Currency of Life." We assessed whether course format and materials achieve objectives for students. We are also investigating whether our methods for helping instructors (training in case-based learning and effective small groups, database of materials and stories from former BIGs, and building an interdisciplinary instructor community) is effective as a model for sustaining this type of program in a large research university.

Bridging the Gap

Contributors: Tevian Dray, Oregon State University; Corinne Manogue, Oregon State University

As with Britain and America, mathematicians are separated from other scientists by a common language. Casual discussions with those in other disciplines suggest far more agreement than exists in fact. In a nutshell, mathematics is about functions, but science is about things. This difference has created a "vector calculus gap" between the way vector calculus is usually taught by mathematicians and the way it is used by other scientists. This material is essential for physicists and some engineers due to its central role in the description of electricity and magnetism. Our poster discusses efforts at Oregon State University to bridge this gap through the use of small group activities that emphasize geometric visualization. Our approach also suggests changes that could be made in the teaching of related material such as the basic properties of vectors, beginning as early as high school. Faculty development workshops are now underway and the activities are being tested at a number of diverse sites.

Bringing Real-World Issues into Engineering Classrooms

Contributors: P.K. Raju, Auburn University; Chetan S. Sankar, Auburn University

This poster session encourages engineering faculty members to experiment with innovative educational materials that prepare students for real-world problem-solving situations and train them in team building, interaction, and interdisciplinary skills. The educational materials in the form of case studies that were developed by LITEE in partnership with industries. Each case study includes a real-world engineering problem supplemented with a multimedia component that brings the industry scenarios live into the classroom. In addition, faculty using this material will be provided with a teacher's manual and instruction plan that describes how the innovative materials could be incorporated in your lesson plans.

Past workshops have been a great success. Some of the comments from the participants were: "Both content and organization among the best I have seen in education methodology...Presentations were excellent...It is a mind opener...Well organized...Enhances team

building…Idea of E-Journal to evaluate and enhance meta-cognitive skills is excellent…Increase students' quantitative problem-solving."

Bringing Workplace Communication into a Technical Communication Course for Industrial and Electrical Engineers

Contributors: Judith Shaul Norback, ISyE Georgia Institute of Technology; Lisa D. McNair, LCC Georgia Institute of Technology; Peter J. McGuire, LCC Georgia Institute of Technology; Michael J. Laughter, LCC Georgia Institute of Technology; Beverly Sutley-Fish, consultant; Garlie A. Forehand, consultant

In this project, Job Communicative Analysis is used to interview engineers, supervisors and senior executives about workplace communication. The results of the analysis include 1) actual workplace materials such as emails, technical reports and slides, 2) information about how the materials are created, 3) criteria used to decide when the materials are well-done and 4) the communication skills needed to produce the materials. A second process is then used to convert the data into the Technical Communication course for industrial and electrical engineers. Initial project results include 1) dramatic improvement by the students in creating effective emails and longer reports, and delivering polished, professional oral presentations; 2) enhanced student motivation in learning from real-world examples; and 3) instructors embracing the opportunity to enhance their traditional Technical Communication curriculum with feedback from engineers, supervisors, and senior executives on the job. Our project is demonstrating 1) ways of enhancing engineering students' communication skills through bringing workplace communication directly into the curriculum, 2) the use of structured communication lab support to expand the classroom instruction, and 3) assessment procedures that measure improvement in writing skills, oral skills, student confidence, and teacher effectiveness. The project is also producing successful models for 1) collaboration between academia and the world of work, 2) collaboration between engineering and the humanities, and 3) improvement of communication skills in engineering students. The website resulting from the project will be demonstrated. The textbook chapter on Engineering Workplace Communication and the two articles and two conference presentations will be referenced. NSF DUE – 0231305.

Case Studies and Computing: Broadening the Scope of Statistics Education

Contributors: Deborah Nolan, University of California, Berkeley; Duncan Temple Lang, University of California, Davis; Wolfgang Polonik, University of California, Davis

We have found many advantages to incorporating case studies in the advanced mathematical statistics course. In addition, using a computer to analyze data from these cases and to conduct simulation studies presents many opportunities and also many challenges. For example, although the computer enables us to go far beyond the small, artificial examples found in traditional text books, many students become focused on the details of using the statistical software and the statistical concept becomes secondary. Most statistical software was not designed for pedagogical purposes, but instead for professional statisticians or data analysts. For the student, the value of gaining a skill, such as programming in SAS, may not offset the problems and is typically not the primary or initial goal of the class. To address these issues, we are developing electronic activities that make it easier for students to start quickly to explore and develop understanding of the concepts of statistics using graphical user interfaces developed on top of the professional statistical software, R. This software provides bindings to the Gtk GUI toolkit and the Gnumeric spreadsheet. An important implication of this feature is that the content of case studies and demos can be integrated into one cohesive document. We provide two examples.

Chemistry is in the News: Preparation for Science Communication

Contributors: Rainer Glaser, University of Missouri, Columbia; Kathleen Carson, University of Missouri, Columbia; Brian Hodgen, University of Missouri, Columbia; Zhengyu Martin Wu, University of Missouri, Columbia; Yongqiang John Sui, University of Missouri, Columbia; Susan Schelble, University of Colorado, Denver; Eric Lupo, University of Colorado, Denver

Science already is pervasive in all aspects of modern society and science grows at an incredible speed. Much of the science important for a person's life will be discovered after the student has left formal education. The preparation of students for life-long learning has to become the highest goal. From this insight derives the mandate to instruct students in the ways science is communicated in society. "Chemistry is in the News" (CIITN) is a project that aims at teaching chemistry in the context of real-world issues. CIITN uses current articles from the popular online newspapers, which are related to the information that students are learning in class and to highlight and discuss how chemistry is present in the real world. Students work in small groups to explore online information sources and answer questions about these articles. By utilizing the popular media in the classroom the instructor can emphasize the importance/relevance of chemistry in the students' lives, which increases the students' motivation to learn chemistry. Students work with their groups to create their own news portfolio project. These projects will be assessed by their peers both in their class and by students at different universities. The peer review process exposes the students to the scientific process while also demanding the students to exhibit higher-order cognitive skills. CIITN main focus is to reintroduce curiosity about science to our students not only to create a better learning environment in the classroom but also to produce life-long learners.

Constructing Media as a Context for Teaching Computing and Motivating Women and Non-Majors

Contributor: Mark Guzdial, Georgia Institute of Technology

To address the high rates of failure among women and non-majors in introductory computer science classes, we developed a CS1 course centered around media and communications. Introduction to Media Computation introduces programming and computing ideas through students programming image filters, splicing and reversing sounds, implementing digital video special effects, building Web searching tools, and writing programs that generate text. We support the course with a textbook (available now through Pearson), a programming environment (for Python), and a collaborative website on which students can share their media creations. In the two semesters that the course has been offered, over 400 students have taken the course, two-thirds of whom were female, with a WDF rate

of 12%. Students report that they find the course relevant and creative, with a rich social context. The course and components of it are currently being tested in two and four year schools outside of Georgia Tech. Our poster describes the course, our assessment, and our future directions, including a second course, a CS minor, and a pathway into the CS major through media computation.

Decreasing Attrition in Computer Science Using Animated Virtual Worlds

Contributor: Wanda Dann, Ithaca College

This poster describes a proof of concept project for the development and application of instructional materials for teaching fundamental programming concepts using an exciting simulation and visualization package. This package provides an environment that supports the creation of 3-dimensional, interactive, animated virtual worlds (which can be easily built by novices!). It is expected that this approach will strengthen and enhance student skills as well as provide sufficient programming experience to improve student performance and retention in introductory computer science (CS 1) and beyond.

Demos with Positive Impact

Contributors: David R. Hill, Temple University; Lila F. Roberts, Georgia College and State University

Demos with Positive Impact (NSF DUE-9952306) is a proof of concept project that is developing an extensive web-based collection of tried-and-tested instructional demonstrations for teaching mathematics. The demos have been contributed by mathematics instructors across the country and the collection was designed to provide teachers with a variety of tools that enhance mathematics teaching and learning. The scope of the project is broad; content includes topics from elementary algebra, precalculus, calculus, statistics, and post-calculus areas such as differential equations and linear algebra. Demos provide animations (animated gif and quicktime movies), interactive java applets, Excel spreadsheets, and specialized codes using MATLAB, Maple, and Mathematica. Along with these technology tools for teaching, the demos provide useful information about how to use the demo, including objectives, appropriate level, prerequisites, technology platform(s), and instructor notes that give details on how the demo has been used in the classroom. While the web site was designed primarily to help the instructor plan classroom activities, some demos include ideas for projects, student assignments, and group work that can be done outside of class.

Demos with Positive Impact has been recognized for excellence by the Eisenhower National Clearinghouse and has been featured in the Mathematical Association of America MathDL Digital Classroom Resources. In addition, the site has been selected as a member of GEM (Gateway to Educational Materials) and has been highlighted in MathForum@Drexel Internet News.

The poster session will include samples of the demos in the collection and an invitation for participation.

Development of Chemistry Research Students in the First and Second Year of Undergraduate Study

Contributor: Brenda S. Ross, Cottey College

Cottey College is a liberal arts junior college for women. Our students transfer to baccalaureate degree-granting institutions after two years and it is critical their experience be equal to or in advance of peers at these institutions. In 1998 we received a grant from the NSF to support revision of our laboratory curriculum. Our intent was to develop a program that allowed chemistry students to participate in laboratory research their first year and required all chemistry students to participate in research their second year. During the first semester of general chemistry laboratory, students focus on techniques, laboratory writing and completion of a multi-week inorganic synthesis and analysis. The second semester of general chemistry laboratory includes standard experiments, analysis of unknown cations, and culminates in a research project on the determination of cation exchange capacity of a clay. The first semester of organic chemistry laboratory is devoted to spectroscopy and synthesis, while the second semester is split between analysis of unknowns and individual research projects in approximately a one to three ratio. The changes to our laboratory curriculum were made slowly and progressively and most recently included addition of a separate research course open to first- and second-year students. As evidence of the success of our program, thirty second-year students and two first-year students have conducted research in the area of synthesis of organic molecules, one first-year student has conducted a computational investigation of similar molecules, and one second-year student is currently using mass spectrometry to investigate components of juniper berries.

Discovery-Based Science and Math in an Environmental and Community Context

Contributors: Julia Burdge, Florida Atlantic University; Stephanie Fitchett, Florida Atlantic University; Bill Green, Miami University; Todd Hopkins, Butler University; Paul Kirchman, Florida Atlantic University; LuAnne McNulty, Butler University; Blake Mellor, Loyola Marymount University; Jon Moore, Florida Atlantic University; Bill O'Brien, Florida Atlantic University; Susan Richardson, Florida Atlantic University; Mark Rupright, Florida Atlantic University; Mwangi wa Githinji, Gettysburg College; Jim Wetterer, Florida Atlantic University

Faculty members from biology, chemistry, environmental studies, mathematics and economics worked together to design the foundation for the science curriculum in the Honors College, a new (opened in Fall 1999) liberal arts college being built within the larger Florida Atlantic University system. With the support of the NSF, the College has developed a discovery-based approach to learning by introducing extended student projects in first and second year biology and chemistry courses; promoted interdisciplinarity by creating educational links among the sciences and between mathematics and the sciences; brought science and mathematics out of the classroom and into the community, using local ponds, lakes, forests and greenways as science laboratories; and supported the building of partnerships between the college and the wider environmental community. At all levels of undergraduate studies, students conduct independent research projects and give oral and written presentations of their findings. Their regular experiences culmi-

nate in (required) senior thesis projects, many of which are interdisciplinary in nature. For faculty, students, and community partners, the discovery-based approach to science integrates teaching, learning and research in a holistic form of scholarship.

e&m TIPERs

Contributors: Curtis Hieggelke, Joliet Junior College; David Maloney, Indiana University-Purdue University, Fort Wayne; Tom O'Kuma, Lee College; Steve Kanim, New Mexico State University

This poster paper will illustrate materials from a collection of new instructional materials for the topics and concepts in electrostatics and magnetism. These materials can be used as classroom materials, quizzes or exam questions, or homework. These materials employ various TIPER (Tasks Inspired by Physics Education Research) formats that include: Ranking Tasks; Working Backwards Tasks; What, if anything, is Wrong Tasks; Qualitative Reasoning Tasks; Bar Chart Tasks; Conflicting Contentions Tasks; Linked Multiple Choice Tasks; Changing Representations Tasks; Meaningful, Meaningless Calculations Tasks; and other types of alternative task formats. The tasks are arranged into sets of issues or questions that provide a way of asking a question in different ways. Such materials support active learning approaches and can be easily incorporated without making major changes in teaching. (Supported in part by NSF CCLI grants DUE 9952735 and 0125831.)

Educational Materials Development for a General Education Course on Art and Geology

Contributors: Denise A. Battles, Georgia Southern University; Jane Rhoades Hudak, Georgia Southern University

Faculty members from a variety of STEM (science, technology, engineering, and mathematics) disciplines have discovered the utility of teaching science concepts in connection with the visual arts. These interdisciplinary courses are a particularly appealing approach to instruction for non-science majors, providing an innovative means of exploring STEM concepts. As evidenced by multiple conference presentations and journal publications, the geosciences are well suited for such courses, which are taught at a number of universities. However, the lack of readily available educational materials poses a barrier to their widespread dissemination. Through the CCLI Educational Materials Development Proof-of-Concept project, the PIs seek to address this apparent deficiency by initiating the development of a college-level Art and Geology textbook. Specifically, the PIs are developing two prototypal chapters of the envisioned textbook, which is being designed to support general education Art and Geology courses for non-science majors. Activities in this proof-of-concept phase of the project will include: 1) development of prototypal chapters, including external review, 2) pilot-testing of the materials in a core curriculum course team-taught by the PIs, 3) evaluation and subsequent refinements of the products, and 4) dissemination to the geology and art communities about the prototype and overall initiative, highlighted by a faculty workshop offered at a major professional meeting. This poster will describe the educational materials development work completed to date, including the generation of the draft chapter, "Jewelry, Gems, and Metalsmithing," and preliminary work on a second chapter on European ice age cave art, and will identify future project activities.

EPICS: Engineering Projects in Community Service

Contributors: Leah H. Jamieson, Purdue University; William C. Oakes, Purdue University

The EPICS (Engineering Projects in Community Service) program has been highly successful in marrying design education with service learning. The educational goals of EPICS include broadening students' professional skills through an extended design experience in which they define, design, build, test, deploy, and support real systems. Partnerships with local community not-for-profit organizations provide motivated and engaged customers. The expectation that their designs will be deployed and used provides a compelling learning environment for students. The resulting experience is well-matched with both ABET's EC 2000 and with industry employers' desired attributes for graduating engineers. Preliminary data also suggests that the social context for technical design appeals to underrepresented groups within engineering and computer science.

Initiated at Purdue in 1995 and with support from the NSF, the Corporation for National and Community Service, Microsoft Research, and Hewlett-Packard, EPICS programs are now operating at ten universities: Purdue, Notre Dame, Iowa State, Wisconsin-Madison, Georgia Tech, Case Western Reserve, Penn State, Butler, Illinois at Urbana-Champaign, and Puerto Rico-Mayaguez. Five additional universities, selected through a competitive proposal process, will start EPICS programs in 2004-05.

From CyberSpace to Real Space: Using Physical Models to Explore the Molecular World

Contributors: Tim Herman, Milwaukee School of Engineering; Michael Patrick, University of Wisconsin; Jackie Roberts, DePauw University

Rapid prototyping technology can be used to create accurate, three-dimensional physical models of proteins with which students can explore the molecular world. These models eliminate the cognitive barrier that exists for some students in converting two-dimensional textbook figures and computer images into "real" three-dimensional structures. As a result, students rapidly develop a deeper understanding of the fundamental concepts of molecular structure, and are better prepared to explore more sophisticated questions related to molecular structure and function. These models have been field-tested in a variety of different undergraduate chemistry and biology courses. We have found in these field-tests that the physical models serve as "thinking tools", stimulating questions that are often answered using molecular visualization tools. As such, these physical models are useful adjuncts to the use of computer visualization in the undergraduate classroom.

We plan to disseminate this project in the form a of a Summer Modeling Institute at which teams of undergraduate faculty will use this modeling technology to design and construct molecular models for use in their classrooms. Institute participants will also share best practices related to the use of these models in the classroom, and plan successful assessment strategies to measure the impact of the models on student learning. This work is supported by an NSF CCLI grant DUE-0088669.

Good Questions for Deep Learning in Mathematics

Contributor: Maria Terrell, Cornell University

For the past year a group at Cornell has been experimenting with ways to change how we ask students to spend time in class. Research has shown what most experienced mathematics teachers know: students can do well in a course and still exhibit surprising deficiencies in the understanding of concepts. The GoodQuestions at Cornell University project seeks to improve mathematics instruction by adapting two methods developed in physics instruction — ConcepTests (http://galileo.harvard.edu/) and Just-in-Time-Teaching (http://webphysics.iupui.edu/jitt/jitt.html).

GoodQuestions aims to raise the visibility of the key concepts and to promote a more active learning environment. We do this in two ways: 1) By using the web to deliver and collect responses to pre-class warm up questions that direct the students attention to the main concepts in the pre-class reading assignment; and 2) By using highly conceptual discussion questions in class. The in-class questions are usually non computational, multiple choice questions, which aim to help students discuss common misunderstandings of the key concepts in calculus.

One of our goals is to see if calculus instructors (some experienced, others novice) will use the questions to change how they spend time in class. Another goal is to see if students improve in both conceptual and computational ability when more class time is spent discussing key concepts, and less time is spent by the instructor presenting solutions to computational problems. The essence of the approach is "good questions": questions that reflect the essential role of student prior knowledge and misconceptions in building a conceptual structure; questions that stimulate students' interest and raise their curiosity; questions that help students monitor their understanding; questions that provide students frequent opportunities to make conjectures and argue about their validity; questions that provide our instructors with frequent formative assessments of what students are learning and that help guide instructors in how to engage students in productive class discussions.

What does it take to craft such questions? How are the students responding? What technological challenges do we face? We offer a report from the field. Support for the Good Questions at Cornell project is provided by the National Science Foundation's Course, Curriculum, and Laboratory Improvement Program (grant DUE-0231154).

Humanized Physics Project

Contributors: Nancy Beverly, Mercy College; Robert Fuller, University of Nebraska, Lincoln; Vicki Plano Clark, University of Nebraska, Lincoln; Beth Ann Thacker, Texas Tech University; Mark Plano Clark, Doane College; Christopher Wentworth, Doane College

The Humanized Physics Project is an effort to develop human-oriented physics activities and associated inquiry-oriented curricula to motivate student learning for the algebra-based introductory physics student, who typically is preparing for a career in the life or health sciences and is intimidated by and/or has little interest in physics and technology. Humans are innately interested in learning about themselves. Although the intended audience of these materials has been the algebra-based physics student, these activities could be modified for use by other student populations. Each Humanized Physics project module has a human-context focus, enhancing accessibility and interest in the physics therein. Within each module, the physics concepts are initially explored through a human functioning or human-oriented activity. The activities loosely follow a Learning Cycle of Exploration, Invention, and Application. Mathematical modeling is integrated into every module, and multimedia materials are used to provide a variety of learning experiences. Samples activities from each module will be presented.

This NSF funded project is a collaboration between the physics departments at the University of Nebraska-Lincoln, Texas Tech University, Mercy College, and Doane College. Some of the project activities can be accessed at the project website at www.doane.edu/hpp A Humanized Physics workshop will be offered at the Summer AAPT meeting in Sacramento. This project has been funded by NSF CCLI Grants DUE 00-88780, DUE 00-88712, DUE 97-50638.

Improving Core Mathematics

Contributors: Gary Krahn, U.S. Military Academy; Don Small, U.S. Military Academy

This proposed project focuses on improving the 4-semester core mathematics program at the U.S. Military Academy by adapting and implementing the program embodied in the text "Principles and Practice of Mathematics" by the Consortium for Mathematics and its Applications (COMAP). We propose a core program focused on problem-solving through modeling and inquiry, supported by mathematical concepts and techniques. The purpose of this real-world, problem-based mathematics program is to emphasize the breadth and variety of mathematics; to develop students into competent, confident problem solvers in the social and decision sciences as well as in the science, technology, engineering, and mathematics (STEM) arenas; and to promote the process of life-long learning. The concepts and techniques of calculus, algebra, trigonometry, geometry, discrete mathematics, probability, statistical reasoning will become supporting "tools" for problem-solving in the core mathematics program. This is a reversal from the traditional practice of presenting application problems as the follow-on for concepts, algorithms, techniques, or procedures.

Integrated Study of Environmental Effects on Organisms

Contributors: Christopher F. Sacchi, Kutztown University; Carol A. Mapes, Kutztown University; Wendy L. Ryan, Kutztown University; Anne E. Zayaitz, Kutztown University

The interaction of organisms with their environment is manifested in biological responses at many scales, from the biochemical to the ecosystem level. The relationships of organisms and their environments have been of concern to biologists in the context of natural environmental variation and is of growing importance in light of the effects on organisms of human-influenced environmental change. In this poster we will describe our efforts, to date, to adapt laboratory exercises in five laboratory courses by incorporating study of physiological responses of organisms to specific environmental variables. Adapted exercises in subject areas including microbiology, marine biology, plant and animal physiology, and ecology and environmental science permit measurement of physiological response of

organisms to several environmental variables. Students, working cooperatively, use computer-interfaced equipment that permits accurate quantification of organismal responses to environmental factors; eventually students analyze this quantitative data using basic statistical methods and are asked to present this data in writing or in oral presentations. Equipment available to students for adapted exercises includes: 1) growth chambers/incubators to regulate environmental conditions including temperature, light, and ambient CO_2, 2) devices to measure biochemical oxygen demand (BOD) and dissolved oxygen (DO) in freshwater and marine systems, and 3) moderately priced photosynthesis and animal respiration systems to measure O_2 and CO_2 consumption or generation by plants and animals. In the poster, we will describe adapted exercises, perceived benefits, and some pitfalls, of the exercises we are adapting and the equipment we have acquired, and the evaluation process we are using for this project.

Integrating Computer Explorations into College Geometry

Contributors: Barbara E. Reynolds, Cardinal Stritch University; William E. Fenton, Bellarmine University

We are developing a text for a college-level course in geometry using The Geometer's Sketchpad. The focus of this course is on developing skills in writing mathematical proofs. Computer lab activities using Sketchpad introduce all topics. These exploratory activities set the stage for class discussions. Students work on activities, making and testing conjectures. Class discussion leads to developing proofs (or refutations) of students' conjectures.

Exploratory activities using Sketchpad are integral to the text, and help students develop intuitive understanding of important geometric concepts. These explorations

- engage students in explorations leading to making and testing conjectures;
- improve geometric reasoning, encouraging transitions from concrete visualization to abstract conceptions to axiomatic thinking;
- develop skill in constructing mathematical proofs; and
- encourage articulation of mathematical observations and ideas.

The course materials support cooperative learning, and offer an introduction to mathematical reasoning. Since most geometry students are future teachers, it is important to model strategies recommended by NCTM (National Council of Teachers of Mathematics). A course based on this text will model such strategies.

Key College Publishing anticipates publishing a Preliminary Version of this text in fall 2005. A faculty development workshop is being planned for the summer of 2005, to model the pedagogy through computer explorations and small group discussions for faculty members who are considering adopting this text. (NSF-CCLI Grants 0125130, 0338301.)

Integrating Geographic Information Systems (GIS) Experiences into Undergraduate Courses Across the Arts and Sciences Curriculum

Contributor: R. Maxwell Baber, Samford University

The Academic Excellence and Geographic Information Systems (AEGIS) project is teaching Samford University faculty how to use GIS and assisting them in the development of discipline-specific GIS modules for introductory level courses. The goals of the project are to increase awareness of GIS, generate growing undergraduate interest in GIS, and provide ongoing support for multidisciplinary GIS activities. GIS applications are being developed across a growing spectrum of professional and academic fields, and student experience with geo-spatial technologies will better prepare them for using GIS within their respective fields. The broader impacts of this project are far-reaching: the integration of introductory GIS into a diverse array of Arts and Sciences courses is leading to further development of GIS modules for advanced courses, and is enhancing student research skills by providing students with multiple opportunities to engage in spatial data acquisition and analysis activities. The impact on undergraduate research skills is strengthened by Samford University's commitment to Problem-Based Learning (PBL). Faculty begin with a GIS short course at the start of their participation in the project, work with colleagues to develop GIS modules customized to the needs of specified courses, and introduce these GIS experiences to students enrolled in their courses. A follow-up workshop is provided to assess progress and provide assistance in the revision of GIS modules as appropriate.

Integrating Research, History, Current Events and Assessment into Interdisciplinary Science Education

Contributors: Anthony Carpi, John Jay College, CUNY; Alfred Rosenberger, Brooklyn College; Anne Egger, San Juan College; Yana Mikhailova, John Jay College, CUNY

Student learning occurs via many pathways. Moreover, the learning pathways that are most effective for any one student depend on that individual's personality, training and other predispositions. In the classroom, we, as teachers, overcome this challenge by offering students diverse learning tools including lecture, Socratic dialogue, demonstrations, question and answer sessions, practice exercises, and laboratories to name but a few. Unfortunately, outside of the classroom the tools available to students for learning have generally been limited to text, until recently. With the growth in the Internet over the last decade, the pathways for student learning have significantly expanded.

In 1998, we began experimenting with an integrated learning environment for undergraduate interdisciplinary science education. Our goal was to provide students with multiple pathways for learning scientific concepts to empower them to use those paths that best suited their individual learning style. Over the past five years, multiple environments and resources were tested. Extensive evaluations and science comprehension assessments were conducted at various stages during the development of these materials to identify the most effective resources for learning. The environment that has emerged from this work is one in which concise, targeted text-based

lessons that focus learners on a core concept are integrated with interactive simulations tools, articles discussing current events and scientific history, full-text research papers, a scientific glossary, and self-assessment exercises. This model, launched publicly with support from the National Science Foundation at http://www.vision-learning.com, has proven highly effective at improving science comprehension and retention among undergraduates (Carpi & Mikhailova, J. Coll. Sci. Teach. 23(1):12-15). Student users consistently rate the tools as more effective than traditional textbooks. In addition, our research shows that the system is highly adaptive to different learning styles, with users choosing the resources that are complementary to their individual learning style.

Integrating Science and Science Education in the Early College Curriculum

Contributors: Jenna Carpenter, Louisiana Tech University; Wes Colgan, Louisiana Tech University; Dawn Basinger, Louisiana Tech University

Focus: A freshman and sophomore integrated science curriculum (ISC) for all math, science, secondary science education and secondary mathematics education majors.

Approach: Develop 6 science courses (biology, chemistry, and physics), up to 6 mathematics courses (precalculus, calculus, and differential equations), and a 5-course science laboratory series (biology, chemistry and physics) that operate in cooperative, technology supported classrooms where content is integrated among courses that emphasize:

- teaming and communication skills;
- laboratory skills;
- mathematical thinking and problem-solving skills.

Deliverables: Mathematics course material that:

- demonstrates relationships between concepts from multiple disciplines;
- relates learning to real world examples;
- integrates teaming, critical thinking, problem-solving, and communication skills;
- integrates effective use of technology.

Science laboratory course materials that focus on more complex scientific problems requiring:

- application of concepts/ techniques from multiple disciplines;
- effective student communication and teaming skills;
- use of mathematics in context; and
- effective student-centered, standards-based instructional and assessment strategies.

Benefits to STEM Education: i) improvement in student connections between science and mathematics course content; ii) increased awareness and adoption of innovative teaching techniques in education majors; and iii) development of learning communities of students and faculty that increase retention rates and speedy progress towards graduation.

Dissemination: See website (http://www.coes.latech.edu/isc) for information on mathematics and science lab course materials and cooperative, technology-supported classrooms for teaching math and science. (NSF CCLI A&I 311481.)

Integration of Collaborative Case-Based Learning into Undergraduate Biology Curricula via Molecular Biology Computer Simulations and Internet Conferencing

Contributors: Mark Bergland, University of Wisconsin-River Falls; Karen Klyczek, University of Wisconsin-River Falls

Case It! is an NSF CCLI-sponsored, international collaborative project involving faculty in the departments of Biology and Teacher Education. The goal of the Case It! project is to enhance case-based learning in high school and university biology courses worldwide via molecular biology computer simulations and Internet "poster sessions". Our previous grant (1998-2003) focused on the development of case studies involving DNA analysis (PCR, Southern blot, dot blot), with an emphasis on human genetic diseases. Students first play the roles of laboratory technicians as they analyze DNA sequences associated with particular cases and construct web page posters giving results of genetic testing. They then play the roles of genetics counselors and family members as they ask and answer questions concerning these tests. To accomplish this, students use three software tools: Case It Investigator to gather background information, the Case It Simulation to analyze DNA, and the Case It Launch Pad to access a web page editor and Internet conferencing system. Class testing involved pre-service science teachers in videotaping, observing and interviewing introductory biology students as they use Case It! computer modules. The results of five years of class testing demonstrated that project improved student learning of biology concepts and encouraged students to examine related ethical issues. The goal of the current grant (2003-2008) is to add simulations of protein lab techniques (ELISA, Western blot) and infectious disease cases.

Integration of Simulation into Undergraduate Fluids/Thermal Science Courses at Howard University

Contributors: Leslie Ann Jones, Howard University; Robert Johnson, Howard University; Sonya T. Smith, Howard University

The project describes the development and integration of educational materials for use in fluids/thermal sciences related courses at Howard University. This work is performed in collaboration with the University of Iowa. The Howard University (HU) component of the project this year used templates developed at UI for FlowLab/ FLUENT in the Fluid Mechanics (MEEG 307) and Applied Thermodynamics (MEEG 306) core curriculum courses. Data from student surveys indicate a positive response to the redesign of these courses to incorporate simulation. The templates compliment the laboratory modules in Applied Thermodynamics course and replace them in the Fluid mechanics course. Previously, the fluids/thermal science sequence had only one experimental component which occurred in the second semester with the Applied Thermodynamics class. Future work includes the development of new templates at Howard University. All new teaching modules developed at Howard University will be made available to the University of Iowa and the other partners in the collaboration.

Integration of Stable Isotopes into Biology and Environmental Science Classes

Contributor: Renate Gebauer, Keene State College

Even though in the past two decades stable isotope analysis has facilitated new levels of understanding in diverse fields such as geology, hydrology, ecology, plant physiology, environmental science, and forensic science few undergraduates have had the opportunity to learn about and have hands-on experience with this modern technique. I will present examples of how we incorporated stable isotope analysis into a non-majors environmental studies class, a sophomore and upper level biology laboratory and in student independent research projects. I will discuss the pedagogical approach to involve students in the process of scientific investigation, and how these exercises were used to discuss important concepts and principles in the biological and environmental field.

Interactive Video: A Tool for Emphasizing the Science in Behavioral Science

Contributor: Gail M. Gottfried, Pomona College and LessonLab, Inc.

Because encouraging students to view psychology as a science enhances their critical thinking and hypothesis-testing skills, inventive new computer-based technology has developed for students to design and conduct supervised experiments. At present, however, resources for classroom experimentation with children are scarce, largely due to logistical and ethical difficulties. To fill this gap, we are using a powerful yet flexible portal-based software platform to develop a virtual laboratory in developmental psychology — a digital library including videos of experimental or observational sessions; transcripts of the sessions, time-coded to match the video; journal articles relating to the lesson topic; links to relevant documents on the internet; commentaries on the children's behavior (solicited from the researchers, parents, children, or other experts in the research area and time-coded to match the video); and interactive tasks that provide a framework for student interaction with the videos. Students gain access to the virtual laboratory exercises, organized in a "course" framework, through a password-protected online portal. The assignments can be used for an integrated, interactive laboratory class for psychological research or as a supplement to other behavioral science courses. The poster provides a detailed look into one set of assignments, focused on naturalistic observations of child language.

Intra-Curricular Software Engineering Education

Contributors: James B. Fenwick Jr., Appalachian State University; Barry L. Kurtz, Appalachian State University

Software engineering education at many comprehensive universities is constrained by a variety of factors including student motivation and available time as well as size and scope of practical projects. There is also concern about insuring individual competency when using group projects. We have a devised a project methodology that addresses some of these issues. The methodology is intra-curriculum because it involves a variety of different courses.

The project originates in an upper division software engineering course and draws upon the specialized expertise of advanced courses (e.g., database, networking, HCI) as well as a pool of junior programmers from low level courses (CS 1,2,3). The software engineers assume management responsibilities in addition to typical developer responsibilities. The other students get to contribute a meaningful component to a large project.

In addition to several iterations of employing this methodology, the grant has resulted in the deployment of two software systems aimed at specifying and controlling the quality of the programming work performed. One system is a C++ variant of the popular Java FIT acceptance testing framework. The other system, named QUIVER, is a high-quality, robust, extensible software verification tool. QUIVER has been used in several courses using both C++ and Java. Pedagogical lessons learned and demos of both software systems will be available.

Is Active Learning for Everyone? Findings from the ITIP Project

Contributors: Dee Silverthorn, University of Texas, Austin; Patti Thorn, Arizona State University

The 2000-2003 Integrative Themes in Physiology (ITIP) project was a collaborative effort of the American Physiological Society (APS) and the Human Anatomy & Physiology Society (HAPS). The project, supported by a CCLI-EMD grant, aimed to develop inquiry-based curriculum materials for teaching and assessing conceptual understanding of interdisciplinary themes in physiology. The theme for the proof-of-concept phase was "Conductance and gradients: What flows where and why?" Materials created by the development team were distributed to novice users, the site testers from HAPS, to assess their effectiveness. By the end of year 1, almost none of the materials had been evaluated and it became apparent that providing curriculum materials was not enough: we needed a strong faculty development component to the project. The goal in the second and third years was redirected to identification of critical issues encountered by faculty as they introduced or expanded student-centered teaching techniques. We used a combination of peer support through listserv conversations and individual mentoring to help site-testers tailor active learning activities to their situation. At the annual HAPS meetings, the grant collaborators held workshops on use of the curriculum materials. During the course of the project we found that even with assistance, some site-testers were not able to convert successfully from a traditional teacher-centered classroom to a student-centered learning environment. From these observations, we have now developed a model of the belief systems that characterize the teachers who are most likely and least likely to be successful in changing the way they teach.

Kinemage Authorship in Undergraduate Biochemistry: A Constructivist Approach to Teaching with Molecular Graphics

Contributors: Robert C. Bateman Jr., University of Southern Mississippi; David Richardson, Duke University; Jane Richardson, Duke University; Deborah Booth, University of Southern Mississippi; Rudy Sirochman, Georgia State University

Structural concepts such as the exact arrangement of a protein in three dimensions are crucial to almost every aspect of biology and chemistry, but most of us have not been educated in three-dimensional literacy and all of us need a great deal of help in order to perceive and to communicate structural information successfully. It is in

the undergraduate biochemistry course where students learn most concepts of molecular structure pertinent to living systems. We are addressing the issue of three-dimensional molecular literacy by having undergraduate students author kinemages. These annotated, interactive, three-dimensional illustrations are designed to develop a molecular story and allow exploration in the world of that story. In the process, students become familiar with the structure-based scientific literature and the Protein Data Bank. We have also developed a variety of instruments to assess this use of molecular graphics-based instruction. Our assessment to date has shown that students perceive kinemage authorship to be more helpful in understanding protein structure than simply viewing premade kinemages. In addition, students perceived kinemage authorship as being beneficial to their career and a significant motivation to learn biochemistry.

Leveraging Enhanced Learning in Computer Programming with Technology and Cooperative Learning Activities

Contributors: Jeffrey L. Popyack, Drexel University; Bruce W. Char, Drexel University; Nira Herrmann, Drexel University; Paul Zoski, Drexel University

This work addresses the problem of effectively delivering large introductory computer programming courses to a diverse student body in an active, participatory manner with limited faculty resources. The problem is complicated by the need for multiple versions for IT majors and non-majors with different goals and needs, and students' broadening diversity of prior experience and readiness for college-level academics.

The redesign has produced Web-based learning modules that engage students in active, participatory learning activities in a supervised environment. Course management tools are used to organize online materials, track student performance, and provide student feedback through automated quizzes and surveys. Practice exams are available as study tools. Online chat hours are used to supplement office hours and are well-attended.

Online submission and return of homework minimize the administrative efforts involved in administering large courses and allow faculty to focus more on the students and their learning. We have created a tool, Labrador, which facilitates downloading assignments and quizzes, post-processes them as appropriate for submission to plagiarism detection services, and converts them to PDF format where they can be graded electronically using pen-based Tablet PC's. The placement exam for assessing students' abilities to bypass introductory courses now incorporates an online test with partial autograding.

Learning outcomes have improved greatly. In general, we have been able to cover more material, ask more "coding" questions on exams, and have had better course performance in general from our students. Withdrawals and failures have dropped significantly while A's have doubled, with A/B/C's up sharply.

LifeLines OnLine: Investigative Case-Based Learning in Biology

Contributors: Margaret Waterman, Southeast Missouri State University; Ethel Stanley, BioQUEST, Beloit College

The LifeLines project (CCLI-EMD 9952525) developed science teaching methods and curriculum materials, prepared a cadre of faulty to use and disseminate those practices, developed a web site rich with resources and faculty products, and assessed the use o cases in college classrooms.

The pedagogical approach, Investigative Case Based Learning (ICBL), aligns problem-based learning with the investigative approaches found in the software, tools and resources of the BioQUEST Curriculum Consortium. Designed initially for adult learners in two year colleges, ICBL involves learners in a collaborative problem space describing a realistic situation. The case provides a context for learning,. Case analysis allows students to identify their own questions and prior knowledge. Students are encouraged to begin to answer questions from the case through extended science investigations, providing a more meaningful experience of science.

Over several workshops 135 faculty members from over 40 colleges and universities produced 65 curriculum modules, primarily in biology. Each module contains a case, related investigative activities, resources, assessments and implementation plans. NSF-funded participants have actively field tested ICBL curriculum modules in their courses, with over half making presentations on their ICBL work either at their institutions or at professional meetings. Several have led ICBL workshops and published their cases. The curriculum modules are part of the LifeLines OnLine website which serves as a portal to community resources for ICBL (http://bioquest.org/lifelines). Also included are extensive faculty development resources for ICBL, a student guide to using cases, field testing materials, ICBL bibliography and links to other case projects.

Making Introductory Physics More Like Real Physics

Contributors: Ruth Chabay, North Carolina State University Bruce Sherwood, North Carolina State University

We have created a new curriculum for the introductory physics course taken by science and engineering students, to address several serious problems. Despite good intentions by instructors and textbook authors, the material appears to students as a collection of special-case formulas rather than as a reductionist, unified approach applicable to a wide range of problems, including novel problems. The course has excluded the atomic nature of matter, focusing almost exclusively on macroscopic descriptions, which is inappropriate in the 21st century. The course does not include serious computational physics, which is now coequal with theory and experiment in contemporary science and engineering. The course fails to engage students in the modeling of messy real-world phenomena, so that students are not asked to make approximations, idealizations, simplifying assumptions, or estimates, and this encourages students to believe that physics has nothing to do with the real world. Our curriculum addresses these issues by having students start analyses from a small number of fundamental principles,

by emphasizing the atomic nature of matter and macro-micro connections, by enabling students to write computer programs to model physical systems and visualize fields, and by having students model real-world phenomena. See http://www4.ncsu.edu/~rwchabay/mi.

Modern Chemical Process Design: Combined Steady-State and Dynamic Approach (CSAD)

Contributors: Karlene A. Hoo, Texas Tech University; Uzi Mann, Texas Tech University; Eric M. Vasbinder, Texas Tech University

The present pedagogy of chemical process design covers only steady-state design concepts (resulting in a process flowsheet) but ignores operational and control considerations. These remain the domain of a control/instrument engineer. Unfortunately, operating requirements during startup and shutdown usually are much different than those at steady-state, and a process designed solely for a given steady-state condition may not be operational or controllable. Today's chemical industry needs more efficient design and they seek chemical engineers capable of doing the tasks of design and control simultaneously. This work addresses this issue.

NetSpy: Teaching Networking with a Programmable Network Sniffer

Contributors: Michael J Jipping, Hope College; Andrew Kalafut, Bradley University; Nathan Kooistra, Hope College; Kathleen Ludewig, Hope College

In the computer science curriculum, the Networking course stands out by virtue of its requirements. The course requires that a lot of difficult material be delivered to students, typically via "hands-on" active learning activities. Active learning and experimentation in a Networking course is typically done by examining a network via its traffic and interpreting the applications and protocols that run across that network. This experimentation is increasingly involving both wired and wireless networks.

Unfortunately, tools that facilitate network experimentation are either expensive or difficult for students to use. Special purpose tools to sniff networks are quite expensive and do not allow general purpose programming to analyze network data. Tools available on Linux or Windows platforms generate cryptic output that is not easily deciphered or analyzed. In addition, wireless network data is sufficiently different from wired network data that tools often do not work on both platforms.

This poster describes a system designed to teach Networking concepts and analysis by using Java to program a platform that delivers both wired and wireless network data. We have developed a system called NetSpy that consists of a network sniffing platform coupled with a Java plug-in interface. Using this interface, students can write Java plug-in modules that can receive network data for analysis. NetSpy has been implemented for handheld computers, extending its usefulness and experimentation ability.

Opening the Genetics Gateway with Automated Support for Student Thinking

Contributors: Albert Corbett, Carnegie-Mellon University; Elizabeth Jones, Carnegie-Mellon University; Ken Koedinger, Carnegie-Mellon University

Genetics is a fundamental unifying theme of biology. The Human Genome Project and advances in genetics and biotechnology will revolutionize biology, medicine and industry. However, genetics is an intimidating challenge for college students across the full range of post-secondary institutions and the growing demand for genetics education outstrips the supply of qualified teachers.

In this project we are developing a genetics cognitive tutor to support active problem-based learning in undergraduate genetics courses and make genetics accessible to more students. Cognitive tutors pose rich problem-solving tasks to students and provide the individualized advice students need to succeed. Cognitive tutors are based on an understanding of both the domain knowledge and strategies that students bring to bear in problem-solving. This problem-solving knowledge is represented as a "cognitive model" within the cognitive tutor, an embedded program that can solve the problems posed to students in the many ways that students solve them. As the student works, the cognitive model is used to follow the student's problem-solving path and provide individualized "just-in-time" feedback and advice. Cognitive Tutor mathematics courses are currently in use by more than 150,000 students in about 1500 high schools and middle schools.

In this project we are developing, piloting and evaluating cognitive tutor lessons in colleges and universities representing a diverse student population. Piloting includes summative evaluations of student achievement gains and formative evaluations of tutor effectiveness and student learning rates.

Paradigms in Physics: Revitalizing the Upper-Division Curriculum

Contributor: Corinne Manogue, Oregon State University

The Paradigms in Physics Program at Oregon State University has totally reformed the entire upper-division curriculum for physics and engineering physics majors. This has involved both a rearrangement of content to better reflect the way professional physicists think about the field and also the use of a number of reform pedagogies that place responsibility for learning more firmly in the hands of the students. We have developed many effective classroom activities that we are beginning to share in national workshops. Along the way we are also learning about what it takes to successfully design and implement large-scale modifications in curriculum and to institutionalize them.

Pathways Through Algebra

Contributors: Wade Ellis, West Valley College; Peg Hovde, Grossmont College; Terrie Teegarden, San Diego Mesa College

Beginning Algebra is one of the main stumbling blocks to student success in that the successful completion is necessary for attaining an AA or AS degree, completing certificated programs and transfer-

ring to four-year institutions. Statewide less than 50% of students who start this course attain a passing grade.

A statewide consortium has developed the Pathways through Algebra Project to address the national and statewide needs to improve the mathematics skills of undergraduate students, particularly for 'at risk' members of special populations. This project consists of a collaboration of the Pathways Task Force, a consortium of Community Colleges, researchers from the Center for Student Success and the Community College Foundation.

Project objectives include identifying, adapting, pilot testing, evaluating and disseminating three specific programs shown to increase success. These include: a math specific study skills course at San Diego Mesa College; computer assisted learning at West Valley College and a math study center at Grossmont College.

Descriptions, course outlines, activities and contact people are available at the website at algebrapathways.org.

Physical Oceanography Course Development, Adapting SCALE-UP at Coastal Carolina University

Contributors: Louis E. Keiner, Coastal Carolina University; Craig Gilman, Coastal Carolina University; Teresa Burns, Coastal Carolina University

We are transforming the physical oceanography curriculum at Coastal Carolina University (CCU) from a traditional lecture-lab structure to a technology-rich, collaborative learning environment by adapting the SCALE-UP physics instructional model (from North Carolina State University) and the Open Source Physics (OSP) curricular materials (from Davidson College). This project serves to increase students conceptual understanding of physical oceanography, which is vitally important to all marine scientists. This project combines the lecture and lab sections into an integrated instructional block, creates collaborative learning groups among the students, and develops in-class conceptual questions and activities to enhance student understanding. We have integrated computer analysis of oceanographic data into the course, adapted physics animations to model oceanographic phenomena, and are disseminating the results to other faculty and K-12 teachers in the area. This project improves their problem-solving ability and their ability to do problems and research activities in groups. We hope that by adapting methods that have been successful in Physics, we can influence the way that other Marine Science courses are taught at Coastal Carolina University and at other universities.

Principles of Design, Engineering, and Technology for Education Majors

Contributors: Peter Crouch, Arizona State University; Eugene Garcia, Arizona State University; Steve Krause, Arizona State University; Dale Baker, Arizona State University; Chell Roberts, Arizona State University; Sharon Kurpius, Arizona State University; Donna Schneel, Arizona State University

A pilot course on technological design for education majors was developed and taught by a team of two engineering and two education faculty. In the course problem-based learning engaged teachers in relevant real-life experiences in design laboratory activities and projects, which were required to be open-ended with alternative solutions. The education students also learned to infuse design, engineering, and technology fundamentals into K-12 curricula by transfer activities which could be the basis for lesson plans that emphasize a design approach to math or science activities. In the class the students used the design process to create artifacts or products using sensors, actuators, and microprocessors. In the final semester project, students designed, built, and documented devices of their own choice, including an "Ultrasonic Cyber-wand for Blind Children"; a "Sweet Spot Golf Putter" for training golfers; and an "Electronic License Plate" that allows parents to track a car their teenagers were driving.

Real Data Promotes Students' Understanding of Developmental Psychology

Contributor: Laraine McDonough, Brooklyn College & City University of New York Graduate Center

Undergraduate students' learn the basic principles of developmental psychology but often have difficulties understanding the ranges of behavior that are considered 'normal' for children at different ages. The goal of this research is to provide students with the experience of being researchers by showing them real data and having them make decisions about how to interpret the data. A DVD was created so that videotaped data on four measures of temperament could be viewed longitudinally (at 12-, 18-, and 24-months of age), cross-sectionally or by each of the four measures. Students watch the videotapes after which they construct dependent measures, code the data, and then conduct the analyses according to within-subjects or between-subjects designs depending on how they viewed the videotapes. Intercoder reliability is also an important part of this educational process. Students' first impressions of the videotapes are often on how variable the behaviors are not only between children but also within the same child at different ages in different tasks. After analyzing the data, students have a clearer understanding of how the conclusions they read in textbooks are often based on a rather prototypical view of development, one that may not true of any particular individual child. Students also gain an appreciation for how data can be interpreted in different ways. Through the use of the DVD, students learn what it means to conduct research, how to code and analyze data and, most importantly, how to engage in critical thinking about research. The next goal is to find data in other areas of research in order to design a research methods course for developmental psychology.

Research-Based Curriculum Development in Thermodynamics

Contributors: David E. Meltzer, Iowa State University; Thomas J. Greenbowe, Iowa State University

We have been engaged in a long-term project to create active-learning curricular materials for thermodynamics. Our initial focus has been on introductory university courses in both physics and chemistry, and we are now extending that focus to courses at the advanced-undergraduate level. The first phase of this project has been to investigate student learning as it takes place with standard instruction, and to probe students' reasoning with thermodynamic concepts in both physics and chemistry contexts. Based on this

research, we have developed preliminary versions of guided-inquiry worksheets that we employ in small-group-learning format. Assessment of the effectiveness of the materials, re-design, and further research and development are underway.

Research-Inspired Writing Skills for Upper Division Chemistry Majors

Contributors: Marin S. Robinson, North Arizona University; Fredricka Stoller, North Arizona University; James K. Jones, North Arizona University; Molly Robinson, North Arizona University

We are in the first year of a four-year project designed to promote research-inspired writing skills in upper-division chemistry majors. The materials (which will be piloted in at least 12 colleges and universities next year) focus on three writing modules: a journal article, a poster presentation, and a research proposal. In each module, students are taught to write for the appropriate audience through a series of reading, analyzing, and writing activities. The materials target students from diverse backgrounds, including language minority students, and are written for chemistry instructors with minimal training in teaching writing. Unique features of the materials include (a) the inclusion of "canned" research projects, making it possible for students without undergraduate research experience to complete data-driven papers; (b) the use of corpus linguistics, allowing for the development of instructional materials based on actual patterns of the language of chemistry; and (c) the accessibility of the materials to nonnative speakers. Assessment, linked to student learning and instructor/user objectives, is an integral part of the project. An overview of our materials will be presented and samples of our current coursepack will be available for review.

Rethinking the Mathematical Statistics Course

Contributor: Mary Parker, Austin Community College and University of Texas at Austin

Mathematics majors and students in some sciences typically take a more theoretical statistics course than a typical elementary statistics course. Typically this course has a prerequisite of calculus and probability. The discussion about curriculum reform in statistics has focused primarily on the elementary statistics course for the last decade.

What aspects of the reform in the elementary statistics course are also appropriate for the math stat course? What should we preserve in the current math stat course so that it continues to give mathematically sophisticated students a strong foundation in statistics? What additional tools and techniques of theoretical statistics should be introduced at this level? Within twenty years, when all students will be using the equivalent of a Mathematica-level program, what can/should we be teaching in theoretical statistics courses? How can a teacher who doesn't have the time/inclination to completely revamp his course make incremental changes that will better prepare students to understand and use contemporary statistics techniques?

Several projects/assignments will be presented whose intention is to enable students to combine insights from analytical techniques with those from simulation and numerical techniques.

The author has taught at the University of Texas at Austin since 1989: the senior-level math stat course for seven years and the graduate-level math stat course for four years. http://www.ma.utexas.edu/users/parker/

Sharing Our Best in Physiology Teaching

Contributor: Jenine L. Tanabe MD, Yuba Community College

Three isolated colleges in northern California form the Yuba Community College District. Reform of the Physiology curriculum at these 3 campuses is in process, a result of faculty and institutional collaboration. All instructors have adopted a uniform curriculum based on successful components from each campus, including computerized data acquisition, data set analysis, student-led inquiries and writing assignments. Supported by NSF CCLI Grant 0311064, all campuses will be similarly equipped with BIOPAC data acquisition equipment, microscopes, video microscopes and computers. Experience faculty will be assisting and mentoring less experienced instructors.

This poster will illustrate some of the student assignments used at YCCD, which can be successfully adapted to nearly any college. All three activities encourage thoughtful presentation of results and conclusions and examples of student reports will be available for review. The Dive Reflex activity fosters student-led inquiry, formation and testing of hypotheses, cooperative group learning, and scientific report writing. The Reaction Time activity quickly allows the development of a database for analysis and comparison. A Pairs Project is used to teach responsibility and creativity in the design and execution of student-led research.

Dr. Jenine Tanabe, Co-PI of the project, will be on hand to answer questions and demonstrate the Reaction Time lesson. Add your result to our database and see how your reaction time stacks up!

SimSE: An Educational Simulation Game for Teaching the Software Engineering Process

Contributors: Andre van der Hoek, University of California, Irvine; Emily Oh, University of California, Irvine

A large difference exists between the software engineering skills taught at a typical university and the skills that are desired of a software engineer by a typical software development organization. This problem seems to stem from the way software engineering is typically introduced to students: general theory is presented in lectures and put into (limited) practice in an associated class project. Although both lectures and projects are essential, they lack a practical, in-depth treatment of the overall process of software engineering—lectures allow only passive learning, and the size and scope of class projects are too constrained by the academic setting to exhibit many of the fundamental aspects of real-world software engineering processes. To address this problem, we are developing SimSE, a computer-based environment that allows the creation and simulation of software engineering processes. SimSE allows students to "virtually" participate in a realistic software engineering process that involves real-world components not present in typical class projects, such as teams of people, large scale projects, critical decision-making, personnel issues, multiple stakeholders, budgets, planning, and random, unexpected events. This poster introduces the concepts behind SimSE, discusses its structure, and will have an associated demo.

Some Mathematics for Citizens: Engaging Students through Public Policy Debate

Contributor: Daniel T. Kaplan, Macalester College

At Macalester College, we have developed a program to teach fundamental quantitative concepts that are important to participating in public policy debate. The program, Quantitative Methods for Public Policy, is an attempt to convince both students and faculty—the non-math types—that a basic fluency with quantitative topics provides a powerful lever for understanding policy debate.

In our program, students from many courses and departments meet together each week to hear experts speak on a policy topic—this year the topic is immigration. In between the experts' sessions, students hear about quantitative topics that illuminate, support, and often contradict the experts' claims.

The set of quantitative topics has been carefully chosen by a group of faculty to be accessible to students with no college-level mathematics and to be informative about a broad range of policy topics encountered in everyday news. Some of the topic are: rates; tradeoffs; correlation and causation; samplingand statistical inference; detection and classification.

Each quantitative topic is introduced in a way that directly addresses the year's policy issue. To generalize the concepts, we illustrate them with examples from many other policy issues, many drawn from newspaper articles so that students see the various ways in which reporting can be incomplete or misleading due to a failure in using basic quantitative concepts.

In the workshop I will give an overview of the quantitative topics, draw on one specific quantitative topic to show how strongly it informs the policy issue, and show examples of student exercises.

Spreadsheet Exercises in Geological-Mathematical Problem-Solving

Contributor: H.L. Vacher, University of South Florida, Tampa

Quantitative literacy (QL), or numeracy, is a problem-solving habit of mind that is developed by solving problems – not routine exercises, but (following Polya) problems that one needs to figure out how to solve. Geological numeracy is the intersection of QL and earth science content. My CCLI grant is to develop geological-numeracy spreadsheet modules to promote QL in earth science courses, and to bring earth science content into QL courses.

What began as modules has, after testing and assessment, evolved into sets of smaller, more-digestible modules. The modules are 15- to 20-slide, self-paced PowerPoint presentations containing embedded "How to Solve It" spreadsheets that students need to figure out. The sets of modules feature benchmark issues that are appropriate for courses in the history of mathematics and/or science, as well as various geology and QL courses. Titles thus far are: (1) The density of the Earth, (2) Scaling Galileo's solar system, (3) Kepler's third law, and (4) The floating lithosphere (isostasy and Archimedes principle). Problems students are asked to solve include: "What is the density of the Earth?" "How large is a ton of rock?" "How large is the orbit of model Saturn if model Earth is 1 ft in diameter?" "How fast is model Earth moving if model Saturn circles campus in 1 day?" "What is the pressure at the base of the lithosphere?" Quantitative content includes weighted averages, circle formulas, the concept that an integral is a sum, logic functions, and most importantly, rearranging equations to produce spreadsheet formulas.

Teaching Nanoscience

Contributors: Gregory J. Salamo, University of Arkansas; Min Xiao, University of Arkansas

Nanoscience is "the small" in every field of study—chemistry, biology, physics, medicine, engineering and material science. All sectors of science and engineering are being dramatically affected by nanoscience. Despite the rapid growth of nanoscience, little has been done to "bridge" traditional disciplines to this dynamic new field within the educational experience that we offer to our undergraduate students. This is unfortunate, since the study of "the small" is a beautiful way to learn many time-honored and new concepts in chemistry, physics, biology, and the engineering of materials. We believe that a *cross-disciplinary undergraduate education* can provide an exciting approach to building this bridge.

While it may be difficult to prove, we have a passionate belief that for many the development of individual creativity is dependent on "hand-on-experience" coupled with an opportunity to dialog about the concepts. In our new undergraduate course, "Voyage at the Nanoscale," we build in discussion times for basic science questions, with chalk board opportunities, invited discussions, problem sessions, and an overall interactive culture where the student, with scientists and engineers from different disciplines. This is coupled with the opportunity to design and carry out simple experiments that are built around an atomic force microscope along with nanofabrication tools.

Teaching Theoretical Stochastic Modeling Courses Using Industrial Partners and their Applied Problems

Contributors: Timothy I. Matis, New Mexico State University; Linda Ann Riley, New Mexico State University

This project creates an innovative learning environment that addresses the challenges of undergraduate engineering and sciences students enrolled in stochastic modeling courses. In particular, these students often have difficulty transferring this knowledge to real industrial problems since the traditional program of study is primarily focused on theoretical development of the subject and not the application of such. Thus the objectives of this project center on incorporating "real-world" applications into the curriculum of an Industrial Engineering (IE) stochastic processes course through the development of a set of technology-based modules in conjunction with several industrial partners. Each module consists of a self-contained DVD that describes a problem through a set of movies, supporting documents, data, and student resources. As a new approach to the discovery and learning process, this project plays an integral role in facilitating knowledge acquisition and transfer among students. In many cases, the traditional delivery of a stochastic modeling course has relied little on technology. With the comprehensive integration of modern technology, however, many of the previous barriers to learning are eliminated. Outcomes of this project are an improved learning environment, higher levels of student transferal of knowledge, the exposure of students to a number of different

technological tools, the integration of advanced technology in the design and creation of the modules, and a curriculum package that is highly transferable to other programs and universities offering stochastic modeling courses.

The Multi-Initiative Dissemination (MID) Project: Materials and Methods for Curricular Reform

Contributors: Eileen Lewis, Univeristy of California, Berkeley; Brock Spencer, Beloit College; G. Earl Peace, College of the Holy Cross; Arlene Russell, University of California, Los Angeles; Pratibha Varma-Nelson, Northeastern Illinois University; Jennifer Lewis, University of South Florida

The Multi-Initiative Dissemination (MID) Project is the union of five systemic curricular reform projects supported by the National Science Foundation in the field of chemistry. These projects are:

- ChemLinks and ModularChem Consortium which have joined to form ChemConnections (http://mc2.cchem.berkeley.edu/);
- Molecular Science (http://www.molsci.ucla.edu/),
- New Traditions (http://newtraditions.chem.wisc.edu), and
- The Workshop Project (http://www.sci.ccny.cuny.edu/~chemwksp/).

The MID Project disseminates the materials and methods of these systemic reform projects as well as information and experiences in the research of teaching and learning as well as assessment. This poster will acquaint conference participants with the goals, methods, and leaders of the MID Project as well as introduce them to some of the tested and proven innovative teaching strategies developed by the projects. The poster will also show responses and outcomes from the approximately 800 faculty who have attended the MID Project Workshops to date.

The Probability/Statistics Object Library

Contributor: Kyle Siegrist, University of Alabama, Huntsville

The Probability/Statistics Object Library (http://www.math.uah.edu/psol) is a library of Java objects for use by teachers and students of probability and statistics. The objects are of two basic types: complete applets and components of applets.

The applets in the library are simulations of random processes, designed to illustrate concepts and techniques in a dynamic and interactive way, and designed to show the agreement between the behavior of random processes and the predictions of the mathematical theory. The applets are intended to stand alone, so that a teacher can easily embed applets in web pages and then add expository text, graphics, data sets and other elements to create a rich, customized learning environment.

The components in the library are the building blocks of applets and other components. Teachers and students can use the components to create custom applets in probability and statistics without having to do much of the low-level, tedious programming, and thus in a fraction of the usual time. The components are of three basic types: virtual versions of physical objects such as coins, cards, dice, and spinners; virtual versions of mathematical objects such as probability distributions and data structures; and custom interface objects such as graphs, tables, and input devices.

The components in the library are designed according to a carefully constructed object model. The mathematical Java objects, in particular, are designed to parallel the underlying mathematical theory, and thus illustrate the close connections between abstract mathematical structures and object oriented programming. All objects in the library are freely available for use, modification, and redistribution according to the General Public License. The Probability/Statistics Object Library is supported by a grant from the Division of Undergraduate Education of the National Science Foundation, award number 0089377.

Three CD-ROM Projects That Provide Modular Supplements for Lectures and Labs in Neuroscience, Cognitive Studies, Psychology, and Genetics

Contributors: Ron Hoy, Cornell University; Bob Wyttenbach, Cornell University; Patricia Rivlin, Cornell University; Bruce Johnson, Cornell University

A group of faculty, research associates, and instructors of neurobiology and behavior at Cornell have developed/are developing a series of CD-ROMs for college and university instructors of undergraduates.

One CD is called "Crawdad" and features a set of laboratory exercises for a semester or quarter of neurobiology laboratories, at the junior-senior level. The modules can also be imported into standard labs in physiology, to provide some neural content. The use of invertebrate animals (crayfish and snails) bypasses many of the animal welfare and use issues that beset labs that rely on traditional exercises using frogs, turtles, and certainly, mammals. "Crawdad" is especially aimed at teaching the integrative action of the nervous system, providing opportunities to teach/learn about sensory and motor systems within the context of observable behavioral acts.

A second CD, "Cognitive Illusions," the phenomenon of sensory illusions and what they can mean for how the brain generates our perceptual world. It is a collection of classic as well as new examples of sensory illusions which can be run from any student's laptop as well as uploaded into an instructor's computer for lecture supplementation. The aim is to provide compelling instructional material that can be used in courses in Psychology, Neuroscience, and the Visual Arts.

A third CD, "Fruitfly," is under development and is aimed at undergraduate courses in genetics, psychology, and neuroscience. "Fruitfly" tackles the relationship between genes, experience, and behavior in an experimental system, Drosophila melanogaster, in which the genetic analysis of specific behavioral mutants allows students to "drill down" to the level of genomics and proteomics (using internet data bases) as well as observe phenotypic abnormalities at the level of individual fly behavior. Where appropriate, neural analyses will be presented via genetic dissection of behavioral acts. Finally, more complex behavioral systems which are under polygenic control can be analyzed at the level of population genetics. At all levels, a quantitative, computational approach will be high-lighted, in keeping with the aim of integrating mathematics with biology.

A fourth CD, "Koe—a virtual voice for learning about sound" is also under development and is aimed at undergraduate courses in introductory psychology, biology, as well as upper level courses in neuroscience, cognitive science, music, and allied health sciences. Koe is a

software workstation that provides students with the "tools" of a acoustics laboratory that allows students to test and measure their's (and their classmates') auditory performance and abilities. Koe can be adapted to focus on human speech, music, or animal acoustics applications, or the physics & engineering of acoustics courses.

Transforming Biological and Engineering Statistics Courses

Contributor: William L. Harkness, Pennsylvania State Universisty

Learning requires practice and engagement. At Penn State, the Department of Statistics restructured several courses that reflect this philosophy. Transforming Biological and Engineering Statistics at Penn State was a year long proof-of-concept project that placed the emphasis on active and collaborative learning in two advanced courses that serve STEM students: (i) Introduction to Biostatistics, serving students majoring in pre-med, biology, biochemistry, molecular biology, forestry, and other related areas and (ii) Experimental Methods in Engineering, serving students in engineering and computer science.

The objectives of our project included increasing the students' mastery of statistical strategies, improving their ability to transfer knowledge of statistical concepts to problems in different disciplines, and fostering the collaborative skills that their professional lives will require. The learning environment was transformed through interactive labs, collaborative projects, and frequent preparedness assessments. Students now spend class time about equally in lectures, computer studio labs and discussion sessions, with the labs enabling hands-on experience with statistical analysis and interpretation, individually and in teams. Discipline-specific materials and activities were developed that take full advantage of current technologies to tailor courses to the students' needs.

In this poster session, we will describe the scope of our project, and its objectives, portray uses of technology, discuss assessment techniques that enhance student performance, provide numerical comparisons on performance in the prior and transformed courses, and relate student and faculty perspectives on the altered educational environment.

Using an Environmental Disaster to Combine Teaching Environmental Chemistry with Undergraduate Research

Contributors: Jeanette K. Rice, Georgia Southern University; J. David Jenkins, Georgia Southern University; Fredrick Rich, Georgia Southern University; Steven Vives, Georgia Southern University

Southeast Georgia has a history of mercury contamination due to unregulated industrial waste disposal. This resulted in four EPA Priority One Superfund Sites in the Brunswick, Georgia area. Long term effects of mercury exposure are deleterious to normal human functioning. The propensity of mercury species to migrate to surrounding areas, and the potential for harm when plant and animal species from contaminated sediments are consumed, leads to an increased interest in the levels of mercury in coastal sediments from neighboring sites. This is particularly relevant with regard to species that spend the majority of their time in contaminated sediments, as mercury readily bioaccumulates. Coastal communities enjoy sport and commercial fishing, and typically consume high quantities of seafood. Georgia has issued a coastal fish warning, owing to increased levels of mercury contamination, however, compliance can not be enforced and public awareness is typically low. We have incorporated this local disaster into the undergraduate environmental chemistry and research curriculum at Georgia Southern, and this presentation focuses on the results to date and the student outcomes from participating in this type of hands-on learning.

Using Controlled Failure to Teach Software Development Process – and Assessing the Results

Contributors: David Klappholz, Stevens Institute of Technology; Lawrence Bernstein, Stevens Institute of Technology

Successful software development requires expertise in both State of the Art (software technology) and State of the Practice (software development process). A far larger fraction of software development projects fail than do projects in any other field in which products are developed. The almost universally accepted reason is the lack of education in and acceptance of State of the Practice. Software development process is unfortunately learned, if it is learned at all, by experiencing project failures, on the job, over a relatively long period —and, hopefully, understanding the causes of their failure.

We have developed a method, Live-Thru Case Histories, for quickly motivating Computer Science students to the critical necessity of learning software development process, and for teaching it to them, by causing them to fail in small development projects, each one emphasizing specific process issues. Live-Thru Case Histories have been used, to good effect, over a number of years in the (undergraduate) Senior Project course at Stevens and in Barry Boehm's graduate Introduction to Software Engineering at USC.

To measure the effects of Live-Thru Case Histories, we have developed survey instruments for measuring attitude towards and knowledge of software development process and are developing an instrument to measure ability to apply software development process. The reliability and validity of the various instruments have been tested through administrations to students at Stevens and USC and to software development professionals at STC 2002 and STC 2003, at various SPIN meetings (LA SPIN and Southern CA SPIN), and at other venues.

Using Just-in-Time Teaching Techniques in Economics

Contributors: Scott Simkins, North Carolina A&T State University; Mark Maier, Glendale Community College

Over the past two years we have been adapting an innovative teaching technique originally developed for physics education – Just-in-Time Teaching (JiTT) – for use in introductory economics courses. Broadly speaking, JiTT techniques combine the use of out-of-class web-based exercises with active-learning pedagogy in a traditional classroom setting that makes students active participants in the learning process. By exploiting the communication and instructional efficiencies provided by the web and web-based course management tools and directly linking out-of-class student academic work with classroom-based learning, JiTT promotes increased student participation in the learning process, provides students and

faculty with prompt feedback on student learning, and encourages better student preparation for class.

This poster provides a description of JiTT pedagogy, its grounding in well-developed educational principles, and our experience with the development, implementation, and assessment of JiTT pedagogy in economics. We are particularly interested in the question, "how well does JiTT work in practice?" Our classroom assessment, based on learning outcomes, student responses to JiTT questions, and students' feedback on the role of JiTT in their learning process, provides some initial answers to this question.

Vade Mecum^2: Educational Multimedia Courseware for Developmental Biology

Contributor: Mary S. Tyler, University of Maine

Multimedia offers an inexpensive and dynamic method for augmenting courseware in biology. To this end, we have created an interactive CD-ROM-web hybrid, Vade Mecum^2: An Interactive Guide to Developmental Biology (Tyler, M.S. and R.N. Kozlowski, 2003, Sinauer Assoc.), which takes the student through the developmental cycles of a number of model organisms and illustrates techniques used in studying these organisms. It includes chapters on slime mold; flatworm; sea urchin; fruit fly; chick; amphibian; and zebrafish. Techniques chapters include the microscope, microdissecting tools, and histological techniques. Vade Mecum^2 includes a searchable glossary as well as definitions of words on rollover; sets of study questions in PDF format; a feature called iVade Mecum, which connects users to interactive puzzles, web sites, and allows users to create personal bookmarks. The CD also links to the web site we created (http://www.develolpmentalbiology.net) to augment the CD, including recipes, glossaries, developmental staging series, addresses of suppliers, and news stories in science. Included on the CD-ROM, in electronic form, is the lab manual, Developmental Biology: A Guide for Experimental Study, 3rd Edition, (M.S. Tyler), which is fully integrated with the CD, with hyperlinks for glossary terms and contents. Vade Mecum^2, therefore, offers an integrate package of learning materials, allowing students to fully prepare for and gain the most from their laboratory experience. Support: NSF-DUE-CCLI Grant 0087657.

What Can We Learn from Teaching Biology Majors, Non-Science Students, and High School Students Microbiology?

Contributors: Debra L. Wohl, University of Richmond; Paula B. Lessem, University of Richmond

Under the guidance of the simple adage "learning is by doing," we have offered experiential learning opportunities to three different populations of students: University of Richmond undergraduates (biology and non-science students) and high school students enrolled in Greater Richmond Area Health Education Consortium summer program. To maximize student learning and efficiency in presentation, we developed one general course design that could be delivered to our three targeted populations. Both the non-science student's course (Unseen Life) and the biology major's course (Microbiology) are offered during the spring semester, which results in similar preparations. Similar in design and subject, Microbes: Life's Small Beginnings (Microbes) is then offered during the summer to high school students. All three courses use the same field sites for sample collection. From the samples, bacteria are isolated and used throughout the course in a series of investigative and hypothesis driven laboratories. Investigations have focused on antibiotic resistance in environmental isolates. Through this teaching model, we have identified differences in learning motivations, as well as created an environment with dialogue and mentoring opportunities across these three disparate student populations.

Workshop Precalculus: Developing Pedagogically Powerful Instructional Materials for an Integrated Course in Functions, Data Analysis and Modeling

Contributors: Nancy Baxter Hastings, Dickinson College; Allan Rossman, California Polytechnic State University, San Luis Obispo; Priscilla Laws, Dickinson College

In the Workshop Precalculus project, the principal investigators are working closely with project consultants to design, evaluate and disseminate instructional materials that seek to help students develop a firm understanding of the function concept and the interplay between functions, data analysis, modeling, and problem-solving.

Workshop Precalculus provides a bridge between the use of mathematics in the real world and the study of calculus. The materials, which will be published by Key College Publishing, are appropriate for both mathematics and liberal studies majors and for use in the quantitative reasoning component of a university's general education program. They are being tested at model adopter sites, representing a variety of institutions, using a variety of teaching formats. Two five-day summer institutes and a weekend institute were conducted to help faculty utilize the materials in their own environments.

Distinctive features of the materials include: (1) replacement of formal lectures with student observations, computer or graphing calculator work, and interactive discussions—in other words, implementation of the "workshop" approach; (2) motivation of underserved populations, especially students who have anxiety about studying mathematics or do not respond to traditional modes of instruction; (3) use of real world projects as an essential vehicle for motivating underlying mathematical ideas; (4) integration of data analysis and probabilistic concepts throughout the materials; (5) innovative use of technology, including Logger Pro and Fathom, to enhance student learning; and (6) close attention to the outcomes of educational research in mathematics and science and to the outcomes of the project's assessment activities.

For more information, contact Joanne Weissman, Workshop Mathematics Project Manager, weissman@dickinson.edu.

Visualization

An Interactive Water Flume with Laser-Based Flow Visualization for Improving Undergraduate Understanding of Fluid Mechanics

Contributor: John P. Crimaldi, University of Colorado at Boulder

Teaching fluid mechanics to undergraduates is made challenging by the difficulty of directly observing basic internal flow phenomena (e.g., boundary layers, flow around obstacles, and turbulence). This project adapts and implements a sophisticated research technique, Planar Laser-Induced Fluorescence (PLIF), into a safe, versatile, and robust instructional tool at the University of Colorado. The PLIF system is part of a dedicated teaching flume, and students use the facility to interact with and visualize fluid flows. The resulting laboratory experiences are combined with classroom discussions about the observed physical processes to create an enhanced learning environment. Projects are often based on research activities occurring within a combined teaching/research laboratory space to foster a strong sense of purpose in the students.

Exploring the Role and Effectiveness of Visualization in Computer Science Education

Contributor: Thomas L. Naps, University of Wisconsin, Oshkosh

Recent surveys of computer science educators suggest a widespread belief that visualization technology positively impacts learning. However, experimental studies designed to substantiate the educational effectiveness of such visualization technology simply do not bear this out.

Closer inspection of past experimental studies reveals an important trend in those studies: that learners who are actively engaged with the visualization technology have consistently outperformed learners who passively view visualizations.

It therefore makes sense to study the educational benefits of various forms of active engagement in the particular context of using visualization technology. This charge was given to the working groups on "Improving the Educational Impact of Algorithm Visualization" at the 2002 ITiCSE conference in Aarhus, Denmark and on "Evaluating the Educational Impact of Visualization" at the 2003 ITiCSE conference in Thessaloniki, Greece. The thesis developed by these groups (of which I was co-chair) is that visualization technology must engage learners in active learning to be effective. If this is true, we need explore different ways of actively engaging learners with visualization technology to achieve a positive impact on their learning.

The groups went on to broadly define six different forms of learner engagement with visualization technology. This poster will present a summary of the groups' conclusions. Additionally, I will demonstrate JHAVÉ, an algorithm visualization platform I have developed to take advantage of these different forms of learner engagement.

Innovating Environmental Pedagogy: Interactive Visualization of the 3D Structure and Nonlinear Dynamics of Complex Ecological Networks

Contributor: Richard J. Williams, Pacific Ecoinformatics and Computational Ecology Lab

This poster describes compelling cross-platform software that helps analyze and visualize complex ecological networks. These network focus on food webs, or who eats whom in ecological systems, but also includes a variety of non-feeding interactions such as competition for nutrients and space. The software incorporates cutting edge information technologies including semantically annotated knowledge bases and high performance OpenGL rendering of 3D visualizations. Both browser-based software for education and java-based software for research will be demonstrated. Users may choose or create the network to be analyzed as well as subject it to species loss and invasions amongst many other options. The NSF projects supporting this work continue to 2008.

Interactive Simulations of Physical and Astrophysical Processes

Contributor: Richard McCray, University of Colorado

We'll demonstrate a few java applets designed for student exploration of physical and astronomical phenomena, including: (1) random walk diffusion; (2) transfer of radiation; (3) Interstellar communication; (4) detection of extra-solar planets.

Linking Visualizations Online to Discover and Unify Mathematics

Contributors: Bob Palais, University of Utah; Andrej Cherkaev, University of Utah; Elena Cherkaev, University of Utah

We will describe and demonstrate some of the visualizations emphasizing the connections and unifying principles relating fundamental mathematical concepts. Some examples are the mathematics of translations and rotations in two and three dimensions, composition, iteration, and inversion, and instantaneous and cumulative change.

Project CLEA's Virtual Educational Observatory: The Universe on a Desktop

Contributors: Laurence Marschall, Gettysburg College; Glenn Snyder, Gettysburg College; P. Richard Cooper, Gettysburg College

The demands of our increasingly technical society require that today's students develop strong analytical skills and learn how to think in a quantitative manner. In this poster we present two projects that address these skills, one from biology, and one from astronomy, and that focus on the use of modern methods of data collection and analysis.

It is traditional in biology for students to gather and analyze data sets that they generate on their own through activities like counting seeds or measuring enzyme activity. However, the labor-intensive nature of these activities prevents students from generating and analyzing large numbers of diverse data sets during the course of a 50 minute class.

Students can therefore benefit by using pre-compiled biological data sets, which allow them to concentrate more on analysis than on routine data-taking. These sets include specific types of DNA sequences, structural data generated through x-ray crystallography, and data from laboratory procedures such as growth curves, electrophoresis, ELISAs, and protein assays. Participants in this workshop will have the opportunity to work with a data set of molecular structures, with Cn3D, a structure visualization program available from the National Center for Biotechnology Information.

Data taking in astronomy is not only labor intensive, but often involves very expensive and complex equipment, and it must often be done at times that are inconvenient for teaching schedules. In the second part of this workshop, participants will be introduced to the materials developed by Project CLEA, which draw on established databases of astronomical information on stars, pulsars, galaxies, and other objects to teach students how astronomers gather and analyze data. CLEA software simulates the operation of large optical, radio, infrared, and x-ray telescopes, and allows students to collect and visualize data selected from large astronomical datasets.

Publishing Your Own Multimedia Map Using Dynamic Digital Map Template

Contributor: Christopher D. Condit, University of Massachusetts, Amherst

A Dynamic Digital Map is a stand-alone "presentation manager" program that displays maps, images, movies, data and text from CDs or via the WWW without the use of browsers. DDMs are created using the multi-platform Revolution programming environment, which features English-like code. Starting with a "DDM-Template" (an open source Revolution program) the author/compiler inserts links to maps, images, and movies, and also text and data to make their own DDM. A "Cookbook" provides a guide to the steps of building the DDM. Once the Template has been modified, the author can create a series of multi-platform stand-alone applications in a single operation.

The key features and functions that enable DDMs to display features in way that takes advantage of their digital format include: 1) The "DDM-Home Screen" and "Index" lists, which displays the content and provides access to the parts of a DDM; 2) Multiple ways to display components, including hypertext links, buttons, author generated camera icons and menus; 3) Instant data display by a click on unit or sample text labels placed on maps and images; 4) Global search capability to find and center maps and images on a requested feature; 5) The ability to display text and captions aimed at three different audiences (or in three different languages).

DDM examples (URL: http://ddm.geo.umass.edu) have been made for the Tatara-San Pedro volcanic complex in Chile, the Springerville volcanic field in Arizona, originally published by the Geological Society of America on CD (Condit, 1995a), and for the geology of western New England (including six field trips).

Teaching Spatial Analysis and Data Visualization in Undergraduate Social Science Research Methods and Data Analysis Courses

Contributor: Richard LeGates, San Francisco State University

This workshop will describe instructional modules designed to teach undergraduate social science students in junior-level research methods and data analysis courses how to do spatial data analysis using Geographical Information Systems (GIS) software and how to represent spatial and aspatial data visually. A faculty/student team at San Francisco State University is developing the modules with NSF CCLI-EMD support. Each module will consist of a 200-age softback course textbook, a CD-ROM with instructional datasets, and supporting web material. The material will focus on teaching students to understand and device public policy solutions to urban problems at the global, regional, and local levels. The workshop will consist of a lecture/discussion describing the pedagogical approach and the nature of the modules.

The Hidden Earth Curriculum – Interactive Visualizations in Introductory Geology Courses

Contributors: Stephen J. Reynolds, Arizona State University; Michael D. Piburn, Arizona State University

Geology is arguably the most visual of the sciences. Visualization by geologists takes place at a variety of scales, from the outcrop to the region to the crystal lattice. Geologists use clues gained at the surface to infer and visualize the geometry of rock units hidden in the subsurface –the hidden Earth.

The Hidden Earth and Hidden Earth Curriculum Projects have explored the connections between visualization and learning in college geology courses, by developing a rich suite of computer-based visual resources, with which students interact to construct knowledge and gain visualization strategies. The computer-based materials are detailed two-dimensional representations depicting three-dimensional perspectives of simple and complex geologic structures and landscapes. The 3D models can be rotated, tilted, sectioned, successively unburied, and made partially transparent to reveal the internal structure. To date, we have created many interactive animations and associated curricula, including Visualizing Topography, Interactive 3D Geologic Blocks, Interactive 3D Geologic Maps, Visualizing Landscapes, Biosphere 3D, and Visualizing Sedimentary Environments.

We have used these materials to research how students use and learn from these visualizations. In one experiment, all subjects profited from both the control and the experimental conditions, but the experimental group, which used the visualizations, profited more than the control group based on normalized gains and other measures. The experiment also had the result of equalizing the performance of males and females and improving the students' overall spatial visualization ability.

The PascGalois Project: Visualization in Abstract Mathematics

Contributors: Michael J. Bardzell, Salisbury University; Kathleen Shannon, Salibsury University

Salisbury University, in collaboration with California State University Fresno, Humbolt State University, Kennesaw State University, New College of Florida, and Pittsburg State University, will develop computing technology materials to enhance the teaching of upper level mathematics courses and courses for prospective secondary education teachers. This is a follow-up to the Proof-Of-Concept CCLI PascGalois Project grant which focused on abstract algebra. The PascGalois Project provides an interesting class of discrete dynamical systems generated over algebraic structures and color graphical representations of these systems that allow students to "see" algebraic and number theoretic properties intertwined with the dynamics. Fractal-like growth is often found in the time evolution of these systems. The primary objectives of the PascGalois project are to: develop laboratory activities and supporting Java applets that provide a visual component for courses such as abstract algebra, discrete mathematics, number theory, dynamical systems, and computer graphics; develop students' visual and intuitive understanding of difficult mathematical concepts; model effective use of technology for prospective mathematics teachers and better prepare them to implement the NCTM standards; create a bridge between upper level courses and undergraduate research, for both mathematics and computer science students, by providing a source of interesting and accessible research projects. Two summer PascGalois retreats at New College of Florida will highlight the undergraduate research efforts.

Video and Image Data Access (VIDA): A Practical Visual Database for Connecting Facts into the Broader Organization of Key Science Ideas

Contributors: Nancy Pelaez, Biological Science, California State University Fullerton; Debra Winters, School of the Arts, California State University Fullerton

VIDA provides a framework for non-science majors who are prospective elementary teachers (PETs) in the form of a science image and video database. Visual reasoning is usually integrated with verbal and mathematical reasoning when meaning is constructed in science. As novices, when PETs reason about science, they struggle to connect isolated facts into the broader organization of key ideas. The VIDA framework covers key science ideas that PETs will be expected to understand and teach. Images assist as a concrete resource to develop questioning strategies about key ideas derived from similarities and differences, sequence of events, and patterns of change, scale, or systems. The VIDA visual resources are organized by keywords from a hierarchical controlled science vocabulary developed as a framework to help PETs notice the patterns that expert scientists find meaningful. The process of annotation and placement of images in the relational database teaches PETs to extract meaning while making the images useful to others. The controlled vocabulary and cataloguing manual explain the VIDA relational database structure's classification, relation, and annotation guidelines. The cataloging fields are compatible with the AAAS BiosciEdNet.org for sharing searchable published image sets on the web. Two tools (Extensis Portfolio for video and images and DAG-Edit for construction of the keyword hierarchy) facilitate publication of searchable image sets for PETs and other students to CD-ROM. The VIDA manual can be adapted by college faculty to develop discipline-specific visual and verbal frameworks for image collections that would be useful for target student populations other than PETs.

Visualizing and Analyzing Earth Processes with a GIS

Contributor: Michelle Hall, University of Arizona

Providing students with learning experiences that model scientific discovery is difficult, especially in courses that have no laboratory component. To address this problem in a large, introductory geologic hazards course for non-science majors, we introduced a series of learning modules that use ESRI's ArcView® GIS to investigate plate tectonics, geologic hazards, and tropical cyclones. The modules are developed around the learning cycle to promote exploring data, identifying patterns and linking those patterns to Earth processes. These activities provide rich learning experiences for students with diverse learning styles by incorporating both quantitative and visual analysis tools. The activities are designed to take full advantage of the visualization and multimedia integration capabilities inherent to GIS, while minimizing the need for the instructor or student to master an individual GIS software package. Over 96% of the students in one course successfully completed these activities as a homework assignment with scores of 84% or better. Evaluation studies show that student knowledge of a topic increased 17% after completing our activities. The exercises take 1.5-2 hours each and are completed as homework, although optional help sessions are available. Initially, students struggled to make observations. They were uncomfortable with their own judgment and the open-ended nature of some questions. With time and experience they became adept at data exploration and ultimately, most students explored their own questions in addition to those in the exercise. Overall, students expressed satisfaction with the assignments and enjoyed the process of exploration and discovery or verification of concepts addressed in the lecture.

Visualizing Social Change

Contributors: David Halle, University of California, Los Angeles; Andrew A. Beveridge, Queens College and Graduate Center CUNY

This project organizes a collection of web-based visual, map enabled, demographically rich materials that enables users at all levels of sophistication to depict and explore growth and social change in the United States since its founding.

The following elements are part of the project: 1) Census data and maps at the county level from 1790 through 2000, which depict the sweeping change in the United States; 2) Census data and maps at the tract level beginning for the largest cities in 1910 expanding until 1990 the entire country is available; 3) Data from the street and road layer of the Census, which is part of the national map of the United States and used to define Census tracts and other census geography; 4) Available images and text that can be geographically located and related to the underlying demography and geography; here we use the award winning photojournalism of Camilo Vergara, who has documented areas of the large cities for the past 30 years; his material will illustrate the demographic material, while the demographics will provide context for his photos; 5) A system for visually displaying and manipulating the maps, data, images and texts.

Web-Based Coursework

A Web-Enhanced DVD as an Instructional Supplement for the Physical Chemistry Course

Contributors: Gabriela C. Weaver, Purdue University; Marcy Hamby Towns, Ball State University; Peggy O'Neil Jones, Metropolitan State College of Denver and Media21; Richard Schwenz, University of Northern Colorado

We are in the midst of developing a 10-chapter DVD (Digital Versatile Disc) to be an instructional supplement to the undergraduate Physical Chemistry course. Each chapter consists of a video movie about scientific research on a topic that relates to the Physical Chemistry curriculum and also has some "real life" applicability that students can relate to. The digital video can be viewed on a standard set-top TV DVD player or on a computer using standard DVD software. In addition, each chapter contains integrated HTML material as background material and problems, all connected seamlessly to the video component through a specialized browser application. The DVD now has three modules completed and three more have been videotaped and are in the editing phase. The two completed modules have been used with students at three different institutions for the last two years. This presentation will demonstrate and describe the features of the DVD and describe the process of creating it. I will also discuss various approaches we are taking to assessing its effectiveness as a learning tool. Preliminary results from qualitative and quantitative studies will be shared.

EarthEd Online: Doing an Even Better Job Teaching the Large Introductory Oceanography Class

Contributor: William Prothero, University of California, Santa Barbara

The purpose of the EarthEd Online software project is to support a modern instructional pedagogy in a large, college level, earth science course. It is an ongoing development project that has evolved in a large general education oceanography course over the last decade. Primary goals for the oceanography course are to support learners in acquiring a knowledge of science process, an appreciation for the relevance of science to society, and basic content knowledge. In order to support these goals, EarthEd incorporates: a) integrated access to various kinds of real earth data (and links to web-based data browsers), b) online discussions, live chat, with integrated graphics editing, linking, and upload, c) online writing, reviewing, and grading, d) online homework assignments, e) on demand grade calculation, and f) instructor grade entry and progress reports.

The software was created using Macromedia Director. It is distributed to students on a CDROM and updates are downloaded and installed automatically. Data browsers for plate tectonics relevant data ("Our Dynamic Planet"), a virtual exploration of the East Pacific Rise, the World Ocean Atlas-98, and a fishing simulation game are integrated with the EarthEd software. The system is modular which allows new capabilities, such as new data browsers, to be added.

Student reactions to the software are positive overall. They are especially appreciative of the on demand grade computation capability. The online writing, commenting and grading is particularly effective in managing the large number of papers that get submitted. The TA's grade the papers, but the instructor can provide feedback to them as they grade the papers, and a record is maintained of all comments and rubric item grades. Commenting is made easy by simply "dragging" a selection of pre-defined comments into the student's text. Scoring is supported by an integrated scoring rubric. All assignments, rubrics, etc. are configured in text files that are downloaded from the course web server. Students rate the writing assignments as the most effective learning activity in the course.

This project is in an evaluation and dissemination phase. An open source model is planned for distribution. For documentation and information about the EarthEd team, see: http://oceanography.geol.ucsb.edu/Collab/software.html.

Education for the International Workplace: Engineering Cultures Multimedia Modules

Contributors: Gary Downey, Virginia Polytechnic Institute and State University; Juan Lucena, Colorado School of Mines

Globalization challenges engineers to prepare themselves for work in a culturally diverse environment where they encounter other engineers and co-workers who define and solve problems differently than they do. Accreditation organizations around the world as well as such multinational corporations as EADS, BMW, Boeing, and Siemens have recognized globalization as a key issue for engineering educators to address in facilitating student learning. The increasingly international workplace is especially important for engineers who find themselves defining and solving problems alongside engineers trained in distinct national traditions.

The authors teach Engineering Cultures to both undergraduate students and engineering professionals as a series of country-based modules, e.g., France, U.K., Germany, Japan, U.S., Mexico, Soviet Union/Russia, and Korea. As students move from country to country, they learn how what counts as an engineer and engineering knowledge has varied over time and from place to place. In each case, the meaning and positioning of engineers is linked to the emergence of the nation state.

This poster presentation outlines the organizing concepts in Engineering Cultures, offers examples of how what counts as an engineer varies from country to country, and demonstrates multimedia modules from the course. It also challenges attendees with a brief Engineering Cultures IQ Test to help gauge the extent of their knowledge of engineering in other countries. In a few short minutes, participants will better understand, analyze, and appreciate the value of engineering perspectives other than their own.

Electronic Media to Enhance Electrical Engineering Education

Contributor: Don Lewis Millard, Rensselaer Polytechnic Institute

This poster presents the results garnered from developing and utilizing web-based multimedia educational materials and technologies that were part of a NSF-sponsored Course, Curriculum and Laboratory Improvement (CCLI) grant (DUE 9950356). The twenty-four interactive learning modules (available via: http://www.academy.rpi.edu/projects/ccli) and three newly developed educational technologies operate within a browser environment. The poster presents how the project developments foster scaffolding of basic principles, can

be broadly utilized in multiple environments (e.g. studio, lecture, distance learning, etc.), and have improved student performance in electrical engineering courses being offered at Rensselaer and UT Dallas. These materials have recently received the 2003 PREMIER AWARD for Excellence in Engineering Education Courseware.

ePsych: Teaching about Psychology Using Multimedia

Contributors: Gary Bradshaw, Mississippi State University; B. Michael Thorne, Mississippi State University; Nancy McCarley, Mississippi State University

ePsych (http://epsych.msstate.edu) is a multimedia website designed to help students master the material from an introductory psychology course. It incorporates elements such as video clips, dynamic images, and java applets to enrich a student's experience of the material. ePsych modules incorporate a colorful storyline conveyed by an embodied agent who shares their knowledge of a topic with students. Several features act to attract and maintain student interest in the material: frequent illustrations, an extensive use of color, dynamic elements, and interactive simulations. Other features are known to improve student learning, such as the use of embodied agents, simplified diagrams, and skill exercises. ePsych also features a flexible navigation system that supports direct access to specific material or a more casual and exploratory perusal.

ePsych represents a case study in multimedia website development. We have worked hard to circumvent the natural limitations of computerized delivery of content material, and to exploit the natural advantages of the computer over a paper-based text. The poster will illustrate these key features of ePsych. Early tests of ePsych demonstrate considerable student acceptance and appreciation for our materials.

Mesolore: Mesoamerica, Interactive Software, and Interdisicplinary Inquiry in Undergraduate Education

Contributor: Liza Bakewell, Brown University

Mesolore: Exploring Mesoamerican Cultures is a CD-Web-based set of course materials that expands the practice of interdisciplinary teaching. Completed in the fall of 2004, Mesolore staff began dissemination efforts for creative class adoption into geography, anthropology, archaeology, history, and Spanish language and culture courses. As a teaching tool, Mesolore aims to introduce undergraduates to the both the intrigues of Mesoamerican writing and culture and to interdisciplinary/multidisciplinary inquiry. As a research tool, Mesolore aims to contribute to Mesoamerican scholarship by providing senior scholars with a readily accessible laboratory of primary and secondary source materials. Mesolore's theoretical objectives center around the following questions: What can be learned about human communication by studying Mesoamerican writing systems? Can these writing systems reveal to us information on health, nutrition, social organization, gender diversification and so on? How effective is writing that makes prominent use of "pictures"? The dissemination effort will continue for the next three years and will include the writing of an interdisciplinary User's Guide and the conducting of workshops at national meetings.

Nuclear Magnetic Resonance and Internet Data Delivery

Contributor: Alexander Grushow, Rider University

The Department of Chemistry, Biochemistry & Physics at Rider University has developed a collaboratively used Nuclear Magnetic Resonance (NMR) facility. The NMR, a 300 MHz Bruker Avance Spectrometer is used not only by students at Rider, but also by faculty at four nearby community colleges and three four year colleges. The faculty at the partner institutions have students produce NMR samples in their own laboratories which they then transport to the Rider campus to enter into an auto-sampler queue for the NMR. The NMR console is linked to the Internet so that after student samples are run, the data are automatically placed on a web-site for the students to access and download for analysis at their remote location. In addition to the off-campus users, the NMR is extensively used by Rider students in several laboratory courses from Organic Chemistry through to the advanced laboratories and in undergraduate research year round. The NMR has also been used by small private companies who don't have access to their own spectrometer. We will describe how the "network" is set-up and its effect on programs for all the partners in the project.

Peer Tutoring Website for STEM Courses: Development and Assessment

Contributors: Paula Whitlock, Brooklyn College; Danny Kopec, Brooklyn College; Myra Kogen, Brooklyn College

The peer tutoring center at Brooklyn College is engaged in developing an innovative website designed to provide around-the-clock support to our busy urban, commuter students. The new website creates a dynamic tutoring environment modeled after the on-campus Learning Center's peer tutoring experience. The paradigm used attempts to reproduce the information transfer that occurs between the peer tutor and the student in order to create a website that engages the student's interest as well as provide useful information. The design team is made up of faculty from across the curriculum working together with advanced Computer Science students and tutors. To date, tutoring web pages for the gateway course in Computer Science have been implemented and tested, and programs in Calculus, Microbiology and introductory Chemistry are under development.

Much has been learned from an extensive, wide-ranging assessment process. One sentiment expressed by faculty is concern that the website intrudes upon their domain and that it may provide "too" much assistance to students. We've also discovered that student expectations change as the semester progresses—early on students want simple explanations but they then expect the website to become more complex as their own understanding matures. Ease of navigation is always an issue and quick access to specific topics is of utmost importance. Investigation into the questions students ask the peer tutors most often has shown that there can be a disconnect between what faculty feel students need to know and what students feel they don't know. Much has been learned and will continue to be learned about the nature and delivery of tutoring material that students find most useful and engaging.

Physical Chemistry On-Line Instructional Materials

Contributor: Theresa Julia Zielinski, Monmouth University

Physical Chemistry On-line is a project that has created a series of modules that serve as working environments where students activity engage in learning a sequence of chemistry concepts, and develop critical thinking, communication, and problem-solving skills that imitate the way modern chemists conduct scientific collaborations. The modules are designed to have students work on interesting real-world chemistry problems. The projects follow the guided inquiry model to enable efficient and effective learning. During an On-Line project students work in teams on a local campus or in cohorts with students from distant campuses to accomplish the guided inquiry tasks, examine models, share experimental data, share the process of analyzing that data, and critically evaluate the quality of reports and communication. The On-Line model has been tested in physical chemistry courses by the Physical Chemistry On-Line Consortium (PCOL) at over 22 campuses and with over 600 students. The methods developed by the physical chemistry project developers can easily be extended to other areas of chemistry, in particular analytical and instrumental chemistry courses, which are ideally suited to project and team activities.

PsychExperiments: An Interactive Multimedia Internet-Based Laboratory for Teaching Research Methods and Statistics in Social Sciences

Contributors: John Eustis Williams, University of Northern Iowa; Kenneth McGraw, University of Mississippi

The Internet based psychology laboratory, PsychExperiments, at http://psychexps.olemiss.edu/ has provided experiments and laboratory exercises in social psychology, experimental psychology, and cognitive psychology for the past five years. PsychExperiments is set up primarily for undergraduate lab demonstrations; however, these demonstrations are actual reproductions of common psychological phenomenon often used in lab courses and allow the student to experience the effects firsthand. Typical lab exercises include facial recognition tasks, implicit association tests, Stroop experiments, Ponzo illusion, pitch memory test, numerical memory, the Mueller-Lyer, mirror drawing, and mental rotation tasks. Although, class use is the main focus of PsychExperiments, it also offers assistance and placement of research experiments for students interested in designing their own research projects.

In courses such as research methods and statistics, the use of PsychExperiments brings multimedia experience and a level of interactivity not commonly found when taught by traditional means. Students are able to not only learn about the research methods used in individual experiments, the dependent and independent variables, and the hypothesis expected, but to also actively participate in the lab exercise and submit data. They are then able to download their data and analyze it with the appropriate statistical techniques. This provides a personal aspect to data collection and analysis not found when using data sets which accompany some text books. PsychExperiments currently has 378 active courses, nationally and internationally, registered to use the site. Note: An interactive demonstration of PsychExperiments will be part of the presentation.

SimEcon®: Economic Issues and Principles

Contributor: Anne E. Bresnock, California State Polytechnic University, Pomona

The poster will contain an overview of the design, usage, and assessment of the Economic Issues and Principles project. The poster will contain a brief description, a schematic diagram of the structure, and screen prints for a sample module. A PowerPoint presentation, the modules, and the project website will be made available to interested participants via a laptop. Copies of the PowerPoint presentation and a research paper that documents the assessment of the modules will also be made available to participants.

Teaching Issues and Experiments in Ecology (TIEE): A Web Site and CD-ROM for Undergraduate Ecological Education.

Contributors: Charlene D'Avanzo, Bruce W. Grant, Susan Musante, Josh Riney, Jason Taylor, and Dan Udovic

TIEE is an NSF funded, ESA sponsored website and CD-ROM designed to help ecology faculty include more student-active teaching approaches in lectures and laboratories. TIEE has three components: 1) Issues—controversial and key topics that engage students in published data sets, even in large classes, plus LTER and other data sets for students to manipulate, 2) Experiments—student-directed research that help students learn concepts and the process of science, and 3) Teaching—pedagogical resources such as a glossary, websites, and essays that interface with Issues and Experiments. This poster in an introduction to TIEE, including evaluatory information.

Teaching Mass Spectrometry via Virtual Instrumentation Combined with Case Studies

Contributors: Joseph J. Grabowski, University of Pittsburgh; Mark E. Bier, Carnegie-Mellon University

Recently developed technology has greatly expanded the utility of mass spectrometry as an essential analytical tool in many areas of science research, trace identification, and diagnostic work. For reasons that include the diverse nature of mass spectrometry instrumentation, and the perceived expertise needed, mass spectrometry is rarely taught to undergraduates, and even fewer students have an opportunity to experience the instrument hands-on. To provide more undergraduates with an introduction to mass spectrometry, we have married the anytime, anywhere capability of the internet, to case-based learning approaches, and createe the Virtual Mass Spectrometry Laboratory. Cases include identification of an unknown liquid found in a Civil War-era medical kit, identification of an serum albumin extracted from a blood sample to identify the species, analysis of a hair sample to determine if cocaine is present, and determination of the polydispersity of different polymer samples. Currently, instruments include GC/MS, MALDI-TOF, and ESI-Ion Trap. For each case study, the user chooses and prepares a relevant sample, configures the virtual instrumental parameters, collects data, re-configure parameters or re-prepare the sample if initial choices were not sufficient, analyzes and manipulates the data, and prepares a report documenting an answer to the question posed in the case study. For each possible configuration of sample preparation and instrumental setting, archived real data is presented to the

user; thus they can see data of any quality from poor to superb, and can experience artifacts and signal-to-noise problems. The General Anesthetic case study will be used to demonstrate the VMSL.

Web-Based Interactive Landform Simulation Model (WILSIM)

Contributors: Wei Luo, Northern Illinois University; Kirk L. Duffin, Northern Illinois University; Edit Peronja, Northern Illinois University; Jay A. Stravers, Northern Illinois University; George M. Henry, Northern Illinois University

This poster presents a web-based interactive landform simulation model (WILSIM) that can be accessed anytime and anywhere via a standard web browser to improve undergraduate students' learning experience of landform evolution. WILSIM employs a cellular automata (CA) algorithm and is implemented as a Java applet. After randomly dropping a precipiton, or rainfall event, onto a topographic grid, the model conducts diffusion, erosion, and deposition as it keeps move the precipiton from current cell to the lowest of the 8 surrounding cells, until the sediment carrying capacity of the precipiton is exceeded, the precipiton reaches the edge of the grid, or the precipiton lands in a pit. The global pattern of landform occurs after the same local rules are applied to many precipitons (i.e., hundreds of thousands of iterations). Students will be able to interact with the model by selecting different parameters (such as slope, rock erodibility, climate, and tectonic uplift) and observe in animation how different combinations of processes (parameters) influence the landform evolution. In addition, snapshots of different evolution stages, cross-sectional profiles, hypsometric curves, and sediment thicknesses are also available for students to better understand the processes involved. WILSIM can be accessed at http://www.niu.edu/landform. This project is supported by the CCLI program of NSF.

WeBWorK™ in the Mathematics Curriculum

Contributor: Jeff Holt, University of Virginia

The NSF-sponsored project listed above focuses on developing materials and implementing WeBWorK™, an online homework system, in a variety of mathematics courses, including Calculus and Financial Mathematics. The WeBWorK™ system administers customized homework to each student, provides instant feedback on submitted work, and exports student records in a spread sheet format. The system was developed at the University of Rochester, and is available for use by academic institutions free of charge. This poster will highlight features of the WeBWorK™ and the materials developed for use with WeBWorK™.

WeBWorK™, an Internet-Based System for Generating and Delivering Homework Problems

Contributors: Michael Gage, University of Rochester; Arnold Pizer, University of Rochester; Vicki Roth, University of Rochester

WeBWorK™, developed by Michael Gage and Arnold Pizer of the University of Rochester, is a freely distributed system that comes with an extensive library of problems. WeBWorK™ won the 1999 International Conference on Technology in Collegiate Mathematics (ICTCM) Award for Excellence and Innovation with the Use of Technology in Collegiate Mathematics. WeBWorK™ is supported by grants from NSF and has already been adopted by many colleges and universities. Readers can try WeBWorK™ for themselves (as a student) by connecting to actual courses at http://webwork.rochester.edu. Much additional information is available at this site.

The goal of WeBWorK™ is to make homework more effective and efficient. It increases the effectiveness of traditional homework by:

- Providing students with immediate feedback on the validity of their answers and giving students the opportunity to correct mistakes while they are still thinking about the problem. As one student said, "I can fix my mistakes while [the] problem is fresh in my mind."
- Providing students with individualized versions of problems which means that instructors can encourage students to work together; yet each student must develop an answer to his or her own version of the problem.

It increases the efficiency of traditional homework by:

- Providing automatic grading of assignments and providing data (individual and statistical) on student performance.

WeBWorK™ can handle most homework problems found in a typical calculus text and is distributed with a library of about 3900 problems covering college algebra and pre-calculus, single and multivariable calculus, differential equations, linear algebra, statistics and probability. It easy to modify current WeBWorK™ problems or to write new ones.