Topical Session Series and Posters

Series A

Friday, April 16 **10:45AM – 12:15PM**

A1 ▸ Building Students' Observational and Analytical Skills Using GIS-Based Investigations of Earth Processes

Location: Washington Room B, Ballrom Level
Presented by: Michelle Hall, University of Arizona

Participants in this interactive, hands-on workshop will explore topics such as plate tectonics, geologic hazards, tropical cyclones, and water resources using curriculum modules developed for introductory level college Earth science courses. Using a Learning Cycle approach, these modules enable students to observe, analyze, and interpret patterns in geospatial datasets and understand their underlying physical processes.

Providing introductory level students with learning experiences that model scientific discovery is difficult, especially in courses that have no laboratory component. However, we met this challenge through self-contained, GIS-based investigations that use authentic scientific data sets and tools. The modules take advantage of the visualization and multimedia integration capabilities inherent to GIS. Clear, detailed instructions and pre-packaged GIS project files eliminate the need for the instructor or student to master an individual GIS software package. Generally, only a 5–10 minute introduction to GIS is required, if at all. By incorporating both quantitative and visual analysis tools, these modules provide rich learning experiences for students with diverse learning styles.

A2 ▸ Remote Instrumentation *(Bring your laptop)**

Location: Conference Theater, Ballroom Level
Presented by: Preethi Pratap, Northeast Radio Observatory Corp.; Allan West, Columbia University; Allen Hunter, Youngstown State University

This workshop will focus on effective ways of using remote instrumentation. The workshop presenters, who have all successfully worked with remote instruments, consist of a chemist, a chemical engineer and an astrophysicist. The session will start with a brief description of the remote instruments that the panel members have been involved with and, if resources permit, a live demonstration of the operation of a radio telescope and an x-ray diffractometer running in the background as the discussions take place.

The panel will then pose several questions to the audience in order to address one of the goals of the conference, namely, how can these remote systems be used effectively and shared among a diverse and interdisciplinary community. Some of the topics that will be discussed are:

- What are the fields that lend themselves to effective use of remote instrumentation?
- Do such instruments facilitate collaborations and how can these interactions be fostered?
- What are the mechanisms for long-term sustainability of the remote technology?
- What are the features/types of instruments that you (the audience) would be likely to use and why?
- What are the safety and security issues that need to be dealt with?
- What role do remote instruments play in the classroom – do students need any hands-on laboratory experiences?

**Please bring a laptop that is capable of accessing a wireless network.*

A3 ▸ Computer Security: Pedagogy and Practice

Location: Roosevelt Room, Third Floor
Presented by: Andrew Phillips, University of Wisconsin, Eau-Claire

This workshop will focus attention on specific approaches to teaching computer and information security, an area of growing relevance and importance in computer science programs nationwide. We'll discuss the development and presentation of standalone computer security courses as well as the infusion of topical course modules in other courses within an undergraduate computer science curriculum. We'll concentrate our attention on specific technical topics in computer security that are current and relevant to modern IT, while also consistent with a traditional undergraduate education in computer science.

Both defense (system hardening and intrusion detection) and attack (technological, physical, and social) scenarios will be discussed. In all cases, the emphasis is on providing specific educational experiences with the issues, strategies, tactics, and tools of computer and network system attackers/ defenders so that students in the curriculum can readily apply these tools in their careers as computer professionals. We'll discuss methods for developing this knowledge through hands-on laboratory exercises, as well as the pedagogical and ethical issues raised by such exercises. The discussion will also focus on developing an ethical foundation on which the students may rely as they gain more experience in computer security.

This will be an "active participation" workshop — participants will be expected to share their experiences, ideas, concerns, and best practices with the group so as to provide everyone with both insight and examples of the do's and don'ts of teaching computer security.

A4 ▸ Teaching Through Touching: Using LEGO® Bricks to Teach Engineers and Liberal Arts Students Engineering

Location: Lincoln Room, Third Floor
Presented by: Chris Rogers, Tufts University

Your typical kindergarten classroom is filled with kids actively participating in learning. They are moving around, talking, exploring using their hands, and asking questions. Your typical college classroom has 20–30 people sitting quietly listening to a single person lecturing at the chalkboard. In the college classroom there are few questions, no activity and very little exploration. The main goal of this LEGO® engineering program is to change the way we teach college-level material, allowing students to be constructive, involved learner rather than a passive listener. In this workshop, you will get a chance to experience the same learning by participating in a small LEGO® robotic competition. Through LEGO® Engineering, one can teach engineering, physics, math and even literacy skills. We have taught everything from control theory to image processing to electronics and microprocessor design to an audience ranging from future engineers to future journalists and future teachers. I will also

show some student designs, from LEGO® crocodiles to LEGO® fish that really swim under water. I will end with how students in Singapore and Boston use the web to design and build together.

A5 ▸ Peer-Led Team Learning: A Versatile Student-Centered Curriculum Strategy

Location: Kennedy Room, Third Floor
Presented by: Pratibha Varma-Nelson, Northeastern Illinois University; Mark Cracolice, University of Montana

Participants in this workshop will experience a Peer-Led Team Learning (PLTL) mini-workshop led by undergraduate students. We will then address the issues associated with understanding why implementing a PLTL program in an undergraduate science, technology, engineering, or mathematics (STEM) course can be beneficial for students from diverse backgrounds and varying pre-college academic experiences.

The PLTL model actively engages students in the learning process by having them solve carefully structured problems in small groups under the direction of a trained peer leader. Peer-led workshops are an effective way to engage large numbers of students with course material and each other. Improved performance and retention, development of communication and team skills, higher motivation and course satisfaction, and increased interest in pursuing further study in science are among the benefits of a PLTL approach. Over 15,000 students nationally are now enrolled in PLTL courses, taught by approximately 150 faculty at 50 institutions.

At the fundamental level, a PLTL curriculum design provides a unique opportunity for students to improve their problem-solving skills, confront their misconceptions, and develop their higher-order thinking skills. The underlying structural change needed to employ the PLTL design is relatively simple, but research shows that reallocation of only a relatively small proportion of total in-class time can produce dramatic, long-lasting gains in students' cognitive abilities, as long as that time is used appropriately.

Participants will also be provided with materials and resources for additional information about the Peer-Led Team Learning model.

A6 ▸ Disciplinary Research Strategies for Assessment of Learning in Large Classes

Location: Washington Room A, Ballroom Level
Presented by: Diane Ebert-May, Michigan State University

Over a decade ago at a large university, I was asked to 'fix' an introductory biology course with an enrollment of approximately 700 students. My initial response was 'what's broken?' A quick review of the course "as was" generated many questions. Why was the giant lecture hall only half full on a given day? Did students have an active role in the course or were they merely subjects of transmission of information? What did students actually learn and understand about biology? My second response was "What to do?" This workshop will focus on current strategies we use to design and implement active, inquiry-based instruction in large science courses and the methods for assessing and analyzing student data to determine the effectiveness of these approaches. Our research designs and strategies are derived from the methods of discipline-based research in the sciences. We use this approach for diagnosing student misconceptions, developing problems to assess student understanding about key concepts in biology, and collecting, analyzing and reporting data that will influence future instruction. We argue that this approach is applicable across disciplines and is scalable for class size. Participants in this workshop are encouraged to bring samples of the assessments (e.g., tests, projects) used in their courses. We will work directly with these materials as we explore, design and analyze assessment strategies and how the data can inform instruction in any large course.

A7 ▸ Evaluating Outcomes: Dare to Discover!

Location: Jefferson Room, Third Floor
Presented by: William Maki, Texas Tech University

Build it and they will come. So you've built it. But are the students using it? Do they like it? Do they learn from it? How do you know? These are empirical questions that can be answered by a good evaluation design. All too often educational innovations are introduced on an *ad hoc* basis and evaluated by an end-of-course questionnaire or a course evaluation form. This case study approach produces a single data point that admits many explanations. Adding additional observations and non-treated groups to form quasi-experimental designs will rule out alternative explanations. Such designs will reveal the influence of the educational innovation on learning and satisfaction. In this session we will consider a few of those designs for which implementation is relatively easy and interpretation of outcomes is relatively clear. The designs will be illustrated by evaluations of information technology enhancements in a freshman survey course and skill training in an upper division research methods course. During the last part of the session, we will take up evaluation problems faced by attendees and discuss potential solutions.

A8 ▸ Teaching a Calculus Course with WeBWork™, an Online Homework System

Location: Fairfax Room, Third Floor
Presented by: William Ziemer, California State University, Long Beach

Much has been done in the way of using computers to deliver homework and/or content for undergraduate courses. Sure it sounds good, but how exactly does this change how one teaches a course? How much extra work for the instructor does it entail? Are there any benefits? The best way to answer these questions is to jump in and do a trial run. First, you will be a student. We will run through the experience from a student's perspective. Then you will learn how to run a course with WeBWork™, and see for yourself what is involved. The only requirement for this workshop is that you know how to use a web browser.

A9 ▸ Marrying Engineering Design and Service Learning Through EPICS: Engineering Projects in Community Service

Location: Arlington Room, Third Floor
Presented by: William Oakes, Purdue University, Leah Jamieson, 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.

This workshop explores benefits, challenges, and issues associated with creating, offering, and sustaining courses that focus on long-term, multidisciplinary, community-based engineering design.

A10 ▸ Making Proposal Writing an Affirming Adventure for Faculty: Inspiring Innovation

Location: Prince William Room, Third Floor
Presented by: Diana I. Marinez, Texas A&M University, Corpus Christi; Janet Andersen, Hope College

For grant proposals to be competitive and successful, the preparation of proposals by faculty must be regarded as a positive developmental experience rather than an onerous obligation to satisfy some institutional expectation. Thus, proposal development and writing must be undertaken within the context of a supportive community of scholars and administrators and be recognized by administrators (including departmental chairs and campus tenure and promotion committees) as scholarship, whether or not funding is approved. This session will focus on the community-building aspects of proposal writing and the expectations and rewards associated with those efforts.

Series B

Friday, April 16 **2:00PM–3:30PM**

B1 ▸ Inquiry Teaching: What Is It and How Do We Know If It Works?

Location: Washington Room B, Ballroom Level
Presented by: Charlene D'Avanzo, Hampshire College

"Inquiry" is one of the most widely used terms in the science education reform literature. Not surprisingly, science faculty define inquiry teaching in different ways and use different inquiry-based approaches. For example Novak defines inquiry as "...the [set] of behaviors involved in the struggle of human beings for reasonable explanations of phenomena about which they are curious." (1964: BioScience: 14:25) while others place more emphasis on development of process skills in their particular disciplines. Through a variety of active approaches workshop participants will illustrate the range of ideas about inquiry teaching in the sciences. We will also examine theories about cognition and learning that support inquiry teaching and findings from college classroom research based on these theories.

B2 ▸ Networked Learning: Using Technology to Improve Learning in Undergraduate Education

Location: Conference Theater, Ballroom Level
Presented by: Charles McDowell, University of California, Santa Cruz; David Yaron, Carnegie-Mellon University

This workshop will discuss the use of technology to enhance the student experience and learning outcomes. Short presentations by the facilitators will be used to launch the discussion.

David Yaron and colleagues are developing virtual labs and scenario-based activities for introductory chemistry (http://ir.chem.cmu.edu). These activities integrate into existing course structures and help students: (i) connect the algebraic manipulations of the current course with authentic chemistry and (ii) bridge chemical knowledge with the real world. The technology supports new styles of interaction with the course material. For instance, the virtual lab is a flexible Java applet that allows students to choose from hundreds of standard chemical reagents and manipulate them as in a real lab. This allows students to design and perform online experiments. This development effort is being extended to support a growing collection of community-authored and community-assessed materials in the NSF's National STEM Digital Library (NSDL).

Charlie McDowell and colleagues are developing a tool to support collaborative use of a computer workstation, with the initial goal of supporting "distributed pair programming". Research supports pair programming in industry and academics. Potential classroom benefits include increased student confidence (especially for women), increased retention in a CS major, increased enjoyment, higher quality programs, and reduced load on teaching assistants and instructors. Removing the co-location requirement will make pair programming viable for a larger audience, including distance learning. More generally, students and instructors may share a single "virtual" workstation (e.g., running the CMU "virtual lab"). A key distinguishing feature is that the "observing" partner can "point" at objects on the shared screen without disturbing the focus or mouse locations of the partner in control of the desktop.

Discussion questions include: barriers to creation, dissemination and adoption of new educational technologies; ways in which the NSF can help overcome these barriers; and other topics of interest to participants.

B3 ▸ Connecting Science to Society

Location: Jefferson Room, Third Floor
Presented by: Margaret Waterman, Southeast Missouri State University; Stephanie Fitchett, Florida Atlantic University; Danny Kaplan, Macalester College

Connecting science to society can provide motivation and serve as a goal for undergraduate STEM courses. Field studies or case studies that place science and mathematics concepts into meaningful social or policy-making contexts offer a powerful method to engage stu-

dents in both disciplinary and interdisciplinary settings. In this session presenters will discuss examples of such approaches used in both lower- and upper-division courses.

B4 ▸ SCALE-UP: Student-Centered Activities for Large Enrollment Undergraduate Programs

Location: Kennedy Room, Third Floor
Presented by: Robert Beichner, North Carolina State University

How do you keep a classroom of 100 undergraduates actively learning? Can students practice communication and teamwork skills in a large class? How do you boost the performance of underrepresented groups in STEM courses? These questions will be discussed at a workshop describing the Student-Centered Activities for Large Enrollment Undergraduate Programs (SCALE-UP) Project. With NSF support, instructional materials addressing these concerns have been created, evaluated, and disseminated. They are now in use by more than 1/3 of all STEM majors nationwide. Physics and chemistry classes are currently in operation, with biology, engineering, and oceanography adaptations in progress.

Educational research indicates that students should collaborate on interesting tasks and be deeply involved with the material they are studying. We promote active learning in a redesigned classroom for 100 students or more. (Of course, smaller classes can also benefit.) Classtime is spent primarily on "tangibles" and "ponderables" — hands-on activities, simulations, and interesting questions. There are also hypothesis-driven labs. Nine students sit in three teams at round tables. Instructors circulate and engage in Socratic dialogues. The setting looks like a banquet hall, with lively interactions nearly all the time.

Hundreds of hours of classroom video and audio recordings, transcripts of numerous interviews and focus groups, data from conceptual learning assessments (using widely-recognized instruments in a pretest/posttest protocol), and collected portfolios of student work are part of our rigorous assessment effort. We have data comparing 16,000+ students. Our findings can be summarized as the following:

- Ability to solve problems is improved.
- Conceptual understanding is increased.
- Attitudes are improved.
- Failure rates are drastically reduced, especially for women and minorities.
- Performance in later courses is enhanced.

In this workshop participants will hear about the classroom environment, try some of the engaging activities, and review the findings of studies of learning in various SCALE-UP settings.

B5 ▸ What I Wish I Had Known in Art School

Location: Lincoln Room, Third Floor
Presented by: Marc Frantz, Indiana University

This workshop features ideas and activities from a course I teach in mathematics and art. I developed the material for the course with the idea of addressing vague uncertainties I had as an art student. In the process I discovered that competence as an artist depends strongly on one's ability to *look* at art and nature, and interpret the observations mathematically.

The ideas, activities, and materials from the course have spread to several institutions through a series of week-long workshops for teachers called VIEWPOINTS, which I teach with Annalisa Crannell of Franklin & Marshall College. The course and VIEWPOINTS are sponsored by the NSF-funded Mathematics Throughout the Curriculum project at Indiana University.

In our session we will see how correct viewing of works in perspective can be done with the aid of mathematics and shish kebab skewers, and how it can enhance the appreciation and enjoyment of artwork in a gallery or museum (which we do in the course). We will also look at some natural perspective drawing problems that require challenging but elementary mathematical solutions, and how those solutions enable non-art majors to create impressive drawings. No artistic talent is required and all materials will be provided.

B6 ▸ Preparing Students for Research and Teaching: Pedagogy, Practice, Curricular Design, and Assessment to Improve Student Learning

Location: Roosevelt Room, Third Floor
Presented by: David Brakke, James Madison University

This workshop will consider several changes in course and curriculum design and delivery for science and mathematics majors and pre-service middle school teachers of mathematics and science at James Madison University accomplished with support of the NSF-CCLI program. We will discuss changes in the biology curriculum beginning with the development of investigative laboratories and continuing through the biology core for freshman and sophomore students and now upper-division courses. We will discuss the process and important steps in changing the curriculum as well as our attempts to assess the results. The second set of changes to be considered is in mathematics — the development and offering of a new calculus sequence, mathematics placement and the assessment of a series of calculus courses. The third area to be discussed is the development of two new programs, IDLS Mathematics and IDLS Science, for the preparation of middle school mathematics and science teachers, which involve faculty from three colleges. The structure of both programs will be described along with pedagogical approaches and assessment of outcomes.

B7 ▸ Mixed Marriages: Learning to Collaborate Across Disciplines

Location: Fairfax Room, Third Floor
Presented by: Peter Crouch, Arizona State University

NSF-funded collaborations on university campuses can lead to innovative educational experiences for students and the development of a stimulating intellectual environment for faculty. Collaboration sets up conditions where university professors from engineering, science, and education are able to learn from each other. This joint learning results in improved classroom instruction, exciting classes, and more motivated students. As one student enrolled in a collaboratively taught course said: "When teachers are enthusiastic about teaching," students' "natural curiosity of the world" is awakened. More specifically, this session will explore what makes collaborations work, how students, faculty, and the university benefit, and the role administrators play in fostering cross-campus collaborations. There will be discussion on the challenges and advantages of collabora-

tion, the impact collaboration can have on the culture of learning and teaching, and the stimulation of interdisciplinary research questions and related funding opportunities. This interactive session will encourage sharing of ideas and strategies for initiating and facilitating collaborative relationships on home campuses.

B8 ▸ Unlocking the Clubhouse: Institutional Reform for Diversity

Location: Arlington Room, Third Floor
Presented by: Allan Fisher, Carnegie-Mellon University

Despite the pivotal role that computers play in the American economy and culture, and despite explosive growth in the job market, only 15–20% of undergraduate majors at leading U.S. computer science departments are female. Women and girls use the Internet just as often as do men and boys, but it is mostly men who are programming the computers, designing and fixing the systems, and inventing the technology.

Starting in 1995, Allan Fisher and Jane Margolis engaged in an interdisciplinary program of research and action at Carnegie Mellon University in response to this situation. In part as a result of those efforts, the entering enrollment of women in the undergraduate Computer Science program at Carnegie Mellon rose from 7% in 1995 to 42% in 2000. Fisher and Margolis report on their experience in their 2002 book, Unlocking the Clubhouse: Women in Computing.

In this workshop, Allan Fisher will briefly review the Carnegie Mellon experience, and will lead a discussion of the institutional barriers to — and enablers of — reform of education programs in favor of diversity. Participants will be encouraged to share their successes, failures, challenges and dilemmas.

B9 ▸ Teaching as Research

Location: Washington Room A, Ballroom Level
Presented by: Bob Mathieu, University of Wisconsin, Madison; Cindy Atman, University of Washington

Hypothesis — "Finding out what students have learned is essentially a research problem, and the scientific method can be applied to the challenge of enhancing student learning. Thus the research skills, practices, and inclinations that are highly developed in STEM faculty represent a tremendous capacity for broad-based improvement of STEM undergraduate education." In this workshop participants will have the opportunity to discuss, support, and challenge this hypothesis in the context of CCLI projects and/or broader experiences.

B10 ▸ Impact of Disciplinary Integration at Two Institutions

Location: Prince William Room, Third Floor
Presented by: Allen Hunter, Youngstown State; Richard Guarasci, Wagner College; Ellen Goldey, Wofford College

Although liberal arts institutions seek to broaden students through exposure to numerous disciplines, students' lack the framework to integrate what they learn, and their knowledge may remain as compartmentalized as academe itself. In separate but similar programs, Wagner College (NY) and Wofford College (SC) have developed curricular learning communities (LCs) to address this and other challenges faced by first year students and their professors.

Wofford's model has resulted in the creation of semester-long courses that have been fully integrated into theme-based (e.g., water, cosmology, biomedical ethics) pairs to form eight LCs. Each LC integrates a laboratory science course for non-science majors with a discussion-based, writing-intensive humanities seminar. Each LC, developed and taught by two faculty members and two undergraduate "preceptors," incorporates K-12 educational outreach, experiential learning, and enhanced use of information technology.

As part of The Wagner College Plan, every first-year student completes an LC. Student cohorts are enrolled in the same two lecture courses that examine that LC's theme from different disciplinary perspectives, and five of these LCs pair a science course with a non-science course (e.g., biology and English literature). In addition, students engage in community-based service learning which is related to their LC theme, and they take a third, non-lecture, reflective course that provides a venue for open discussion that integrates all LC components.

This interactive workshop will: 1) overview each programs' structure (highlighting those facets most adaptable to any institution), 2) reveal the programs' challenges and tactics for overcoming them, and 3) identify dissemination and evaluation techniques that have been most beneficial. The programs at Wagner and Wofford have had a broad impact on each institution and beyond.

Series C

Saturday, April 17 **8:30AM–10:00AM**

C1 ▸ Creating and Using Visual Representations to Construct Knowledge in STEM Education

Location: Washington Room B, Ballroom Level
Presented by: Felice Frankel, Massachusetts Institute of Technology, Stephen Reynolds, Arizona State University

Visualization is thoroughly embedded in the process of science and in STEM education, as we try to envision objects, models, and processes that are very small (atoms), are very large (tectonic plates), occur on too short or too long of a time scale to observe directly (initial microseconds of the universe versus landscape evolution), do not have visible aspects (electromagnetic field), or are strictly theoretical. This workshop will explore ways that students can use and create visualizations to model scientific principles, theories, or data as a means to validate or confront their knowledge. We will explore interactive and static visualizations, including those created by students, and will involve attendees in thinking about the role of visualization in constructing knowledge and how students can model and visualize their own field.

C2 ▸ Visualizing Scientific Data Sets: From Molecules to Galaxies *(Bring your laptop)**

Location: Conference Theater, Ballroom Level
Presented by: Laurence Marschall, Gettysburg College; Sandra Porter, Geospiza, Inc.

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 workshop we present two projects that attempt to nurture those skills, one from biology, and one from astronomy. Both projects focus on the use of modern data sets of diverse measurements.

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 amounts of diverse data 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. 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 expensive and complex equipment. It also 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, visualize, and manipulate data selected from large astronomical datasets.

**Participants in this workshop should bring a laptop with the following equipment: Windows™ (XP preferred), CD Drive, 500 MB free disk space (preferred). CD's will be distributed with the datasets used in the workshop.*

C3 ▸ Science for All Americans: A Universally Accessible Class for the New Millennium

Location: Roosevelt Room, Third Floor
Presented by: Michele Wheatly, Wright State University

People with physical disabilities have been referred to as the "last minority" in STEM careers. Science has traditionally been viewed as "hands on" and students with disabilities have not been encouraged to participate in laboratory activities. WSU is a modern university that has developed a reputation for barrier-free architecture and accessible programming. Creating Laboratory Access for Science Students (the CLASS project) is an interdisciplinary collaboration between the College of Science and Mathematics, the College of Education and Human Services, and the Office of Disability Services that seeks to provide national leadership in promoting access in STEM education. A range of disseminable products have been produced including: universally accessible introductory science lab experiments across a range of disciplines; a handbook (print and CD ROM) for science educators that provides information on adaptations and novel educational strategies for teaching students with physical and learning disabilities; training videos that can be used to heighten awareness among groups of professional science educators; and a yearly summer workshop to train educators in CLASS materials and to expose high school students with disabilities to the sciences. The strategies developed in the CLASS project were subsequently used to obtain an Undergraduate Mentoring in Environmental Biology (UMEB) grant to support year-round undergraduate research for students with disabilities. It is also being used in collaboration with the College of Engineering and Computer Science to plan for a Center for Research and Education in Assistive Technology. The workshop will expose participants to a range of CLASS project activities and products. The effect that the CLASS project has had on institutional transformation will be discussed, as well as its role in systemic reform of science education across the Nation.

C4 ▸ Just-in-Time Teaching: Addressing Student Engagement, Interaction, and Learning via Coordinated Web/Classroom Activities

Location: Jefferson Room, Third Floor
Presented by: Evelyn Patterson, U.S. Air Force Academy

Just-in-Time Teaching (JiTT) is a pedagogical strategy designed to provide 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, started in 1996 (Novak et. al., 1999), is now used in over 300 SMET and humanities courses at over 100 institutions across the US and abroad. The heart of JiTT is the feedback loop between in-class and out-of-class learning. The pre-class warmup exercise builds the foundation for the classroom interaction. Students have already wrestled with the day's topics; faculty are aware of the students' knowledge and understanding. This timely activity also breaks down anonymity barriers, a feature particularly important in large enrollment classes. Post-instruction JiTT assignments attempt to help students master the learning process as well as subject matter content. At USAFA many students work on these assignments in faculty-staffed EI (extra instruction) classrooms. Student responses and faculty experiences in the EI room inform and motivate subsequent warmup assignments, lesson plans, and post-instruction assignments.

The expanding JiTT community consists of faculty in more than 30 disciplines from all types of institutions, teaching at all levels, but many of their issues, concerns, and goals are common. September 2003 marks the beginning of the "Just-in-Time Teaching Digital Library" (JiTTDL), an $850,000 NSF-funded project, designed to create a shareable collection of JiTT resources and materials and to interconnect and grow the multidisciplinary JiTT community.

In this workshop we will illustrate, with hands-on examples, how the JiTT approach is applicable in all learning situations. Participants will experience the JiTT environment, work with others to create and critique sample JiTT materials, and leave the session with ideas and start-up tools to enable them to implement JiTT in their own classrooms.

References: Novak, Gregor M., Patterson, Evelyn T., Gavrin, Andrew D., and Christian, Wolfgang. (1999). Just-in-Time Teaching: Blending Active Learning with Web Technology. Upper Saddle River, NJ: Prentice Hall.

C5 ▸ Biology, Chemistry, and Biomedical Engineering Undergraduate Laboratories: Ideas for Adaptation

Location: Lincoln Room, Third Floor
Presented by: Bhawani Venkataraman, Columbia University; Christopher Sacchi, Kutztown University; Kay C. Dee, Tulane University

This workshop will feature widely-adaptable ideas and materials from CCLI-funded biology, chemistry, and biomedical engineering projects, related to undergraduate laboratories. The biology project adapted digital imaging technology for laboratory exercises in thirteen courses throughout the curriculum. Using microscopes equipped with digital cameras, students have used image analysis and presentation software to perform increasingly sophisticated analyses of biological materials as they progress through the curriculum. Assessment of student learning using formative and summative instruments designed specifically for the project provided insights for further refinement of the adapted laboratory exercises. The transferability of these exercises to new settings and the lessons learned in this multi-investigator project will be discussed. The chemistry project used CCLI support to add demonstrations of fundamental principles in areas of current scientific, technological, and public interest to the undergraduate laboratory curriculum. Laser technology was used to illustrate connections between concepts taught at different levels of the chemistry curriculum, and scanning probe microscopies were used to relate microscopic phenomena to macroscopic applications. Experiments from the research literature were adapted for implementation in the instructional chemistry laboratories. The biomedical engineering project used the concept of teaching around Kolb's cycle to implement active learning opportunities in a number of undergraduate courses. An undergraduate teaching laboratory was developed to accommodate hands-on experiments in the areas of biomechanics, biomaterials, and cell/tissue engineering. Information from this project that participants will be able to adapt to their own needs includes layout of the multi-disciplinary laboratory space, essential equipment needs and projected costs, sample experiments that integrate current research into the undergraduate experience, and a statistically-validated summative assessment questionnaire designed for biomedical laboratory courses.

C6 ▸ Concept Inventories: Tools for Uncovering STEM Students' Misconceptions

Location: Arlington Room, Third Floor
Presented by: Donovan Evans, Arizona State University

As pointed out by a rich body of research, including the three video case studies, *Lessons from Thin Air, Private Universe,* and, particularly, *Can We Believe Our Eyes?*, students subjected to traditional instruction often do not adequately resolve the misconceptions that they either bring to a subject or gain while studying a subject. These misconceptions block the establishment of connections between basic concepts, connections that are necessary for understanding the macro-concepts developed in further work. This workshop will look at the array of "Concept Inventory" assessment instruments that are available or in preparation in STEM subjects for assessing students' understanding of concepts. To be discussed will be the concept of a Concept Inventory and its history, with special emphasis on the lessons learned by the developers of a number of these instruments in the process of constructing their Inventories. Participants will participate in some of the tasks involved in developing good Concept Inventories.

C7 ▸ Achieving Interdisciplinary Impact: Clearing the Hurdles to Mesolore's Classroom Adoption

Location: Fairfax Room, Third Floor
Presented by: Elizabeth Bakewell, Brown University

This workshop will begin with a description of the dissemination travels of a CD/Web resource, *Mesolore: Exploring Mesoamerican Culture,* down an unpaved, rocky road to the undergraduate classrooms of U.S. colleges and universities and into a few venturesome high schools. It will then engage in discussions with participants of their own dissemination efforts. In the process, workshop participants will explore how Mesolore's interdisciplinary approach presents new ways of viewing and studying traditional topics, thereby enhancing classroom pedagogy in multiple disciplines, including geography, anthropology, history, archaeology, language and culture, and education. Participants will hear tales of how attention to gender and bilingualism are means by which adoption interests can be raised among unlikely faculty. While Mesolore is a focused consideration of the Mixtecs of Oaxaca, Mexico, with broader New World contextualizations, it engages with issues of native languages, historiography, indigenous rights, ethnobotany, ethnomathematics, and gender. Mesolore's resources encourage students to consider the long history of indigenous legal battles in the Americas by joining the reading of a 16th century Mixtec document created for colonial land disputes with a listening to contemporary historians and activists speak about their work on indigenous land rights. Mesolore's resources also provide for a more traditional consideration of indigenous culture by taking into account the role of written texts — and their poetic and performative uses — in asserting and maintaining the class hierarchies before European contact. Mesolore can be used to teach about ethnobiology and ecology, joining a reading of indigenous representations of their environment with lectures by biologists, archaeologists, and ethnographers. Broadly, Mesolore can bridge the past with the present and bridge disciplines, so that inquiry into the meaning of ancient cultures and texts can be joined to discussions of language change and loss, migration, gender, ecology, and historiography. Critical to the workshop will the input of participants of the sharing of experiences.

C8 ▸ Activities for Introducing Students to Statistics

Location: Prince William Room, Third Floor
Presented by: Allan Rossman, California Polytechnic State University, San Luis Obispo

In this workshop participants will experience some of the learning activities for introducing students to statistical concepts that my colleague Beth Chance and I have developed. 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 in this

workshop 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.

C9 ▸ Looking at Learning

Location: Kennedy Room, Third Floor
Presented by: Cindy Atman, University of Washington; Bob Mathieu,
University of Wisconsin, Madison

Many effective educators tie their decisions about instructional activities to their knowledge about their students. For example, aspects of students' prior experience, prior domain knowledge and motivation for studying a topic can be relevant to instructors. This list could go much longer. The things you have taken into account in designing your educational innovations belong on this list and also may be helpful to others. In this workshop we will discuss what insights we need about learners in the STEM disciplines represented by workshop participants, and how these insights can and have informed the design of teaching innovations. We will then compare these insights across the disciplines and identify questions that don't have answers. These unanswered questions can inform a future research agenda.

C10 ▸ Undergraduate Research: Approaches to Success

Location: Washington Room A, Ballroom Level
Presented by: John Mateja, Murray State University; Charlotte Otto, University of Michigan, Dearborn

This workshop will address the myriad of questions that surround starting and sustaining a successful undergraduate research program. The session will engage participants in a discussion identifying what undergraduate research is, who is responsible for it (faculty, departments, academic units like colleges, separate units/offices for UG research, the central administration?), who supports it, how is it sustained over the long haul, what are the "common" elements of successful programs, what are the institutional obstacles to providing better support, how can you tell if students and faculty are benefiting (what makes it quality), and how can you tell the story about successes to other audiences (parents, legislators, industrial partners, other academic partners). Participants from a variety of institutional settings will enrich the discussion.

Series D

Saturday, April 17 **1:30PM–3:00PM**

D1 ▸ Using Computation and Visualization to Enhance the Teaching of Ordinary Differential Equations

Location: Washington Room B, Ballroom Level
Presented by: Paul Blanchard, Boston University

Until recently the teaching of differential equations mainly focused on symbolic algorithms that produced solutions to special types of equations. But now the personal computer provides the opportunity to do much more. Numerical algorithms can be introduced earlier and more easily, and solutions can now be visualized using numerical solvers and animations. As a result, the focus can be shifted away from symbolics, and students are exposed to a more conceptual view of the subject. In this workshop, we will demonstrate a number of the computer programs and animations that we have developed to support our approach.

D2 ▸ Virtual Laboratories *(Bring your laptop)**

Location: Conference Theater, Ballroom Level
Presented by: Jeff Bell, California State University, Chico, Franklin Wattenberg, U.S. Military Academy; Joseph Grabowski, University of Pittsburgh

Virtual laboratories that are visually-, sensory-, and kinesthetically-rich and that are based on sophisticated modeling and simulation, or on real data, can provide engaging and rewarding laboratory experiences for students. Virtual labs are cheaper and safer than hands-on labs and can provide students access to experiments that would not be possible or practical in a traditional laboratory. Experiments can be carried out in a virtual laboratory much more quickly than the equivalent experiment in a real laboratory, allowing students the opportunity to examine alternative protocols within an experiment, to analyze much larger data sets, and/or to use the results from initial experiments to help them design subsequent experiments.

Nonetheless, virtual experiences are not real. Thus, effective use of virtual experiences provides a challenge as well as an opportunity. This session will include demonstrations of virtual labs across the STEM curriculum along with a discussion of how to best take advantage of virtual laboratories. Topics that may be included in the discussion are: How important is it that virtual experiences are used in combination with hands-on experiences? How well do students learn from simulations? How difficult is it to incorporate virtual laboratories into a course? Can virtual laboratories be used to replace lectures? How do we help students to learn to use virtual laboratories critically? What are the benefits of giving students the tools so that they can modify existing virtual laboratories, or even create their own? What are the best ways to assess what students learn using a virtual laboratory? What are the challenges in creating a virtual laboratory? We hope that everyone that attends this workshop will help us in tackling some of these difficult and important issues.

**Please bring a laptop capable of accessing a wireless network.*

D3 ▸ Research Instrumentation Used in Education

Location: Jefferson Room, Third Floor
Presented by: Mitchell Johnson, Duquesne University; John Boothby, San Jose State University; Kiko Galvez, Colgate University

The focus of this panel will be on innovative applications in the classroom of instrumentation traditionally used in science and engineering research settings. The facilitators will share their experiences in the successful classroom use of mass spectrometers, flow cytometers, and other research-grade analytical equipment, and discuss how to integrate the real data collection experiences such instruments facilitate into laboratory exercises, classroom instruction, and undergraduate research experiences.

D4 ▸ Teaching Spatial Analysis and Data Visualization in Undergraduate Social Science Research Methods and Data Analysis Courses

Location: Lincoln Room, Third Floor
Presented by: 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-page softback course textbook, a CD-ROM with instructional datasets, and supporting web material. The material will focus on teaching students to understand and devise public policy solutions to urban problems at the global, regional, and local levels. The workshop will consist of a lecture/demonstration describing the pedagogical approach and the nature of the modules.

D5 ▸ Calibrated Peer Review — A Writing and Critical Thinking Instructional Tool

Location: Washington Room A, Ballroom Level
Presented by: Arlene Russell, University of California, Los Angeles

Calibrated Peer Review™ (CPR), a new discipline-independent, instructional management tool enables an instructor to make frequent writing assignments that probe student understanding of concepts without increasing instructional resources for grading. Instructors can choose from the growing library of field-tested assignments or create their own assignments. In a Calibrated Peer Review assignment, students write short essays on a specific topic. Guiding questions focus both the direction that students should take in organizing their thoughts for the essay and encourage critical thinking about the topic. After electronic submission of the essays, students review "calibration" essays, which train them as reviewers. When students have demonstrated they are competent reviewers, they review three anonymous essays written by their peers and finally their own essays. To launch a "CPR Assignment," an instructor selects an assignment, creates a class list, and sets the due dates for essay submission and assignment completion. A rich set of feedback on group or individual student progress and performance is available at an instructor's fingertips. Well-designed CPR assignments have been demonstrated to enhance student understanding of the topics, to facilitate self-based learning using technology, to improve writing skills, and to teach evaluation skills.

The workshop will begin with an introduction to the program and a review of the evaluation data. Participants will then have an opportunity to adapt or develop materials for their own courses on topics they would like their students to understand better. An exam question or a homework assignment, which students have struggled with, provides an ideal topic for a CPR assignment. Participants should come with topics they want their students to understand deeply.

D6 ▸ Tutorials in Introductory Physics: A Research-Based Approach to Improving Student Learning in the Introductory Course

Location: Arlington Room, Third Floor
Presented by: Paula Heron, University of Washington

Results from discipline-based research on learning and teaching have shown that many college and university students emerge from introductory physics courses without having developed a functional understanding of important fundamental concepts. The response of the Physics Education Group at the UW has been to conduct research to identify serious and persistent difficulties. The findings are guiding the development of materials to supplement (not replace) the lectures, laboratory, and textbook of a traditional course. The guided-inquiry approach taken in Tutorials in Introductory Physics has been shown to be effective in promoting the intellectual engagement of students. More than 75,000 copies have been used by undergraduate students at over 60 institutions. Translations into several languages are underway.

Workshop participants will work through an excerpt from this curriculum. No special background in physics is necessary and the instructional strategies incorporated in the workshop are appropriate for the teaching of other sciences, mathematics, and engineering. The benefits and challenges of instruction by guided inquiry will be considered. The workshop will conclude with an illustration of the type of research underlying the development of the tutorials and a discussion of some practical issues involved in classroom implementation.

D7 ▸ Adding to Your Tool-Belt: Strategies for Improving Retention Through Learning Communities and Partnering with Two-Year Colleges

Location: Roosevelt Room, Third Floor
Presented by: Ronald Ulseth, Itasca Community College

You will learn strategies that can be employed at your home campus to improve the student experience and student success. This interactive session will explore recruiting, learning communities, intensive personal coaching of students, and university articulation. It will provide strategies on how to develop dynamic learning communities within your institution and effective recruiting and retention partnerships between two-year colleges and university STEM departments. The session will focus on how the two-year colleges can play a key role to provide a more diverse background of STEM majors for upper division programs at universities because the two-year colleges generally serve more people of color, more non-traditional

students, and people with a wider socio-economic background. Implementation of these strategies to recruit and retain students in STEM programs has been magnificently demonstrated at Itasca Community College by building relationships with all of the required partners, including high school teachers, community members, local STEM professionals, regional universities, funding agencies, and most importantly the students from the time they are in high school all of the way until they are members of industry. In their engineering transfer program, Itasca Community College has produced a success rate greater than 80% from entering freshmen to those transferring and graduating with a B.S. degree in engineering. About two-thirds of the students in this program are first generation college students.

D8 ▸ Roots and Branches: Promoting the Diffusion of Curricular Reform Ideas Throughout Undergraduate Science Education

Location: Kennedy Room, Third Floor
Presented by: Priscilla Laws, Dickinson College

This workshop will explore the intellectual roots of several activity-based undergraduate curriculum development projects based on the outcomes of physics education research. These include *Physics by Inquiry, Tools for Scientific Thinking, Workshop Physics, Interactive Lecture Demonstrations, RealTime Physics, Powerful Ideas in Physics, Tutorials in Introductory Physics,* and *Explorations in Physics.* Select activities from these curricula that use computer data acquisition systems along with electronic sensors and video analysis will be demonstrated. Examples of how the proper use of activity-based curricular materials can enhance student learning will be shown. Finally the role of the NSF CCLI program and its predecessors in the creation of activity-based physics curricula and computer tools and its diffusion to different institutions, student populations, and other disciplines will be discussed.

D9 ▸ Using Environmental Impact Analysis for Teaching Interdisciplinary Science

Location: Fairfax Room, Third Floor
Presented by: James Haynes, SUNY College at Brockport; Michelle Hluchy, Alfred University

Over the past two decades, we have used a multidisciplinary approach to science education that uses environmental impact analysis as a theme to tie together the complex array of sampling/classification skills, research/analytical techniques, scientific theories, and communication skills students need to address environmental problems. Although there are many types of environmental analyses (assessments, audits, technical reports, etc.), just as there are different strategies to facilitate science education, we have found that focusing on environmental impact statements (EISs) in a format derived from the National Environmental Policy Act (NEPA) offers a broad based, pedagogically sound and accessible way to introduce undergraduates students and faculty to applied environmental problem-solving at the same time we are teaching how science in any discipline is done. Creative faculty across the nation, in disciplines ranging from earth sciences and biology to chemistry and engineering to geography and sociology have adapted and implemented this approach in their courses and programs. During the workshop, we will discuss the approach, providing fully-documented summaries with easily adaptable sample exercises of the teaching methods and curricula; work with participants to develop ways to integrate this approach into their own courses/curricula; and discuss methods of assessing student learning resulting from this approach.

D10 ▸ Engineering Education: It Starts With the Learner

Location: Prince William Room, Third Floor
Presented by: Glen Ellis, Smith College

What is known about teaching engineering? We know that the traditional approaches for teaching engineering are often at odds with the accepted precepts of effective learning. Evidence shows that these traditional approaches are particularly detrimental to underrepresented groups in engineering. Smith's Picker Engineering Program, the only engineering program at a women's college, was founded four years ago with a vision for changing the approach to engineering education. The differences: changes in the content reflecting that we teach engineering in a liberal arts environment, and changes in how the curriculum is delivered. As a new program that's free from historical constraints-and with the help of a close partnership with Smith's education department-the Picker Program is applying research on learning to guide its development of the undergraduate curriculum.

Using examples from the Picker Program as a starting point, this workshop will focus on strategies for making research on learning come to life in the engineering and science classroom. Through an interactive dialogue that encourages the sharing of best education practices, this workshop will explore issues in learner-centered education, including:

- How can we engage student experiences and preconceptions to help them learn?
- How can we help students organize their knowledge in ways that help them see the big picture and enables them to apply their knowledge?
- How can we help students understand, evaluate and take responsibility for their own learning?
- How can engineering programs function better as a system to facilitate learning?
- What do we know about educating women in engineering? What have we learned at Smith?