

Sunday, July 30

Sunday, July 30, evening

Opening Ceremonies

7:15 PM – 8:15 PM Loeb Theater

Plenary Lecture: High performance chemistry: Cars and beyond.

Sponsored by Vernier Software and Technology on the occasion of their 25th anniversary

7:15 PM – 8:15 PM Loeb Theater

Timothy Ruppel, (Senior Product Specialist, PerkinElmer Instruments, Inc) and **Joseph Turpin**, (Associate Senior Analytical Chemist, Elanco Division, Eli Lilly and Company, Indianapolis, IN)

Modern Chemistry and the sciences in general have long been considered high performance disciplines, including the performance necessary to master them. But the skills learned may take individuals to areas not considered while the nose is pointed to textbooks. The authors describe their experiences that led to their collaboration in support of open wheel racing at the Indianapolis 500 and will illustrate some of the technical advances that are a result of high technology, performance, and speed.

Symposia sessions

Sunday, July 30 afternoon

2:00 PM - 5:00 PM STEW 302

S1: About the General Chemistry Laboratory - Session 1 of 4: Overview

Rudolph W Kluiber (Rutgers University, USA)

General Chemistry Laboratory provides a major hands-on introduction to college chemistry for many science and engineering students. In practice, the mode of teaching and academic success of this course varies greatly. It is the purpose of this symposium to share course variables such as philosophy, content and execution which can improve a student's interest in, as well as understanding of, chemistry.

2:00 introduction

2:05 Robert Richman P1: Explain to the instructor

2:25 Michael Doherty P2: Lab safety scavenger hunt: A student-centered approach

2:45 C. Jayne Wilcox P3: Producing a lab safety video

3:05 break

3:15 William Donovan P4: Research modules in the General Chemistry Laboratory

3:35 Andrea Pionek P5: Implementing the science writing heuristic at a liberal arts college

P1: Explain to the instructor

Robert Richman (Mount St. Mary's University, USA)

This paper offers an alternative to group learning methods, which have the advantage of making the students more active participants, but the disadvantage that flawed explanations might propagate misunderstanding. Since instructor time and expertise are often underutilized in the General Chemistry laboratory, I introduce occasions in my laboratory procedures when students must offer explanations of their observations to the instructor. These Socratic moments help to eliminate misconceptions and direct student attention to experimental details that might otherwise be overlooked. Developed specifically for a small college setting, this method should also be successful at large universities employing teaching assistants.

P2: Lab safety scavenger hunt: A student-centered approach

Michael Doherty (East Stroudsburg University, USA)

Safety instruction is an important component of a general chemistry laboratory experience. Often, safety training is one of the initial activities students face. Until recently, our students watched safety videos or presentations by instructors. Both approaches failed to actively engage students as participants. At the center of our current four-pronged approach is a student “scavenger hunt”. Students are responsible for locating all of the safety features of the laboratory, mapping their locations, and addressing their use. Students must first propose their own answers to safety questions in writing. Afterward, best answers are agreed upon and shared. Our goal is to help students transition to a higher level of safety awareness and involvement. In professional scientific life, they will be expected to be active, thoughtful, participating members of a safety-minded team, rather than naive users of externally imposed rules. As an opening day activity, this exercise fosters an interactive, conversational, and learner-centered atmosphere in the laboratory.

P3: Producing a lab safety video

C. Jayne Wilcox (Harper College, USA)

Regardless of the chemistry course, its first laboratory period is perhaps the most important. This lab period should set the tone for the rest of the semester, acquainting students with their equipment and informing them of safety features and standards. At Harper College, we have produced our own 15-minute video to supplement the safety orientation our instructors’ give to their students. The logistics of making this film will be presented, after which the video will be shown.

P4: Research modules in the General Chemistry Laboratory

William Donovan (The University of Akron, USA), **Prabir Dutta** (The Ohio State University, USA), **Vinnie Subramaniam** (The Ohio State University, USA), **Patrick Woodward** (The Ohio State University, USA)

Chemistry is, by its nature, an experimental science. An interesting paradox is that the cognitive skills that are neglected in most introductory level chemistry laboratories are exactly those needed for success in chemical research. Real research inherently involves a more independent and open-ended type of thinking which permits the frustrations of failed experiments, the challenge of learning from failures, and occasionally the exhilaration of successful experiments. Most students in our first and second year courses are taking chemistry only because it is required. These students, many of whom never experience chemical research, often lose enthusiasm for chemistry and science because they fail to see the links to real-life challenges and opportunities. To address this challenge, the NSF-funded Ohio REEL (Research Experiences to Enhance Learning)

Consortium for Undergraduate Research was recently established (<http://ohio-reel.osu.edu>). The central focus of the REEL Undergraduate Research Consortium is the development and implementation of a series of laboratory Research Modules for use in the first and second year chemistry courses in 15 Ohio institutions. In this talk we will discuss our efforts to date to implement research modules in the general chemistry program and describe the organization and future directions of the Ohio REEL Consortium.

P5: Implementing the science writing heuristic at a liberal arts college

Andrea Pionek (Cornell College, USA), Mary Anne Teague (Cornell College, USA)

Cornell College is a small (1200 students), liberal arts college located on the rolling hills of eastern Iowa. It is one of the very few colleges in the United States that operate on what we call the One-Course-At-A-Time (OCAAT) system. At Cornell this system consists of nine three-and-one-half week blocks where students and faculty are involved with only one course during a given block. This schedule provides some interesting challenges for laboratory courses but also some wonderful flexibility. The science writing heuristic (SWH) is an alternative format for chemistry laboratories that involves the students in guided inquiry activities and reinforces these concepts with a unique laboratory report format. We felt the SWH would benefit our students by improving their laboratory experiences and making laboratory more meaningful. This format was implemented in half of the sections of Chemical Principles I and all sections of Chemical Principles II over the last academic year. This talk will discuss the process of changing the laboratory format and early impressions of using SWH from both faculty and students.

2:00 PM - 5:00 PM STEW 314

S2: Assessment and Equity in Chemistry Curricula - Session 1 of 1

Kevin Pate (Marietta College, USA), **Willy Hunter** (Illinois State University, USA)

This symposium of general interest to the Chemical Education community will focus primarily on the assessment of chemistry curriculum and equity in access to chemical knowledge.

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| 2:00 | introduction |
| 2:05 | Moises Camacho P6: Authentic / alternative assessment in chemistry / science education 1: The effect of the autoquiz on the achievement of science college students |
| 2:25 | Simone Aloisio P7: Widening international perspective through science |
| 2:45 | Richard Bauer P8: Project pathways: Connecting chemistry, physics, and math |
| 3:05 | Kevin Pate P9: Assessment tools for chemistry and biochemistry departments |
| 3:25 | break |
| 3:40 | Simone Aloisio P10: Assessing a new chemistry curriculum |
| 4:00 | Norma Gatica P11: Supplemental instruction in chemistry courses |
| 4:20 | Todd Pagano P12: Job related simulations for improved content understanding, peer-guided learning, and classroom dynamics |
| 4:40 | Paul Charlesworth P13: Removing barriers to success: Reducing gender differences in 3-D |

P6: Authentic / alternative assessment in chemistry / science education 1: The effect of the autoquiz on the achievement of science college students

Moises Camacho (University of Puerto Rico-Mayaguez Campus, Puerto Rico)

The autoquiz is an assessment technique in which the students read, understand, analyze, synthesize and evaluate the assigned topics (e.g. chapter). Then they prepared 15 questions of the most relevant content of the chapter. After they have learned the answers (and reasons for the best or most correct of them) they presented the autoquiz orally to the class. The professor evaluated both the quality of the questions, answers, reasons, and examples provided by each student according to the written instructions. The sample consisted of about 100 students per semester (500 in total) during several semesters. The students who prepared, presented, and approved one autoquiz per chapter also approved the regular quizzes and three partial examinations of the professor 80 to 100%. In addition, the autoquiz students also approved the course with 90 to 100%. This constructivist technique was invented and applied by the author and has been very effective in demonstrating the extent of understanding of a topic. There was a significant statistical difference between the mean scores of regular and autoquiz students. The autoquiz technique is important for science education at all levels since several studies have demonstrated that almost all students have forgotten the basic principles and concepts of chemistry, science, and mathematics in general which indicated rote- memorization, and not a genuine understanding and long-term memory of these principles.

P7: Widening international perspective through science

Simone Aloisio (California State University Channel Islands, USA)

We have developed a general education class titled Science and Technology in Japan that is being offered in the Spring 2006 term. In addition to on-campus instruction, the class includes a one week study abroad experience in Japan. The class is an interdisciplinary class that is being team taught by a chemist and a biologist, with several guest speakers from music, history, psychology, geology, and engineering. The primary learning objectives for the course are 1) to widen students' international perspective through the study of Japan and Japanese society; and 2) to introduce students to the scientific method and how it is used to study four particular topics: cherry blossoms, earthquakes, the shinkansen or bullet train, and climate change. The course will focus on one question: "How do we study these topics?". That question will also be discussed with the expert guest speakers from other disciplines. The students come from a wide-range of academic majors, and many have never been abroad. We will assess these outcomes using a pre and post class surveys, as well as instructor observations of student projects.

P8: Project pathways: Connecting chemistry, physics, and math

Richard Bauer (Arizona State University, US), James Birk (Arizona State University, USA), Robert Culbertson (Arizona State University, USA)

A coordinated series of four graduate courses for in-service secondary mathematics and science teachers is under development at Arizona State University. A first cohort of 80 teachers in 4 classes in 4 school districts completed the first course in the series, "Math Functions" in spring 2005 and took the second course, "Connecting Math and Science: Physics and Chemistry" in fall 2005. (The third and fourth courses, "Connecting Math and Science: Biology and Earth Science" and "Engineering Design" will be given in a subsequent semesters.) "Connecting Math and Science: Physics and Chemistry" was developed with the following goals for the teachers: (1) improved understanding of foundational concepts and processes in physics and chemistry, (2) adoption of student-centered, inquiry-based teaching strategies, and (3) increased awareness of the connectedness of concepts featured in the math functions course to physics and chemistry. The

philosophy, structure, and content of this course will be discussed.

P9: Assessment tools for chemistry and biochemistry departments

Kevin Pate (Marietta College, USA)

Assessment: Few (if any) of us enjoy it, yet all of us are required to do it. This talk will discuss a number of approaches for assessing individual chemistry courses and overall chemistry or biochemistry majors. Our chemistry department currently utilizes a variety of assessment tools, including embedded exam questions, rubrics, standardized exams, and student opinion surveys. This talk will be aimed at faculty who might be looking for new assessment approaches to be used at their own colleges or universities. The talk will demonstrate how the various tools might be used in both departmental assessment and general education assessment. If time permits, an opportunity will be provided for audience members to suggest/discuss additional assessment tools utilized in their own departments.

P10: Assessing a new chemistry curriculum

Simone Aloisio (California State University Channel Islands, USA)

In its first year of implementation, the chemistry faculty at CSUCI have begun curriculum assessment. The learning outcomes for the chemistry program incorporate the “Big Ideas” of chemistry: geometric structure, electronic structure, forces between molecules, thermodynamics, kinetics, and chemical reactions. Required courses learning outcomes were aligned to these program outcomes as part of the assessment. The objective is to perform ongoing assessment of the program by assessing student success in the course learning outcomes, and monitoring student progress towards the program outcomes (the “Big Ideas”). Starting with geometric structure, the program has assessed course outcomes related to this program outcome by using mostly embedded tools. The results of this assessment project, along with challenges of this process will be discussed.

P11: Supplemental instruction in chemistry courses

Norma Gatica (Cuyahoga Community College-Eastern Campus, USA), Sandie Crawford (Cuyahoga Community College, USA)

The Learning Center at Cuyahoga Community College, Eastern Campus, offers a program called Supplemental Instruction (SI). Students at CCC depend on the Professor or the tutor for instructional support, while the figure of teaching assistants (TA) is non-existent. The SI program aims to provide a similar level of instructional assistance as the one that would be provided by TA by assigning a Supplemental Instructor to each course for the duration of the term. The tutor attends the lectures regularly, as regular students do. Therefore, the TA not only reviews the content of the course but he also learns first-hand what is expected from the students. The students are given the opportunity to select the best time to hold recitations for each course by filling a survey run by the instructor. These recitations are to be conducted by the Supplemental Instructor. Initially just the Introductory Chemistry Courses participated in this program, after a few semesters this program has proven to be very successful. At present more advanced classes, such as Organic Chemistry, are requesting the services of Supplemental Instructors. This paper will present an analysis on how attrition and students’ performance are affected by the existence of the Supplemental Instruction Program.

P12: Job related simulations for improved content understanding, peer-guided learning, and

classroom dynamics

Todd Pagano (Rochester Institute of Technology, USA)

With the goal of preparing our students for roles as competent members of the scientific citizenry, we apply a novel approach to teaching and assessing certain laboratory concepts and techniques. The culmination of our approach is student participation in simulations of real-world laboratory situations. The simulations act as unit capstones, practical laboratory assessments, procedural reviews, and samplings of future employment settings. Prior to a simulation experience, the student develops skills lists (detailed records and explanations of procedures) and completes several related activities or experiments. The simulations require the student to complete laboratory work by responding to a memo of a real-world application. By design, the experience is open-ended and often requires the student to demonstrate some mastery of the subject. The students present the results of the activity in a simulated “company department meeting”. A pedagogical advantage of this student-centered and cooperative approach transfers much of the responsibility of learning to the student by allowing them to monitor their own learning through the development of skills lists and successful completion of the simulations. Peer-guided learning occurs as the students work together as an interactive team with the common goal of completion of the assigned task.

P13: Removing barriers to success: Reducing gender differences in 3-D

Paul Charlesworth (Michigan Technological University, USA)

Spatial visualization is considered to be one of seven human intelligences and is an active topic in educational research. Based on previous research, two distinct themes emerge: 1) well-developed 3-D spatial skills are critical to success in STEM fields, and 2) the 3-D spatial skills of women typically lag significantly behind their male counterparts. Understanding the need for training for some individuals, particularly women, Michigan Tech implemented a spatial skills course in 1993 with NSF support. This course has been shown to have a significant impact on the retention of female engineering students over the past ten years. In 1998, MTU received funding from NSF to develop multimedia software and a workbook aimed at improving 3-D spatial skills. These user-friendly, gender-neutral materials have been proven to develop the 3-D spatial skills of first-year engineering students. This paper presents preliminary findings when testing these materials in STEM fields outside of engineering and pre-college students in middle and high school.

2:00 PM - 5:00 PM STEW 310

S3: Inspiring Ideas for Physical Chemistry Lecture and Laboratory - Session 1 of 2

Richard Schwenz (Univ. of Northern Colorado, US)

Presenters will share ideas for teaching physical chemistry lecture and laboratory that can be incorporated into classes. The symposium will also seek to answer important underlying questions such as “How do you know when your students understand physical chemistry?”, “How do you address the issue that physical chemistry overlaps the other subdisciplines of chemistry more than ever?”, and “what can you possibly leave out of the already overcrowded curriculum?”

2:00 introduction

2:05 Richard Schwenz P14: A Physical Chemistry Curriculum for the 21st Century

2:25 Theresa Julia Zielinski P15: Using JCE Digital Resources in Physical Chemistry Courses

2:45 Erica Harvey P16: Online Physical Chemistry

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| 3:05 Jeffrey Fieberg | P17: Quantum or Thermo First? Yes. |
| 3:25 | break |
| 3:35 Keith Dunn | P18: How Much Statistical Mechanics is Enough? |
| 3:55 Steven Gravelle | P19: Application of the Science Writing Heuristic in the Physical Chemistry Laboratory |
| 4:15 Carlos Contreras-Ortega | P20: From the Specific to the General: The Scientific Route to Understanding |
| 4:35 Samantha Glazier | P21: Engaging Students Using Current Topics in Chemical Research |
| 4:55 | discussion |

P14: A Physical Chemistry Curriculum for the 21st Century

Richard Schwenz (Univ. of Northern Colorado, US)

At the beginning of the 20th century, physical chemistry was just emerging as a discipline focused on describing thermodynamics. During the next hundred years, a fully developed discipline has evolved which now focuses on a detailed examination of the evolution of quantum states of molecules, while paying attention to the tremendous amount of material from the past. Physical chemists have also become extremely involved with the development and characterization of new materials. The evolution of the field is reflected in the curriculum and textbooks by how much material is packed into each. One difficulty has become what to cover and at what depth. What to leave out is becoming a significant issue given the limitations on the practical size of textbooks, and the number of lecture classes in the typical one-year sequence. In addition to the sheer amount of material, cognitive education specialists are significantly better informed as to presentation pedagogies that enable enhanced student learning. A further question has been raised about the order in which material is presented to the students.

P15: Using JCE Digital Resources in Physical Chemistry Courses

Theresa Julia Zielinski (Monmouth University, USA)

A large variety of digital resources for teaching physical chemistry are available through JCE. This presentation will review the contents of the SymMath collection, the Living Textbook of Physical Chemistry, and the Learning Communities OnLine collection. The availability of other digital resources will also be mentioned.

P16: Online Physical Chemistry

Erica Harvey (Fairmont State University, USA)

Second-semester physical chemistry (quantum) is offered as an online course at Fairmont State using the Vista platform. Interactive synchronous class “meetings” are held with Horizon Wimba communication software using 2-way audio and application-sharing capabilities, in addition to e-board and chat. Archives are available for students who cannot attend the sessions. Students assess their own preparation level prior to each class session by making discussion posts and framing substantive content questions in private electronic logs. Readings and problems are largely taken from an electronic text (Quantum States of Atoms and Molecules) available through JCE Online. Students working through the 9 course modules present and critique explanations and derivations, write essays, solve quantitative problems, and draw pictures to illustrate quantum mechanical and spectroscopic concepts. Individual and group assignments are submitted in Mathcad, Word, Paint and Excel. Students are also required to achieve perfect scores on 10-question electronic quizzes

drawn from ~100-question quiz banks for each module. Weekly yoga activities introduce a kinesthetic component to the course. Required discussion/reflection posts encourage students to use new vocabulary and concepts as they draw connections between physical chemistry and yoga. The ACS Standardized Exam in Quantum Chemistry is given in a face-to-face meeting at the end of the course.

P17: Quantum or Thermo First? Yes.

Jeffrey Fieberg (Centre College, USA), Keith Dunn (Centre College, USA)

Many recent colloquia on the physical chemistry curriculum have focused on the order of topics in the modern two-semester sequence. The discussions have often centred on the topic of whether it is best to teach quantum mechanics or thermodynamics first. The authors are pleased to report we have finally arrived at a definitive answer for this conundrum: yes. For the past several years we have offered our students the option of taking either pchem course first. We have had success using two of the major texts, McQuarrie and Simon, and Atkins and dePaula. We will discuss the considerable curricular benefits of this approach, both to majors and nonmajors, and admit to a few drawbacks and inefficiencies.

P18: How Much Statistical Mechanics is Enough?

Keith Dunn (Centre College, USA)

A working knowledge of how thermal energy is partitioned among the available levels of a system allows students to develop both an understanding of chemical principles and an intuition into reactivity. Statistical mechanics provides the molecular basis for explaining such fundamental properties as average energy, entropy, heat capacity, and even equilibrium position. Unfortunately, the mathematical complexities associated with ensemble behavior often obscure the physical insight provided from statistical mechanics from all but our most mathematically gifted students. I present here a strategy for teaching the basic concepts of statistical behavior and its chemical ramifications based entirely upon the molecular partition function and a system of non-interacting particles. Included will be a discussion of a 1-2 week laboratory exercise using Mathcad to model a simplified reacting system.

P19: Application of the Science Writing Heuristic in the Physical Chemistry Laboratory

Steven Gravelle (Saint Vincent College, USA)

This presentation explores the use of the Science Writing Heuristic (SWH) laboratory format (developed by Thomas Greenbowe at Iowa State University) in the junior-level Physical Chemistry lab at Saint Vincent College and contrasts this experience with its use in General Chemistry. The Science Writing Heuristic provides a framework for both the laboratory structure and the laboratory report that results in a more inquiry-based experience for the students. Historically, our laboratory courses in General Chemistry and Physical Chemistry have used verification-style experiments, and we wished to move to more inquiry-based student-centered laboratories. To make this transition, we adopted the SWH format. In this presentation, I will discuss the results of surveys and other methods we used to compare the conventional lab format with the Science Writing Heuristic. From this comparison, I hope to show how the SWH format has altered the way that both students and I as a faculty member think about laboratory experiments.

P20: From the Specific to the General: The Scientific Route to Understanding

Carlos Contreras-Ortega (Universidad Católica del Norte, Chile), Nelson Bustamante (Universida

Catolica del Norte, Chile), Juan Luis Guevara (Universidad Catolica del Norte, Chile), Victor Kesternich (Universidad Catolica del Norte, Chile), Carlos Portillo (Universidad Catolica del Norte, Chile)

Consider the following questions: 1) Why do some equations have limitations? 2) What do these limitations tell us about what's happening in nature? 3) How do we explain the situations outside of the limits of these equations? Granted these questions are not often discussed in first year chemistry textbooks, but their importance to building student's understanding of the limitations of models and algorithms can not be understated. In this presentation, we will discuss the benefits of using limit equations as a starting point in explaining the mathematical relationships between measurable quantities. We will share our general mathematical strategy of moving systematically from equations with limits to more general equations and illustrate how some of the most common equations in chemistry can be deduced. This method helps emphasize to students the necessity of thinking about these questions of limitations, and how knowledge in the various branches of physical chemistry and physics can help tie macroscopic observations to what is taking place at a microscopic level.

P21: Engaging Students Using Current Topics in Chemical Research

Samantha Glazier (St. Lawrence University, USA)

The practical implications of derivations, equations and topics that we present in class are not always readily apparent to students even when thoughtful examples are shown. It is a short logical step to illustrate relevance by the use of current literature. Examples such as how free energy is used to explain problems in nanochemistry or how Michaelis-Menton kinetics are used to solve enzyme reaction mechanisms have the potential to pique students interests and deepen their understanding of lecture material. Some of the challenges of engaging students in chemical literature are the conceptual density of articles and the technical rhetorical style. If these barriers can be overcome, co-discovering current topics in chemistry with students provides an opportunity for genuine exchanges of ideas from other courses, research projects and personal interests. Central to my teaching philosophy is finding ways to learn from and with my students and motivates my interest in incorporating difficult and uncertain materials to balance the established material that I present in lecture. I will share the successes and challenges encountered while reading biophysical chemistry journal articles as a class. Session attendees will be encouraged to reflect on the function of current progress in science in their own courses.

2:00 PM - 5:00 PM STEW 306

S4: Research in Chemical Education - Session 1 of 6

Christopher Bauer (Univ. of New Hampshire, USA)

This symposium, sponsored by the CHED Committee on Chemical Education Research, is a forum for research conducted on the teaching and learning of chemistry at any level. Presentations will address: 1) the motivation for the research and the theoretical bases in which it is grounded, 2) the methods used to gather and interpret data, and 3) the findings and their significance interpreted in light of theory and method. Authors are being strongly encouraged to bring copies of an extended abstract to share with the audience.

2:15 introduction

2:20 Dawn Rickey P22: Investigating instructional conditions that promote reflection: Macro-molecular connections, and model revision in general chemistry laboratory

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| 2:40 | Seth Anthony | P23: Effects of instructional conditions on persistence of students' molecular-level ideas about aqueous solutions |
| 3:00 | | break |
| 3:10 | Andrei Straumanis | P24: SALG and POGIL: A multi-institution assessment |
| 3:30 | Amy Phelps | P25: "Gone" into solution: Assessing the effect of hands-on activity on student solubility comprehension |
| 3:50 | Lucille Garmon | P26: Who benefits from innovations in science teaching: Reaching the less well prepared |
| 4:10 | | break |
| 4:20 | Charles Cox | P27: Use of concept maps and collaborative grouping for problem solving interventions |
| 4:40 | MaryKay Orgill | P28: Using concept inventories to assess students' understanding in general chemistry classes |

P22: Investigating instructional conditions that promote reflection: Macro-molecular connections, and model revision in general chemistry laboratory

Dawn Rickey (Colorado State University, United States), Melonie Teichert (Colorado State University, USA), Lydia Tien (Monroe Community College, USA)

The Model-Observe-Reflect-Explain (MORE) Thinking Frame is an instructional tool that has been shown to promote metacognitive reflection and deeper understanding of chemistry ideas when used in general chemistry laboratory courses. Recently, we have adapted the MORE Thinking Frame for use in new contexts, including general chemistry courses at a research university (Colorado State University in Fort Collins, CO), a primarily undergraduate institution (James Madison University in Harrisonburg, VA), a two-year college (Monroe Community College in Rochester, NY), and a high school (Fort Collins High School in Fort Collins, CO). Coincident with the implementation of the MORE Thinking Frame in new instructional contexts, we are collecting and analyzing data to determine under what instructional conditions students (1) engage in reflection/metacognition, (2) make connections between macroscopic observations and molecular-level mechanisms, and (3) revise their personal models for consistency in light of experimental evidence. We will present the results of our analyses of student models, video of students working in the classroom, and student interviews as they relate to the research question posed.

P23: Effects of instructional conditions on persistence of students' molecular-level ideas about aqueous solutions

Seth Anthony (Colorado State University, U.S.A.), Dawn Rickey (Colorado State University, United States), Melonie Teichert (Colorado State University, USA), Lydia Tien (Monroe Community College, USA)

Students engaged in using the Model-Observe-Reflect-Explain (MORE) Thinking Frame with general chemistry laboratory modules have been shown to develop more scientifically correct molecular-level views of chemical systems and processes, as measured by analyses of their initial (pre-lab) and final (post-lab) models. Optimally, students would then demonstrate application of this improved understanding in a variety of contexts well beyond the timeframe of the laboratory module. In this study, we examine the persistence of student models relating to the dissolution of

chemical compounds in water after participating in a MORE laboratory module on this topic, as measured by students' subsequent written models, responses to exam questions, and responses to interview questions. We investigate the influence of variations in the model assignments and laboratory activities on the ideas that students express about aqueous solutions throughout the first-semester general chemistry laboratory course.

P24: SALG and POGIL: A multi-institution assessment

Andrei Straumanis (College of Charleston, USA)

As part of an ongoing assessment of Process Oriented Guided Inquiry Learning (POGIL), the Student Assessment of Learning Gains (SALG) survey was administered in organic chemistry classes at four different institutions. For comparison, the survey was also administered in classes taught using traditional lecture methods and those using POGIL. The results indicated that regardless of materials used, instructor, institution, and different student backgrounds, those taught with POGIL reported greater gains than those taught more traditionally.

P25: "Gone" into solution: Assessing the effect of hands-on activity on student solubility comprehension

Amy Phelps (Middle Tennessee State University, USA), *Laura Whitson* (Middle Tennessee State University, USA)

Solubility is difficult for many general chemistry students. The concept that clear, colorless liquids may contain charged atoms or molecules able to interact with other clear, colorless liquids also containing aqueous species is difficult to grasp. Our belief was that students were unable to apply abstract ideas of solubility to tangible chemistry settings. The control group completed a traditional lab in which students observed ionic displacement reactions and then used reaction series to identify unknown solutions. The treatment group laboratory included two teacher demonstrations, after which the students moved to stations to complete hands-on activities to build solubility concepts. Finally, students performed a modified version of the traditional laboratory procedure. Pre- and post-tests to determine students' understanding of solubility were administered to all groups. An analysis of co-variance was run using the pre-test score as the co-variate and the treatment group was found to have statistically significant higher post-test scores. Qualitative data were also collected to provide a better understanding of the differences between groups.

P26: Who benefits from innovations in science teaching: Reaching the less well prepared

Lucille Garmon (Univ. of West Georgia, USA)

A number of interventions have been introduced in science courses in the past ten to twenty years, such as SI, POGIL, PLTL, inquiry-based learning, the modular approach, etc. Several of these have been implemented by science departments at one mid-sized comprehensive university. To gauge their effectiveness, the records of participating students were examined to judge preparation for the course (based on GPA in pre-requisite science/math courses) and motivation (based on class attendance). This paper will examine the correlation between participation in SI or PLTL and success in the course for four types of students: highly motivated and well prepared, highly motivated but less well prepared, well prepared but less well motivated, and below average in both preparation and motivation.

P27: Use of concept maps and collaborative grouping for problem solving interventions

Charles Cox (Clemson University, United States), *Melanie Cooper* (Clemson University, United

States), Ron Stevens (UCLA, USA)

The development of problem solving skills is an objective for most chemistry classes. The processes by which students solve problems can often be difficult to ascertain. However, with IMMEX software, it is possible to determine how students solve problems and where students make mistakes, thereby allowing for implementation of intervention methods to improve problem solving success. This talk will focus on two such intervention methods, concept mapping and collaborative grouping, that were implemented in a second semester general chemistry course. Student abilities, as measured using Item Response Theory, were used to compare the effectiveness of these interventions. The effects of gender on the response to the intervention methods will be discussed.

P28: Using concept inventories to assess students' understanding in general chemistry classes
MaryKay Orgill (UNLV, USA), Penny J. Gilmer (Florida State University, USA)

There is a need for monitoring what students know when they enter college science classes and which concepts and skills they master or do not master as a result of participating in those classes. Formative assessments can inform an instructor who wants to modify instruction to meet the needs of his students. In the current study, we have used "concept inventories" as a means of assessing student understanding in first-semester general chemistry classes. The concept inventories consist of a list of concepts that are considered to be important in first-semester general chemistry classes. Students rank their understanding of the individual concepts using a Likert-type scale, with responses ranging from "I have not heard of this concept" to "I am very confident of my understanding of the concept, and I am certain I could explain it so others could understand it." We used the concept inventories as formative pre- and post-assessments in the general chemistry classes in 42 different classes at 12 universities, colleges, and community colleges in two different states. We describe the main results of the concept inventories and the implications of these results for chemistry teaching. We also describe some unexpected benefits of using the concept inventories.

2:00 PM - 5:00 PM STEW 206

S5: Teaching to the National Science Standards: Use of History and Nature of Science in the Classroom - Session 1 of 1

Jeff Hepburn (Central Academy, USA)

The use of history anecdotes and the nature of science in the chemistry classroom is one of the foundations of the National Science Standards. It also creates an important component to enhance any chemistry class. Presenters will share creative activities used in the classroom demonstrating the history and/or nature of science.

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| 2:00 | introduction |
| 2:05 Laura Ruebush | P29: Developing students' ideas about the nature of scientific models |
| 2:25 Ted Clark | P30: Evaluating aspects of scientific literacy among undergraduate chemistry students |
| 2:45 Mark Michalovic | P31: Famous chemists: Telling stories and teaching chemistry |
| 3:05 Mark Michalovic | P32: Famous chemists: Telling more stories and teaching chemistry |

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| 3:25 | break |
| 3:35 | Jeff Hepburn P33: Using chemical magic to demonstrate the nature of science |
| 3:55 | Andrew Cherkas P34: Nature of the atom in history |
| 4:15 | Jeff Hepburn P35: Using historical aspects to enhance the chemistry classroom |
| 4:35 | discussion |

P29: Developing students' ideas about the nature of scientific models

Laura Ruebush (Texas A&M University, USA), Simon North (Texas A&M, USA), Michelle Sulikowski (Vanderbilt University, USA)

There is increased interest in conveying information concerning the development and use of models in science. Recent research focusing on the creation of instructional frameworks that support learning in this area has demonstrated that there is limited improvement in the student's understanding of the nature of models, even after explicit instruction. In an effort to engage students in the process of model development we have adapted a "Black Box" exercise, previously reported by Jennifer Cartier. First year chemistry students at a private southern university were asked to create a model of the inner workings of the Black Box using an open-inquiry framework. Working in teams they created, then defended, their models while engaging in an open peer-review process. Using concept maps and surveys, pre and post-intervention, we were able to track changes in student's understanding of the development, use and validation of scientific models. Conclusion regarding our efforts will be presented.

P30: Evaluating aspects of scientific literacy among undergraduate chemistry students

Ted Clark (the Ohio State University, USA), Caroline Clark (Ohio State University, USA)

A key component of scientific literacy is an understanding of the nature of science. Although a single definition of the nature of science is problematic, and much debated, there is currently general agreement that science is a human endeavor that is reliant on empirical observation and subject to change, and that such a conception of science should be conveyed to students and science educators. Despite the importance of communicating to students the nature of science, it is not well understood how students' insights into the nature of science develop as they progress from high school through undergraduate programs. To begin to address this issue, we have undertaken a quantitative examination of students' views of the nature of science among chemistry students at a large public university (n=325). Although not a longitudinal study, our results may begin to address the question of how students' perceptions of science change. In particular, it is significant that our data set will include students with extensive classroom and chemical research experiences. In many ways, these students are the "finished product" of a rigorous undergraduate chemistry curriculum. It will be beneficial to consider if these students express significantly different views from those of other undergraduates, and to compare their perceptions with those of high school students. To accomplish these analyses, SPSS software will be used and a statistical analysis of variance completed to assess the importance of different student descriptors, including gender, GPA, academic major, and year in school.

P31: Famous chemists: Telling stories and teaching chemistry

Mark Michalovic (Chemical Heritage Foundation, USA)

Lise Meitner, unraveled the mystery of nuclear fission, but did not get to share in the Nobel prize

awarded to her co-discoverers. Her story has useful applications in teaching atomic structure and nuclear chemistry. Telling the stories of scientists like Meitner and their discoveries can add a human dimension to technical subjects and illustrate scientific thinking and processes. This workshop provides both background knowledge and free quality classroom materials for teachers. In addition, attendees will learn how to access free online lesson plans and other resources on the history and nature of science aligned with the National Science Education Standards.

P32: Famous chemists: Telling more stories and teaching chemistry

Mark Michalovic (Chemical Heritage Foundation, USA)

The periodic table is chemistry's most recognizable icon. In retracing the process by which Dmitri Mendeleev developed his first periodic table students can learn a great deal about how the table organizes information in a convenient and meaningful way. Telling the stories of scientists like Mendeleev and their discoveries can add a human dimension to technical subjects and illustrate scientific thinking and processes. This workshop provides both background knowledge and free quality classroom materials for teachers. In addition, attendees will learn how to access free online lesson plans and other resources on the history and nature of science aligned with the National Science Education Standards.

P33: Using chemical magic to demonstrate the nature of science

Jeff Hepburn (Central Academy, USA)

It is essential that students are aware of the Nature of Science in the Chemistry classroom. A Chemistry teacher and a semi-professional magician will demonstrate various activities to show the Nature of Science to students. Some of the secrets to these demonstrations will be revealed. Others won't-- but isn't that part of the Nature of Science.

P34: Nature of the atom in history

Andrew Cherkas (Stouffville DSS, Canada)

The history of atomic theory can be used to illustrate the nature of science, while allowing students to understand the nature of the atom and atomic theory better.

P35: Using historical aspects to enhance the chemistry classroom

Jeff Hepburn (Central Academy, USA)

One of the National Standards stresses that the science student be exposed to the Historical aspect of science. This paper will demonstrate the use of various components used to show the historical aspect of Chemistry. The use of pictures and autographs of many Nobel Prize winning chemists along with anecdotal stories will be presented. The use of Chemistry books dating over 100 years and Chemistry stamps will also be discussed as a means of enhancing the classroom.

Workshops

Sunday, July 30 afternoon

W3: Chemical Misconceptions : Prevention, Diagnosis, and Cure

2:00 PM - 5:00 PM STEW 311

Al Hazari (University of Tennessee, USA)

Chemistry is a conceptual subject and, in order to explain many of these concepts, models are used to describe and explain the microscopic world and relate it to the properties of matter. As students progress in chemistry, the models they use change and many contradict their everyday experiences and use of language. This workshop includes information and activities about some of the key misconceptions that have been uncovered by research and ideas about a variety of teaching approaches that may help avoid students acquiring some common misconceptions.

Capacity: 30 Fee: \$ 20

W4: Cheminformatics Workshop

2:00 PM - 5:00 PM WTHR 214

Norah MacCuish (Mesa Analytics & Computing, LLC, USA)

This workshop will introduce professors to cheminformatics through a lecture portion and a hands-on computer laboratory called the Cheminformatics Virtual Classroom. Mesa Analytics & Computing, LLC is developing an interactive laboratory in collaboration with six major universities (Indiana University, University of Michigan, Virginia Commonwealth University, Virginia Tech, University of New Mexico, and University of Arizona), and funding from a Phase II SBIR grant from the National Science Foundation. This workshop will give participants an opportunity for hands on experience with the virtual classroom software. Cheminformatics in many ways parallels bioinformatics, but has less exposure. Students, especially chemists heading off to careers in industry, should have hands-on computing experience with chemical computer interfaces in addition to having a general understanding of the problem space at graduation. Searching chemical database systems, structure-activity prediction in 2D and 3D will be discussed, as well as many opportunities to visualize chemistry in a computational form. Visit the home page for the project at <http://www.chemvc.com:8020/>

Capacity: 20 Fee: 10.00

W5: Light, Color and Nanotech: Chemistry Applications in Display Devices

2:00 PM - 5:00 PM BRWN 1135

Karen Nordell (Lawrence University, USA)

Chemistry is a vital part of sports arena replay screens, flat panel computer displays, and electrochromic ebook readers. These high technology devices can be used illustrate the importance of chemistry in modern life. This hands on laboratory experiment workshop includes experiments with light emitting diodes, preparation of liquid crystals, and the preparation of electrochromic displays. The workshop will make the connection between periodic properties, electronic energy levels, color, diffraction, redox, and these nanotechnology display devices. This workshop is partially supported by the Materials Research Science and Engineering Center on Nanostructured Interfaces at the University of Wisconsin-Madison (<http://mrsec.wisc.edu/edetc>).

Capacity: 35 Fee: \$25

W6: Living By Chemistry - Bringing Chemistry to Life for Students

2:00 PM - 5:00 PM STEW 322

Angelica Stacy (UC Berkeley, USA)

Living By Chemistry is an innovative high school chemistry curriculum project that aims to make chemistry accessible to all students without sacrificing content. This workshop will address some of the misconceptions that interfere with students' success in chemistry and present some possible solutions. We will provide a quick overview of this new approach and focus on activities from the

first two units – Alchemy and Smells. Participants will become acquainted with our curriculum first-hand, performing activities which address atoms, the periodic table, molecular shape and structure, and bonding.

Capacity: 40 Fee: none

W7: National Science Standards and the ACS High School Exams

2:00 PM - 5:00 PM STEW 313

Thomas Holme (UW - Milwaukee , USA)

This workshop introduces the concepts needed to judge the alignment of assessment items with the National Science standards and with the state standards of the teachers who participate. The process by which ACS Exams are constructed will be described and the alignment of the items on the two most recent exams will serve as the template for applying the concepts presented.

Capacity: 0 Fee: 10.00

W8: Peer-Led Team Learning (PLTL)

2:00 PM - 5:00 PM WTHR 317

Ana Fraiman (Northeastern illinois university, USA)

Theoretical and practical elements of The PLTL Workshops will be introduced. Students who have served as peer leaders will be present to demonstrate workshops. Development of workshop materials, training of peer leaders, implementation and institutionalization issues will be discussed. Participants will be provided an implementation guide book which contains sample workshop materials for organic, general, and allied health chemistry.

Capacity: 30 Fee: minimum

W9: Teaching Within the Rhythms of the Semester

2:00 PM - 5:00 PM WTHR 217

Cheryl Frech (University of Central Oklahoma, United States)

What are your teaching rhythms? This session will help you explore the time dimensions of teaching a course. Using a series of mini-lectures and small group activities, we will *help you identify the unique rhythms of your courses *explore the common critical moments in a course *find strategies to defuse time problems. Teachers of chemistry at all levels will benefit from considering the time aspects of teaching.

Capacity: 20 Fee: \$5.00 for duplication costs

Monday, July 31 morning

Plenary Lecture

Does Chemical Education Research Have Answers to Offer the Chemistry Community?

Sponsored by Vernier Software and Technology on the occasion of their 25th anniversary.

8:00 AM – 8:50 AM Loeb Theater

Diane M. Bunce (The Catholic University of America)

Questions of why students have trouble learning chemistry and what can be done to increase their learning remain of paramount importance to all who teach chemistry. Chemical education research addresses aspects of these big questions and offers insight and progress along the path to

understanding the issues, yet does it fully answer the question? Many, who were trained as chemists, are not sure how to judge the quality of chemical education research or know what to do with its published research findings. Thus there are two problems that exist, namely, 1) Does chemical education research ask the questions that the chemical community wants answered and if not, why not? 2) Does the chemistry community know how to judge the quality of chemical education research and use the results to improve the learning and teaching of chemistry?

This presentation will address how chemical education research adds to the scientific understanding of situations we encounter in the teaching and learning of chemistry and how and why it doesn't. Questions of how to judge, interpret, and use published peer-reviewed chemical education research will be discussed along with a comparison of chemical education and traditional research.

The format of this presentation will be to ask questions that are often asked of chemical education research and attempt to provide answers and understanding of how chemical education research operates. Real situations will be used as examples wherever possible and the music of the 60's will be used as a backdrop to help further our understanding of the topic. Become part of a lively discussion that will attempt to answer the questions often asked of the discipline from both chemists and the chemical education community itself.

Symposia sessions

Monday, July 31 morning

9:00 AM - 12:00 PM STEW 302

S1: About the General Chemistry Laboratory - Session 2 of 4: Philosophy

Rudolph W Kluiber (Rutgers University, USA)

General Chemistry Laboratory provides a major hands-on introduction to college chemistry for many science and engineering students. In practice, the mode of teaching and academic success of this course varies greatly. It is the purpose of this symposium to share course variables such as philosophy, content and execution which can improve a student's interest in, as well as understanding of, chemistry.

| | | |
|-------|-------------------|--|
| 9:00 | | introduction |
| 9:05 | Steven Brown | P36: General Chemistry Laboratory survey |
| 9:30 | Kereen Monteyne | P37: General Chemistry Laboratory: Current status and barriers to change |
| 9:50 | Amy Phelps | P38: Chemistry laboratories: What do we want students to walk away with? |
| 10:10 | | break |
| 10:20 | Richard Bauer | P39: Ten years of guided inquiry at Arizona State University |
| 10:50 | Rudolph W Kluiber | P40: GenChem: A silicon analog of the carbon based General Chemistry Laboratory instructor |

P36: General Chemistry Laboratory survey

Steven Brown (University of Arizona, USA)

What is the “norm” for a general chemistry laboratory program? How much variation is there from program to program? This survey of more than sixty representative colleges and universities was conducted in an effort to broaden our understanding of the general chemistry lab. The 41 questions probe such topics as who delivers the education, how are experiments selected, who selects the experiments, how are experiments delivered to students, what is the pedagogical content of the experiments, what is the nature and extent of student writing, how is cooperative learning used and what kinds of support materials are used to promote learning. The intent is to identify major trends and to share this information with those responsible for developing and maintaining general chemistry laboratories. Results of this survey will be presented. The survey can be accessed at <http://quiz2.chem.arizona.edu/labsurvey/>

P37: General Chemistry Laboratory: Current status and barriers to change

Kereen Monteyne (California State University Fullerton, USA), **Brian Jenkins** (California State University Fullerton, USA), **Kristina Morey** (California State University Fullerton, USA)

The science laboratory is viewed as an essential component for student learning in the sciences. It provides an ideal environment in which students can directly experience and develop models of science concepts. Too often, however, the advantage of the science laboratory is wasted on activities that require little more than the ability to follow a procedure and plug numbers into a formula. Inquiry-based methods have been studied extensively and reported in the science education literature as supporting increased student achievement in content knowledge, process skills, and general reasoning skills. The benefits of inquiry-based teaching strategies and materials, however, have yet to be realized and implemented in tertiary level science courses, especially in the laboratory. A web-based instrument was developed to survey the use of inquiry-based activities in the general chemistry laboratory at colleges and universities across the United States. The perceived barriers to adoption and implementation of inquiry-based activities in the general chemistry laboratory were surveyed with the aim of identifying potential mechanisms for improving the connection between development of educational materials and implementation of these materials at participating institutions.

P38: Chemistry laboratories: What do we want students to walk away with?

Amy Phelps (Middle Tennessee State University, USA)

Chemistry laboratories is an expected part of most chemistry courses especially at the introductory level. Interestingly, little has been done to evaluate their effectiveness in enhancing student understanding of concepts. This paper discusses a study where 5 of 10 laboratory experiments were changed to a more inquiry approach. These inquiry-based experiments were done in three sections of the course while the rest of the sections did the typical expository labs. Three instructors taught 6 of these sections: 3 experimental and 3 control. The results on the laboratory final were compared and qualitative data was collected to help explain the statistical results.

P39: Ten years of guided inquiry at Arizona State University

Richard Bauer (Arizona State University, US), **James Birk** (Arizona State University, USA), **Pamela Marks** (Arizona State University, US), **Doug Sawyer** (Scottsdale Comm. College, USA)

Ten years ago the first set of guided-inquiry investigations were piloted in one section of General Chemistry I lab at Arizona State University. A second set was piloted the following semester in a section of General Chemistry II lab. An initial start of 16 investigations has grown to 48, which are used in all sections of the various flavors of general chemistry courses offered at ASU. Over this ten year period we've impacted nearly 25,000 students and some 200 teaching assistants. The purpose of this paper is to present our perspectives on development, implementation, and institutionalization of our version of guided inquiry.

P40: GenChem: A silicon analog of the carbon based General Chemistry Laboratory instructor

Rudolph W Kluber (Rutgers University, USA)

One of the classical lessons taught by Mendeleev is that the elements in the same group of the periodic table have similar properties. In the past, teaching the General Chemistry Laboratory has been relegated to carbon based instructors. Confirming predictions based the Periodic Table, we have now created a silicon based instructor called GenChem. GenChem creates, corrects and grades PreLabs and gives introductory audio-visual presentations; individualizes each experiment, warns of poor experimental work, or bad calculations and grades and records each student's efforts; keeps voluminous records and at the end of the course assigns each student a course grade. In conjunction with its carbon counterpart, it creates a Lab Manual and creates (and displays on demand) the course syllabus. GenChem does these tasks promptly, accurately and honestly and perhaps better than its carbon analog. Over all using silicon is much less costly than carbon. However silicon does not allow for checking for eye protection nor does our siliconized instructor do research.

9:00 AM - 12:00 PM STEW 218CD

S6: Accommodating Learning Modes in the Chemistry Classroom - Session 1 of 1

Tyson Miller (University of Connecticut, USA)

Teaching strategies that accommodate student learning modes (auditory, visual, kinetic, and olfactory) often have a huge impact on both student learning and satisfaction. There are many topics of conceptual difficulty within the chemistry curriculum that lend themselves to innovation in teaching style for conquering a given topic beyond a standard lecture/lab approach. This symposium will feature the latest chemical education research on novel methods for optimizing student learning using techniques that accommodate student learning modes for all levels of chemistry.

| | | |
|-------|-------------------|---|
| 9:00 | | introduction |
| 9:05 | Lynda Jones | P41: Powerful Multiple Modality Teaching |
| 9:25 | Dan Bedgood | P42: I Never Really Learned Chemistry Until I Had to Teach It! |
| 9:45 | Jung R. Oh | P43: Periodic Table by Students: Connecting Learning with Students' Interests and Daily Lives |
| 10:05 | Jeong H Hwang | P44: Use of Student Projects to Develop Student Identity with Science |
| 10:25 | | break |
| 10:35 | Alexandra Yeung | P45: Students' Learning Styles and Academic Performance |
| 10:55 | Vickie Williamson | P46: Using Visualization Techniques to Promote Mental Models in Chemistry Classrooms |

| | |
|-------------------------|--|
| 11:15 James Birk | P47: Visualization: An Important Component of Introductory Chemistry Instruction |
| 11:35 Thomas Kuntzleman | P48: Hands-on Molecular Visualizations |
| 11:55 | discussion |

P41: Powerful Multiple Modality Teaching

Lynda Jones (HOLY MOL-EE! Institute, U.S.A.)

Dramatically increase your power to teach and reach all different learners by using song, dance, dramatization, social interaction, engaging visuals, manipulatives, guided student notes, and carefully ordered presentation. These examples of great teaching have been developed and refined over 6 years. Students love them, and they are effective.

P42: I Never Really Learned Chemistry Until I Had to Teach It!

Dan Bedgood (Charles Sturt University, Australia)

It has been shown that teaching intensifies one's understanding of a subject and, therefore, teaching practice should be part of a student's training. Students in Chemistry Fundamentals at Charles Sturt University must complete an assignment in which they need to explain an assigned topic – to their Grandmother, for instance. After this exercise, students must write a brief reflection on the experience. Goals of the exercise will be described, as well as analysis of student reflections, and results of student surveys about the experience.

P43: Periodic Table by Students: Connecting Learning with Students' Interests and Daily Lives

Jung R. Oh (Kansas State University - Salina, USA)

A hands-on 'Periodic Table' project in the General Chemistry course was assigned to respect a variety of learning styles, to connect student learning to personal interests, and to have them enjoy an "ownership" of learning. Students are to research a chemical element they select, and to design concise representations for a collective Periodic Table display, and then to present informative, creative projects using media of their own choice (e.g. quilt, rap song, video clip, and display). The outcomes of this non-traditional teaching strategy were rewarding: (1) students were motivated in learning about the subjects, chemistry, by connecting learning with their personal areas of interests and daily lives, (2) students indicated this as enjoyable and valuable learning experience in their course portfolios and survey, (3) teacher's enthusiasm to know students beyond a standard lecture and laboratory approach increased through observations of their unique talents and ways of connecting chemistry. Many students in engineering technology programs incorporated kinesthetic learning styles for this assignment.

P44: Use of Student Projects to Develop Student Identity with Science

Jeong H Hwang (University of Illinois at Chicago,), **Donald Wink** (UIC,), Julie Ellefson (Harper College,), Marlynne Nishmura (UIC,), Dana Perry (Chemistry,), Maria Varelas (UIC,), Stacey Wenzel (UIC,)

A key problem in the preparation of teachers is the development of a sense of enduring identity with science content and processes. This is especially challenging and important with those preparing to be elementary educators, since they often are not concentrators in science yet will have to cover science content in self-contained classrooms. This paper will report on the methods

used to develop their identity with science, in particular through a term-length process developing a project that links their own learning to a project of interest to them. Modes of engagement and issues of problematic engagement will be presented along with theoretical basis for this work.

P45: Students' Learning Styles and Academic Performance

Alexandra Yeung (University of Sydney, Australia), Justin Read (The University of Sydney, Australia), Siegbert Schmid (The University of Sydney, Australia)

It is well established that students have preferred modes of learning and processing information, which are often described as learning styles. These styles can be characterised in a variety of ways, including by the Felder-Silverman Index of Learning Styles (which includes the visual / verbal dimension) and by instruments derived from the Myers-Briggs Type Indicator (MBTI). As a consequence, it is easy to determine the learning style preferences of our students. Such information becomes particularly valuable for teaching development when coupled with an examination of those students' academic performance. In this work, the Paragon of Learning Styles Inventory (an MBTI) was used to determine the learning styles of approximately 1000 first year chemistry students at the University of Sydney. This presentation will provide evidence that there can be very substantial differences in academic performance between students with different learning styles, and will discuss some of the implications of these findings.

P46: Using Visualization Techniques to Promote Mental Models in Chemistry Classrooms

Vickie Williamson (Texas A&M University, USA), Thomas Jose (Blinn College, USA)

Visualization techniques in the chemistry classroom are used to promote more expert-like mental models in students. A chemist can visualize 1) a chemical reaction on the macroscopic level, 2) what the reaction will look like to the human eye in the laboratory, and on the particulate level, and 3) what changes are taking place in the atoms and molecules. Techniques to help students create these mental images include laboratory simulations and demonstrations on the macroscopic level. Techniques that promote mental images on the particulate level include physical models, role-playing, fixed computer models, dynamic computer animations, student-generated drawings/animations, and interactive computer models. Implementation strategies for each technique will be discussed.

P47: Visualization: An Important Component of Introductory Chemistry Instruction

James Birk (Arizona State University, USA), Richard Bauer (Arizona State University, US), Pamela Marks (Arizona State University, US)

Visualization, both at the macroscopic and the microscopic levels, is important in learning and teaching chemistry. Much research has indicated that a conceptual approach to instruction is critical to learning chemistry. Students can answer algorithmic questions much easier and with less knowledge than conceptual questions. One approach to developing a conceptual understanding of introductory chemistry uses molecular-level images of chemical phenomena. Such images can convey a tremendous amount of information, but can also cause misconceptions if poorly constructed or misused. We will discuss features of images designed to avoid possible misconceptions. We will also give examples of how we use molecular images to develop a conceptual understanding that enables students to apply chemical knowledge to problems with greater success.

P48: Hands-on Molecular Visualizations

Thomas Kuntzleman (Spring Arbor University, USA)

A variety of lessons have been developed which allow students to actively participate in the simulation of the behavior of matter at the molecular level using macroscopic objects (pennies, beans). We are interested in how lessons of this type improve student fluency within the macroscopic and submicroscopic domains of Johnstone's triangle. In addition, we are interested in how hands-on simulations may improve student understanding of the mathematico-symbolic descriptions of molecular behavior. To this end, we have developed lessons in which students manipulate macroscopic objects, forcing them to obey certain "rules" which mirror the kinetic behavior of molecules. Mathematical analyses of data acquired leads to interesting results.

9:00 AM - 12:00 PM STEW 314

S7: Approaches to Research and Organic Chemistry - Session 1 of 1

David Fraley (Georgetown College, USA), **Willy Hunter** (Illinois State University, USA)

This symposium of general interest to the Chemical Education community will focus primarily on research in the undergraduate chemistry curriculum and modification to organic chemistry.

| | | |
|-------|-------------------|--|
| 9:00 | | introduction |
| 9:05 | Roger House | P49: A two-year college research experience for undergraduates |
| 9:25 | Brian Groh | P50: New and improved green experiments for the organic chemistry lab |
| 9:45 | Zac Rouse | P51: Research in undergraduate organic chemistry laboratory |
| 10:05 | Christine Hermann | P52: Forensics laboratory experiment in organic chemistry |
| 10:25 | | break |
| 10:40 | John McClusky | P53: One new tool to help students interpret ¹ H NMR |
| 11:00 | David Fraley | P54: Common organic compounds to love or dislike, but certainly to use |
| 11:20 | Ray A Gross Jr | P55: The chlorine rule: Teaching students how to determine the number of chlorine and bromine atoms in the formula of an organic polyhalide by analysis of the molecular-ion region of its mass spectrum |
| 11:40 | Richard Gurney | P56: Completely solvent-free oxidation of borneol to camphor: Synthesis, isolation, and purification |

P49: A two-year college research experience for undergraduates

Roger House (Harper College, USA), Thomas Dowd (Harper College, USA), Tom Higgins (Harold Washington College, United States), Dan Stanford (Harper College, USA)

Two Chicago-area community colleges, William Rainey Harper College and Harold Washington College, were recently awarded an NSF Small Grant for Exploratory Research to establish on-campus undergraduate research in chemistry. During the academic year, students work with full-time community college faculty on their unique research projects and transition to collaborating four-year institutions for a summer research experience. Current partners include Hope College and Illinois State University, two programs with a strong commitment to undergraduate research. In addition, these partnerships provide networking, outreach, and community-building activities for the students and faculty involved in the program. This presentation will describe the structure of this research experience, the challenges and successes of its implementation, and preliminary

evaluation of the student and mentor experiences.

P50: New and improved green experiments for the organic chemistry lab

Brian Groh (Minnesota State University, Mankato, USA)

We are in the process of making a transition to greener organic laboratory experiments through an ongoing three-phase approach. The first phase was evaluation of existing labs, second, the modification of experiments based upon literature precedent, and third, the development of new experiments. Our goal is to improve the health and safety of our experiments by incorporating greener reagents and solvents or devising solventless reactions. We will report primarily on our success with three experiments. One is a modification of the Glaser coupling reaction which utilizes a safer base and solvent and accomplishes the coupling under homogenous conditions and in shorter reaction times. Second is a greener, catalytic oxidation of cyclohexenone to adipic acid which greatly reduces the amount of waste generated and gives consistently higher yields than our old procedure. Last is an exceedingly simple, solventless conversion of an alcohol to the corresponding alkyl chloride in very high yield.

P51: Research in undergraduate organic chemistry laboratory

Zac Rouse (Northeastern Illinois University, USA), **Veronica Curtis-Palmer** (Northeastern Illinois University, USA), **Ana Fraiman** (Northeastern Illinois University, USA)

Northeastern Illinois University is part of a consortium participating in an NSF funded program named CASPiE, which stands for the Center for Authentic Science Practice in Education. The goal of the CASPiE program is to offer undergraduate research experiences to a diverse group of ethnic, academic, and economic backgrounds. The synthetic pathways and variations in feedstock for production of Biodiesel was chosen as the research area at NEIU and has proven to be a compatible topic with the chemistry curriculum and the common interests of the learning community. The module implementation is set into the existing lab curriculum and schedule for all enrolled students in each course. Peer-leaders work with small student groups in the lab as well as outside of the lab during critical points of the research experience. This paper will present the current development and implementation of the module from the perspective of faculty, peer-leaders, and students.

P52: Forensics laboratory experiment in organic chemistry

Christine Hermann (Radford University, US), **Ginger Cobren** (Radford University, U.S.)

During the spring semester of 2006, a new forensics laboratory experiment was introduced into the organic chemistry laboratory. Urine was tested for either sugars or ketones. Red spots were tested for the presence of blood with phenolphthalein and /or peroxides. Illegal white powders were present in the lab. These were tested using qualitative tests for the presence of functional groups. No human urine and blood was used in this experiment. No illegal drugs were actually present. The organic chemistry students had to explain the chemistry behind the tests.

P53: One new tool to help students interpret ^1H NMR

John McClusky (Texas Lutheran University, USA)

NMR interpretation not only allows students to analyze laboratory products and determine molecular structure, but more importantly it teaches them to solve complex problems. However, the wealth of information that allows molecular identification also makes spectral interpretation difficult for many students. A tool has been developed which allows students to logically analyze

spectra and to visualize how peak multiplicity reveals molecular connectivity. The NMR Mosaic reinforces problem solving skills, makes mistakes in interpretation much more recognizable, and aids interpretation of complex multiplets.

P54: Common organic compounds to love or dislike, but certainly to use

David Fraley (Georgetown College, USA)

Although Organic Chemistry comprises a mere single chapter in General and Liberal Arts Chemistry textbooks, it is a major component in the field of Chemistry. The opportunity to introduce basic organic concepts, various functional groups, simple nomenclature, and common organic compounds to beginning students is important. For example, all the students in Liberal Arts Chemistry and half the students in General Chemistry will not take an Organic Chemistry course, thus this is their single opportunity to see the material. Biology majors need an early introduction to Organic, because it forms the foundation of Biochemistry. In an effort to make the material more approachable, a list has been carefully developed that categorizes some 50 compounds into 17 functional groups. Common uses are given for each. The list also provides a good review for upper level Chemistry majors. Audience response will help to refine the list.

P55: The chlorine rule: Teaching students how to determine the number of chlorine and bromine atoms in the formula of an organic polyhalide by analysis of the molecular-ion region of its mass spectrum

Ray A Gross Jr (Prince George's Community College, USA)

The low-resolution mass spectral isotope patterns of compounds containing varying combinations of chlorine and bromine atoms in their formulas are displayed in many texts. The isotope pattern of an unknown may be compared to the pattern in the text to determine the number of chlorine atoms and bromine atoms in the formula of an unknown. The halide stoichiometry inherent in these patterns is also apparent in the form of a chlorine rule. Students can quickly determine the number of molecular chlorine and bromine atoms by application of the rule, which will be exemplified.

P56: Completely solvent-free oxidation of borneol to camphor: Synthesis, isolation, and purification

Richard Gurney (Simmons College, United States)

A general laboratory experience for sophomore level undergraduates has been developed to demonstrate the oxidation of borneol to camphor. The synthesis, isolation and purification steps are accomplished in the complete absence of solvent, while also minimizing the energy requirements. The hazards of standard oxidants, such as chromium VI and sodium hypochlorite are eliminated with the adoption of activated manganese dioxide on silica gel as the oxidant. As time for the experiment is greatly diminished, students can work to improve the procedures and test hypotheses through inquiry based experimentation.

9:00 AM - 12:00 PM STEW 202

S8: Biochemistry: The Science of Life - Session 1 of 2

Susan Karcher (Purdue University, USA), **Anna Wilson** (Purdue University, USA)

Biochemistry is the union of biology and chemistry. Teachers from each field of study can benefit from recognizing how features from the other discipline help clarify and explain the various topics they teach. This symposium brings together instructors from all three disciplines--biochemistry, biology, and chemistry--to discuss what each discipline contributes to improving how we present

concepts and materials to students. Examples from lecture topics and lab experiments that unite the three disciplines will be presented.

| | | |
|-------|------------------|---|
| 9:00 | | introduction |
| 9:05 | Scott Thompson | P57: What are they thinking? - Triangulating students' misconceptions in Biochemistry |
| 9:25 | David Wilson | P58: Strategies for integrating Biology and Chemistry throughout the freshman science curriculum |
| 9:45 | Christina Miller | P59: Integrating Biology and Chemistry into the Biochemistry class through student-centered instruction |
| 10:05 | | break |
| 10:15 | Loyd Bastin | P60: Student-centered/problem-based approach to teaching Biochemistry |
| 10:35 | Lawrence Kaplan | P61: Isolation, purification and characterization of beta-galactosidase: A semester long biochemical investigation |
| 10:55 | Susan Karcher | P62: The Genetics of beta-galactosidase--encoded by the lacZ gene in E coli--laboratory exercises for Biochemistry and Molecular Biology students |
| 11:15 | | discussion |

P57: What are they thinking? - Triangulating students' misconceptions in Biochemistry

Scott Thompson (Arizona State University, USA), Nathan Barrows (Arizona State University, USA), Janet Bond-Robinson (Arizona State University, USA), Scott Lefler (Arizona State University, USA), S. Robin Saxon (UC Santa Barbara, USA), Duane Sears (UC Santa Barbara, USA)

Concept inventories (CIs) are useful instruments for diagnosing and determining the distribution of student misconceptions. Our current research focuses on developing biochemistry concept inventories (BCCIs) along three themes: (1) structure and function of biomolecules, (2) properties of amino acids and (3) reversible equilibrium. These BCCIs map undergraduate biochemistry students' responses to specific misconceptions and thus allow us to assess the prevalence of students' biochemical misconceptions. This presentation will describe the use of the BCCIs in conjunction with think-aloud protocols (TAPs) to explore student misconceptions. This triangulation strategy provides a mixed methods approach to identifying robust misconceptions and exploring their persistent and pervasive nature.

P58: Strategies for integrating Biology and Chemistry throughout the freshman science curriculum

David Wilson (Parkland College, Champaign, IL, USA)

In 2004, Parkland College created a new position for an instructor of biology and chemistry. The need was based in part on the desire to integrate the two disciplines more effectively. Although a biochemist was hired, the knowledge and experience base required for this position goes well beyond traditional biochemistry curriculum. Some experience teaching both disciplines in a traditional fashion was essential. However, there are reasonable and sometimes very simple methods for developing skills and knowledge that will allow most instructors to effectively integrate other scientific disciplines into their own courses. For example, a quick Google search on "quantum numbers" and "cancer" will provide a tremendous amount of reading material that any chemist can integrate into their own courses. The chemistry laboratory is another excellent avenue

for developing interdisciplinary exercises. A well designed integrative lab will often provide the necessary motivation for students to learn the more complex chemical concepts in order to solve a problem they perceive as interesting. This presentation will report on successes and obstacles in integrating not only chemistry and biology, but also physics, earth sciences, and other sciences into a variety of courses. There will also be some discussion on the efforts of the Parkland College Natural Sciences Department to develop interdisciplinary/multidisciplinary courses, including forensics, a course on culturally relevant scientific issues, and a course on change and evolution in the origin of the cosmos and life.

P59: Integrating Biology and Chemistry into the Biochemistry class through student-centered instruction

Christina Miller (Adams State College, USA)

In my senior-level biochemistry course I teach a group of students who vary both in background and in interest, having majors in biology, biochemistry or chemistry. To maintain student interest I employ various types of active-learning techniques, including the use of in-class activities. These activities are done in small groups and often involve outside reading to be done prior to class. The activities range from reading a short article from "Chemical and Engineering News" (more for the chemists), to reading medical case studies (more for the biologists) to challenging worksheets which incorporate multiple ideas (more for the hard-core biochemists). The students are graded on group-answers to questions posed on the material and are tested individually on this information during hour exams. Student evaluations of the activities have been positive and I will discuss how they affect student learning.

P60: Student-centered/problem-based approach to teaching Biochemistry

Lloyd Bastin (Widener University, United States), Robert W. Morris (Widener University, United States)

This talk will describe a student-centered approach for teaching Biochemistry to science majors recently implemented at Widener University by a chemist and a biologist. The approach has been successfully implemented into one-semester and two-semester courses. The topics are introduced solely or mainly through the use of problems. Each chapter or topic is introduced using take-home start-up exercises and/or brief lectures that are designed to provide the students with the necessary background to proceed with the class exercises. The class exercises consist of class problems designed as group exercises that challenge the students' critical thinking ability in addition to strategically introducing biochemistry topics. The class problems are followed by group or class discussions of difficult problems. The data from the past two years will be presented.

P61: Isolation, purification and characterization of beta-galactosidase: A semester long biochemical investigation

Lawrence Kaplan (Williams College, US), Amy Gehring (Williams College, USA)

Most undergraduate biochemistry courses have a laboratory component designed to illustrate the concepts introduced in the class. Many of these laboratory programs consist of a collection of unrelated experiments, each completed in one laboratory period. We have found that students gain more of a sense of real biochemical research while learning the basic concepts if the lab program is cumulative with the experiment for each week dependent on previous experimentation. With this in mind we have developed a series of experiments involving the isolation, purification and extensive characterization beta-galactosidase. The students isolate a genetically engineered

histidine tagged beta-gal from *E. coli* using specific reagents to break open the cells. Purification employs a one-step Ni affinity column. The enzyme is characterized, and its molecular weight determined, by gel electrophoresis and its enzymatic properties determined by assay with an o-nitrophenyl-beta-galactopyranoside (ONPG) substrate. Following these introductory experiments, the students must propose and then conduct a multi-week long series of experiments to study a particular aspect of the structure or function of beta-gal. A diverse range of classical experiments have included: determination of the Michaelis constant under various conditions, the necessity and nature of an ion cofactor, specific inhibitors and their binding constants, thermal stability, pH profile, comparison to beta-gal from other organisms, the role of free sulfhydryl groups and of histidine in enzymatic activity. Experiments involving site directed mutagenesis allow the students to explore the role of specific amino acid side chains in the catalytic activity. The details of the lab program including some of these projects will be discussed.

P62: The Genetics of beta-galactosidase--encoded by the lacZ gene in E coli--laboratory exercises for Biochemistry and Molecular Biology students

Susan Karcher (Purdue University, USA)

Beta-galactosidase is an enzyme that splits lactose into glucose and galactose; it is encoded by the lacZ gene in the lac operon of *Escherichia coli*. An operon is a set of structural genes transcribed as a single messenger RNA and adjacent regulatory regions that control the expression of these genes. Because beta-galactosidase is a relatively stable enzyme that is easily assayable using the substrate ONPG (o-nitrophenyl-beta-galactopyranoside), it is used in biochemistry laboratory exercises. The beta-galactosidase system of *E. coli* was used by scientists François Jacob and Jacques Monod. From their analysis of mutations in the lac operon, they developed a model of transcriptional regulation of the lac operon by the lac repressor. They formulated a model of genetic regulatory mechanisms, showing on a molecular level, how genes are activated and suppressed. They received a Nobel Prize in 1965 for this work. This paper describes a laboratory exercise using *E. coli* strains with different mutations in the lac operon to demonstrate to students the regulation of beta-galactosidase production in *E. coli*. Students identify the nature of the mutations in each strain based on their determination of the beta-galactosidase activity of each strain. While this exercise is used in college introductory genetics laboratory classes, it can also be incorporated into biochemistry laboratory classes where students use beta-galactosidase to study properties of enzymes. This addition of a genetics exercise to a biochemistry exercise is a useful combination of molecular biology and biochemistry that can enhance the student's understanding of this enzyme.

9:00 AM - 12:00 PM STEW 214D

S9: Building the Community of Green Chemistry Educators - Session 1 of 3: Greening the curriculum - laboratory experiences

Julie Haack (University of Oregon, USA)

Chemistry is a rapidly evolving discipline and societal pressures and economic incentives are demanding that chemists develop new ways to carry out vital chemical processes using environmentally benign ("green") methods. By incorporating green chemical principles into the chemistry curriculum, educators have the opportunity to transform student perceptions about the role chemistry plays in our society and to prepare future scientists, educators and policy makers to address the national need to discover and develop sustainable chemistry for the future. This symposium focuses on community development (high school and university) of green chemistry educators by showcasing new materials, summarizing newly available electronic tools, and

highlighting a diverse array of outreach activities. Educators will receive ideas and support for incorporating green chemistry throughout diverse teaching environments.

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|-------|-------------------------|--|
| 9:00 | | introduction |
| 9:05 | Liz Gron | P63: Redesigning introductory laboratory education for a green future |
| 9:25 | Richard Gurney | P64: Learning to be green: Involve students in the decision making process |
| 9:45 | Carl Lecher | P65: Development of a scenario-based green organic chemistry laboratory curriculum at Marian College |
| 10:05 | Martin V. Stewart | P66: Solid-supported reagents provide meaningful undergraduate research projects in green chemistry |
| 10:25 | | break |
| 10:35 | Larry Augenstein | P67: Orange and green in organic chemistry lab |
| 10:55 | Margaret Kerr | P68: Green chemistry at Worcester State College: Curriculum changes and demo development |
| 11:15 | Gautam Bhattacharyya | P69: Chemistry for the 21st century: What I have learned as a green chemistry instructor |
| 11:35 | | discussion |

P63: Redesigning introductory laboratory education for a green future

Liz Gron (Hendrix College, USA)

The laboratory associated with the General Chemistry lecture at Hendrix College has been redesigned to teach our introductory students green, analytical chemistry using environmental samples. Herein we report a laboratory that uses iron as a model toxic metal as an important method to engage students. Students have an intrinsic interest in metal toxicity; however, it is unconscionable to use the most familiar materials, e.g. Hg, Pb and As, in the laboratory at this level. We maintain a green attitude by using iron while capturing student interest by making parallels to more dangerous materials. These experiments are based on classic quantitative analysis procedures so our greenest students begin to develop analytical skills, an understanding of environmental chemistry and a green sensitivity towards their work. Molecular (UV-Vis) and atomic (FAA) spectroscopy are used on real and artificial environmental water samples. Modification of standard protocols allow our introductory students to acquire accurate data within the available time. Students create calibration curves and use standard unknowns to check the precision and accuracy of their techniques. These laboratory experiments are supported with web exercises that discuss the toxic metals in the environment.

P64: Learning to be green: Involve students in the decision making process

Richard Gurney (Simmons College, United States)

To engage students in the asymptotic approach to a perfect green experiment, a laboratory experience was developed whereby informed decisions must be made throughout the entire process. Students actively choose the synthetic pathway and the methods of isolation, characterization and purification of the final product by assessing risk at each step of the process. The experiment empowers students to make informed decisions in the laboratory and provides an opportunity to become directly involved in the “greening” experience. Over the past two years,

students have collectively approached the greenest method to oxidize alcohol to a ketone in the absence of solvent, using a heterogenized catalyst, and a microwave energy source, while isolating and purifying the product in the complete absence of solvent. We hope this will encourage students to further explore the field and understand the implications of choosing one synthetic pathway over another.

P65: Development of a scenario-based green organic chemistry laboratory curriculum at Marian College

Carl Lecher (Marian College, USA)

Designing organic laboratory experiments that capture student's imaginations while at the same time foster higher-order cognitive skills is an ongoing challenge for laboratory instructors. Fortunately, green chemistry affords us a unique opportunity to do both. Marian College has begun the process of implementing a comprehensive scenario-based green organic chemistry laboratory curriculum. The scenario format has the student working on a 'real-life' hypothetical situation that is addressed through the use of green chemistry. This chemical problem of the scenario frames the pre-lab discussion, leads the student into a guided procedure, and provides an avenue for the discussion of green chemistry in the lecture. Scenarios can be designed to incorporate higher-order cognitive skills such as analysis and evaluation into both the procedure and post lab write-up. The green laboratory procedures for these scenarios have been primarily based on experiments developed or modified in-house by undergraduate researchers. Additionally, procedures have been adapted from green laboratory procedures in the chemical literature. This presentation will highlight the implementation and successes of the curriculum.

P66: Solid-supported reagents provide meaningful undergraduate research projects in green chemistry

Martin V. Stewart (Middle Tennessee State University, U.S.A.)

Adsorbing an inorganic compound onto a porous surface often affords a solid-supported reagent that exhibits enhanced chemical reactivity while minimizing the generation of hazardous wastes during recovery of the product. We are engaged in a continuing project involving a succession of undergraduate chemistry students whose goal is to better characterize these materials. Previous results demonstrated that depositing ceric ammonium nitrate onto the surface of silica gel affords a genuine example of a solid-supported reagent that functions in chemical reactions as an oxidizing agent. More recently, we proposed conditions causing crystallization of the inorganic reagent onto the surface of silica gel, an occurrence that renders the system chemically unreactive. The present work confirms this hypothesis through direct observations with optical microscopy. Partial support from the Undergraduate Research Council of the College of Basic and Applied Sciences at Middle Tennessee State University is gratefully acknowledged.

P67: Orange and green in organic chemistry lab

Larry Augenstein (University of Colorado at Colorado Springs, USA), Barbara Gaddis (UCCS, USA), Allen Schoffstall (University of Colorado at Colorado Springs, USA)

Green Chemistry is introduced to our organic chemistry students using the reduction of a ketone. Students, familiar with the reduction of ketones using sodium borohydride from organic lecture and a previous experiment, reduce benzofuran-2-yl methyl ketone with carrots. For purposes of comparison with a traditional experiment, a microscale sodium borohydride reduction of the same ketone is performed in parallel. Reaction progress and confirmation of the reaction product are

achieved using thin layer chromatography (TLC). The exercise introduces students to several Green Chemistry concepts: renewable resources, safer reagents and solvents, and green waste. The main features of the experiment, and student results and feedback will be discussed.

P68: Green chemistry at Worcester State College: Curriculum changes and demo development

Margaret Kerr (Worcester State College, US)

Over the past 3 years, Worcester State College has implemented a green chemistry organic laboratory curriculum. This paper will discuss the success of this program and the challenges of bringing green chemistry into a laboratory curriculum. In addition to the changes in the organic laboratory, research is being done to develop green labs and demonstrations appropriate for the General, Organic and Biochemistry course.

P69: Chemistry for the 21st century: What I have learned as a green chemistry instructor

Gautam Bhattacharyya (University of Oregon, USA)

Although the vast majority of graduates of undergraduate and graduate programs in chemistry pursue careers in industry, anecdotal data suggest that current curricula do very little to prepare the students for their future professions. Furthermore, since 1986 panels from the NSF and the AAAS have suggested that science instructors need to do more than just cover content in their courses. For example, they need to give students a sense of the nature of science (NOS). In addition to helping students learn chemistry, the green laboratory curriculum is an ideal forum for discussing the interdisciplinary nature of the sciences, the factors that affect decisions made in industrial settings, and topics in NOS. This presentation will focus on how I have tried to integrate these ideas into the lab courses at the University of Oregon.

9:00 AM - 12:00 PM STEW 218AB

S10: Computation, Modeling and Molecular Visualization across the Chemistry Curriculum - Session 1 of 4

Elisabeth Bell-Loncella (University of Pittsburgh at Johnstown, USA)

This symposium will highlight the various ways faculty have used visualization, simulation, molecular modeling, mathematical software, and related computational methods to enhance and expand the learning experience in the undergraduate chemistry curriculum – in the classroom, in the laboratory, and in research. Papers describing specific activities for individual courses as well as department initiatives to integrate computation across the curriculum will be included.

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| 9:00 | introduction |
| 9:05 Keith Anliker | P70: Using molecular modeling software in a non-majors chemistry lab |
| 9:25 Jeffrey Fieberg | P71: Exploring vibrational motion in the general chemistry laboratory: molecules rock! |
| 9:45 Morton Hoffman | P72: Dispelling myths and misconceptions through the visualization of quantum concepts in general chemistry |
| 10:05 Ping Furlan | P73: Computation and molecular visualization in general chemistry lab using CAChe |
| 10:25 | break |
| 10:35 Michael Golde | P74: Using excel spreadsheets to enhance student understanding in the |

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| | general chemistry course | |
| 10:55 | Stanislaw Skonieczny | P75: Novel computer lab experiment: studies of diels-alder reactions |
| 11:15 | George Long | P76: Non-traditional approach to traditional calculations |
| 11:35 | | discussion |

P70: Using molecular modeling software in a non-majors chemistry lab

Keith Anliker (IUPUI (Indiana Univ.-Purdue Univ. Indianapolis), USA), Kelsey Forsythe (IUPUI (Indiana Univ.-Purdue Univ. Indianapolis, United States)

A number of years ago we began using microcomputer versions of Spartan software in a large elementary chemistry lab course that is taken by non-majors, students completing coursework for allied health professions, and students who are preparing to enter our mainstream chemistry courses for science majors. Our initial use focused on helping students to visualize molecular geometry and understand the bond angles in simple molecules. We also mapped charge distributions to help students with the concepts of bond polarity, regions of high or low electron density and overall dipole moment. We have recently expanded this lab experience to incorporate investigation of bond lengths, resonance and molecular vibrations. To do this, we have changed the focus of the lab exercises from using the software to visualize molecules that were pre-built, to having students build and create their own simple molecules—then having them investigate the molecules they have created. Examples of the exercises, discussion questions from the lab manual, and the way that we introduce and implement this lab project will be described.

P71: Exploring vibrational motion in the general chemistry laboratory: molecules rock!

Jeffrey Fieberg (Centre College, USA)

A guided-inquiry module will be presented in which general chemistry students use PC Spartan to explore many facets of vibrational motion. The students see various vibrational modes come alive as molecules jump into motion. The students then assign names to particular modes based on previous life experiences, such as the motion of scissors, dogs' tails wagging, and the definition of symmetric (vs. antisymmetric). They also discover equations that predict the total number of vibrational modes for linear and non-linear molecules. The exercise culminates with the arrival at Hooke's Law after quantifying the relationship between vibrational frequency and 1) the mass of the atoms and 2) the bond energy.

P72: Dispelling myths and misconceptions through the visualization of quantum concepts in general chemistry

Morton Hoffman (Boston University, USA), Dan Dill (Boston University, USA), Peter Garik (Boston University, USA), Alexander Golger (Boston University, USA)

Because of the counterintuitive nature of the quantum world, which renders difficult the imagining of its reality, students, understandably, acquire myths and misconceptions, and miss critical connections in their study of atomic and electronic structure. Despite the efforts of their instructors and the authors of their textbooks, students in general chemistry have a great deal of difficulty understanding, for example, the distinction between electron orbital energy and the energy of the quanta of electromagnetic radiation absorbed and emitted during transitions. Because a picture is worth (at least) a thousand words, students remember the static images that they are shown as modified through their personal prisms, and not the written and oral explanations and disclaimers that are presented for clarification. In fact, the quantum world is not static, and time dependence is

the basis of change. We have developed guided-inquiry computer activities that provide a visual means to understand the temporal properties of electron waves and how their mixtures account for the interaction with light. In this way, students can visualize the beats that correspond to dipole excitations of atoms, which form the basis of the selection rules for quantum absorption and emission.

P73: Computation and molecular visualization in general chemistry lab using CAChe

Ping Furlan (University of Pittsburgh at Titusville, USA)

As part of the University of Pittsburgh Computing across the Chemistry Curriculum project, we have developed and adapted several General Chemistry Laboratory activities to introduce first year students to the basic features and tools of the CAChe computational chemistry software developed by Fujitsu. When studying thermochemistry, student predict the fuel value of hydrocarbons and primary alcohols of varying chain length and make comparisons with experimental values. To enhance an existing experiment, the synthesis and IR spectrum of aspirin, we have added a CAChe component, in which students first compare different methods for calculating the IR peaks of the relevant functional groups using a small model molecule. They then apply the best method to predict the IR spectra of aspirin and the starting materials and compare them with the experimental ones to see if their syntheses are successful. The activities help students visualize how structural groups correspond to the IR absorptions and why IR can be effective for compound identification. While studying molecular structure, students use CAChe to build and visualize 3-D renditions of common species. The activity helps student gain additional insight into how electron pairs affect molecular shape which ultimately affects molecular properties.

P74: Using excel spreadsheets to enhance student understanding in the general chemistry course

Michael Golde (University of Pittsburgh, USA)

The computer has allowed teachers to help students visualize many aspects of chemistry. Using spreadsheets and molecular modeling software as templates, we can create lecture demonstrations and scenarios for students to explore. For example, in quantitative subjects such as equilibria and thermodynamics, the magnitudes of properties such as equilibrium constants and free energy changes have immediate significance for the expert, but may be less meaningful for the beginning student. Spreadsheets can help by allowing parallel representations of the data using live graphs and bar charts; messages can be displayed to alert the user to important results. The drudgery of entering numbers can be avoided by using a scroll bar, which also allows the user to scan rapidly through an entire reaction or titration. Some examples from General Chemistry will be presented, illustrating the versatility of Excel and showing how the presenter has tried to address some difficulties which students encounter in this course.

P75: Novel computer lab experiment: studies of diels-alder reactions

Stanislaw Skonieczny (University of Toronto, Canada), *Mima Staikova* (University of Toronto, Canada)

A new computer lab experiment was developed for an upper level course to study the outcome of Deils-Alder reactions. The WebMOpro interface was used with the Gaussian suit of programs. Students were able to choose best pairs of dienes and dienophiles and predict if exo- or endo-products would form faster.

P76: Non-traditional approach to traditional calculations

George Long (Indiana Univ. of PA, USA)

The Physical Chemistry laboratory has traditionally been the home of extensive, in depth, and even tedious calculations. Modern computer tools have allowed more detailed calculations to be done in less time. The improved efficiency in performing the mechanics of these calculations provides both risk and opportunity. The risk is that students will find the path of least resistance, and approach the calculation as a black box which requires only the correct buttons be pushed. The opportunity is that the additional time may allow the instructor to ensure that students link the calculation to the chemical principle, and retain the conceptual rigor typical of these activities. This presentation will discuss some important considerations involved in the process of incorporating detailed computational methods to several more or less traditional physical chemistry labs.

9:00 AM - 12:00 PM STEW 322

S11: Designing Experiences that Engage Students in Learning: Research in Engineering Education - Session 1 of 1

Heidi Diefes-Dux (Purdue University, USA)

Engineering education research can inform our designs for effective classroom instruction and lab experiences that engage students in learning both engineering and the sciences. This symposium will identify issues and opportunities that span curricula development and implementation and cut across chemistry and engineering education. Topics will include instructional design such as anchored inquiry lab experiences, open-ended contextualized problem-solving experiences, and the use of student teams.

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| 9:00 | | introduction |
| 9:05 | Faik Karatas | P77: Freshman Undergraduate Students' Views of Nature of Engineering |
| 9:25 | Tamara Moore | P78: The Relation of Open-Ended Problem Solving Solution Quality to First-Year Engineering Student Team Effectiveness |
| 9:45 | PK Imbrie | P79: Assessing Team Effectiveness in the Engineering Classroom |
| 10:05 | Sean Brophy | P80: Instructional Models for Developing Adaptive Expertise |
| 10:25 | | break |
| 10:35 | Cordelia Brown | P81: Integrating Problem Solving Sessions into Engineering Courses |
| 10:55 | Mica Hutchison | P82: The Effect of Cooperative Learning Experiences and Instructional Methods on Chemical Engineering Students' Self-Efficacy Beliefs: A Comparative Investigation |
| 11:15 | Susan Walden | P83: Departmental Learning Community Examined Through Interpersonal Networks |
| 11:35 | Matthew Verleger | P84: BIOMod - Online Quantitative Cellular Biology Learning Modules for Engineers |
| 11:55 | | discussion |

P77: Freshman Undergraduate Students' Views of Nature of Engineering

Faik Karatas (Purdue University, USA), **George Bodner** (Purdue University, US)

There has been a significant amount of research in the literature about students' views of nature of

science (NOS) at all education levels (Abd-El-Khalick & Lederman; 2000, Bell et al., 2000; Bodner & Samarapungavan, in press.). However, there has not been any noteworthy investigation of students' views of nature of engineering (NOE). We believe that understanding students' NOE has as much impact on engineering education as NOS does on science education. The purpose of this study is to investigate freshman engineering and science students' perceptions of what the engineering is. The subject population includes 35 freshman science (9) and engineering (26) students at Purdue. To probe students' ideas, a 9-item open-ended Views of Nature of Engineering (VNOE) survey was developed by a panel of chemistry and engineering educators. Categories for which students' responses were collected include similarities and differences between engineering and science, characteristics of engineers, engineering as a discipline and process of engineering development. Two of the most apparent response to the question about engineering are "engineering is a way to makes people live better and easier (n=9)" and/or "engineering is problem solving" (n=14). More comprehensive research about NOE should be conducted by employing interviews accompany to VNOE survey.

P78: The Relation of Open-Ended Problem Solving Solution Quality to First-Year Engineering Student Team Effectiveness

Tamara Moore (Purdue University, USA), Heidi Diefes-Dux (Purdue University, USA), PK Imbrie (Purdue University, USA)

ABET requires that engineering graduates be able to work on multi-disciplinary teams and apply mathematics and science when solving engineering problems. One manner of integrating teamwork and engineering contexts in a first-year foundation engineering course is through the use of Model-Eliciting Activities (MEAs) – realistic, client-driven problems based on the theoretical framework of models and modeling. This study looks at the quality of student team solutions to Model-Eliciting Activities and team effectiveness, specifically interdependency (cooperation among team members to accomplish a task), goal-setting (team sets outcome goals and sub-goals to accomplish tasks), and potency (shared belief among team members that they can accomplish their goals). In Fall 2005, a Model-Eliciting Activity called Factory Layout had students in a first-year problem solving course develop a procedure to arrange the floor plan of aluminum tubing factories. The context for the task was established in a memo from the general manager of industrial planning (client) to the student teams asking them to create a reusable process that will be implemented as the company expands, to optimize factory layouts. Eleven student teams were observed during the problem solving process. Following the MEA, students rated their team effectiveness during this activity using a Team Assessment Instrument. The goal of this paper is to present the results of an investigation of the relationship between the quality of the solution produced by the team and student team effectiveness. The quality of the student team solution is rated using a rubric called the Quality Assurance Guide which assesses whether teams fully met the client's needs. It is based on a five point scale where five corresponds to "Shareable and Reusable: The solution not only works for the immediate situation, but it also would be easy for others to modify and use it in similar situations" and one corresponds to "Requires Redirection: The product is on the wrong track. Working longer or harder won't work." Student team effectiveness is assessed using two instruments. The observations of the teams were done using an observation tool which allowed the researcher to rate the teams on three forms of interdependency, two forms of potency, and two forms of goal-setting. The observer also had space in the tool to take detailed field notes of the performance of the team. Through the Team Assessment Instrument, teams rated their own performance using twenty-six Likert scale items which also

assess interdependency, potency, and goal-setting. This quantitative instrument has been found to have reliability and validity in previous studies - the Cronbach's Coefficient Alpha is over 0.9, which exceeds the desired level of 0.8. Findings presented here suggest that, during the Model-Eliciting Activity, effectiveness in student teams can boost the quality of team solutions, a promising result for the ongoing challenge to meet ABET criteria.

P79: Assessing Team Effectiveness in the Engineering Classroom

PK Imbrie (Purdue University, USA), Heidi Diefes-Dux (Purdue University, USA)

The ability to be an effective contributor to a multidisciplinary team, a criterion of EC2000, hinges on developing skills to communicate effectively and to understand a wide range of issues, including professional and ethical responsibility, the impact of engineering solutions in a global and societal context, and knowledge of contemporary issues. As such, engineering education has seen a significant increase in the emphasis on a wide range of teamwork skills that engineering students will need when they enter the workplace. Unfortunately, even with the increased emphasis on the use of student teams in academia there is little-to-no research that makes use of instruments that show evidence of reliability and validity to quantify how successful the teaming experience actually is for participating students. This talk will present a model that enables engineering educators to identify effective student teams in a broad range of educational settings (i.e., small and large classes, freshman through senior students and cooperative learning environments to design course). Students' perception of team effectiveness is operationalized in terms of a self-report instrument requiring students to indicate the degree their team worked together across a range of domains, including: interdependency, goal-setting, potency, and learning. To be presented are the scale's psychometric properties along with a confirmatory factor analysis to evaluate the scales construct validity. In addition, the presentation includes a discussion of a variety of web-based teaming tools that have been specifically developed to support both students and faculty.

P80: Instructional Models for Developing Adaptive Expertise

Sean Brophy (Purdue, US)

Adaptive expertise requires the co-development of new conceptual with prior knowledge and the development of identity relative this new knowledge. That is, expertise in a domain is more than fluent application of engineering principles and computational skills. Flexible use of expertise that leads to innovative ideas requires knowledge about the domain in addition to knowledge about ones self as an engineering. Therefore, effective learning environments need instructional methods that engage students in a rich set of learning activities that develop conceptual knowledge of the domain within multiple context that are both informative and interesting. In addition, many young engineering undergraduates are naïve to the field and need opportunities to explore their "role" in becoming a member of the engineering community. Many instructional models are emerging that blend these objectives well. For example, anchored inquiry environments like Problem Based Learning, Learning by Design, and Challenge Based Instruction are guided by general principles that inform the decision making process of instructional design. This paper explores instructional models that co-develop multiple learning objectives in a way that engages learners toward learning valuable learning outcomes. Preliminary results from a survey given to first year engineering students illustrates the interaction between learners goals and descriptions of engineering and their perceptions of themselves as learners within that context.

P81: Integrating Problem Solving Sessions into Engineering Courses

Cordelia Brown (Purdue University, USA)

Problem solving is a major component in many engineering courses. There have been a number of documented strategies for integrating structured problem solving into the learning environment. This document describes a preliminary study that notes the effectiveness of integrating structured problem solving sessions into an Electrical and Computer Engineering (ECE) course. The initial focus of the study will concentrate on a junior level Microprocessor Systems and Interfacing course. There are two divisions to this course. One division is integrated with structured problem solving sessions, and other is taught using a traditional lecture approach. The study will focus on how the problem solving sessions are integrated into the course. Data from this study will be used to observe the impact these problem solving sessions have on engagement, learning, and retention. From this data, future problem solving session studies will be developed for the Introduction to Digital System Design course and other ECE courses.

P82: The Effect of Cooperative Learning Experiences and Instructional Methods on Chemical Engineering Students' Self-Efficacy Beliefs: A Comparative Investigation

Mica Hutchison (Purdue University, United States), George Bodner (Purdue University, US), Deborah Follman (Purdue University, United States)

Undergraduate engineering students' self-efficacy beliefs - their perceived confidence in their abilities to complete the tasks that they deem necessary to achieve a desired outcome – have repeatedly been linked to their achievement, retention, and interests in the field. Understanding what these students' efficacy beliefs are and how they can be influenced has thus become the focus of many engineering education researchers. The study reported here used a combined quantitative and qualitative survey instrument to investigate undergraduate chemical engineering students' self-efficacy beliefs during their first required chemical engineering-specific course, Chemical Engineering Calculations (CHE 205). Surveys were administered to all students enrolled in the course during the fall and spring semesters of the 2005-2006 academic year. Quantitative measures were used to evaluate students' perceptions of their performances on course tasks and their ability to succeed in the class. Open-ended survey questions prompted the students to list aspects about CHE 205 that affected their confidence in success in the course. The results presented here are based on the findings of a comparative investigation looking at the effect participation in the cooperative education program and differing instructional methods may have on chemical engineering students' efficacy beliefs. These findings suggest how the chemical engineering environment, curriculum, and classroom practices might influence students' self-efficacy, a significant factor to be considered in attempts to boost both the retention of capable students who are considering leaving the program and the performance, satisfaction, and enthusiasm of those who persist.

P83: Departmental Learning Community Examined Through Interpersonal Networks

Susan Walden (Univ. of Oklahoma, USA), Deborah Trytten (University of Oklahoma, USA)

In January 2003, we began interviewing industrial engineering (IE) students at OU to elicit the reasons that school had achieved gender parity in undergraduate enrollment. To differentiate factors specific to this school at this institution our research model included interviews with students in other majors at OU and with IE students at other research universities. Some people attributed the IE school's gender parity to their high percentage of female faculty. Because the chemical, biomedical, and materials engineering (CBME) school only had one female, tenure-track, faculty member out of 15, yet the school's female undergraduate enrollment was above the

national average, we included that school as one of our comparator populations. Revealed in our data, robust vertical and horizontal social networks seem to contribute to IE's attractiveness to female students. (Murphy et al, *Frontiers in Education*, Indianapolis, 2005) Analysis of the interviews with 23 chemical engineering students, 13 female, 10 male, 9 sophomores, 4 juniors, 5 seniors, exposes prominent networks in that school as well. These networks derive primarily from a departmental peer mentoring program, informal study groups, formal group work, a few highly involved faculty, and a general sense of one-for-all, all-for-one as the students battle the demanding curriculum. The literature base states that involvement with social networks is a fundamental piece of engaging students in their learning environment. This presentation will explore the similarities and differences between the networks revealed for IE and for CBME and examine how those networks may be influencing the gender proportion in each school.

P84: BIOMod - Online Quantitative Cellular Biology Learning Modules for Engineers

Matthew Verleger (Purdue University, USA), Heidi Diefes-Dux (Purdue University, USA)

To help students understand quantitative biology and biological engineering concepts and their connection to the material presented in a traditional cellular biology class, four interactive learning modules were developed. The modules go beyond the typical static presentation of material by requiring students interact with quantitative biology concepts in a way that fosters students' development of higher level critical thinking skills and a more sophisticated mental model of biological phenomena. The four online learning modules cover four diverse topics; Ion Transport, Phylogenetic Relationships, Gene Regulation/Protein Synthesis, and Protein Networks. The modules were incorporated into a traditional lecture, working as a supplement to the lecture, not as a replacement. Utilizing this blended classroom design, the modules were developed to meet a perceived need for greater visual interaction in the portions of the instructional content. Content which was perceived to be better suited to online delivery was moved from the lecture in to the modules. Assessment of these modules was done using multiple pieces of data. Paper-based pre/post testing and a paper-based attitudinal survey were completed as part of each module. Additionally, in-module questions and mouse activities were recorded to a database for further analysis. Student attitudes have been overwhelmingly positive, and moderate learning gains were documented for all four modules.

9:00 AM - 12:00 PM STEW 214A

S12: Innovations in Teaching Nurses - Session 1 of 1

Ashley Mahoney (Bethel University, USA)

This symposium will be a follow up on the "What Nurses Need to Know" session held at 18th BCCE. Enrollments in nursing courses are rapidly growing, yet they often receive little attention. This symposium will allow for the sharing and dissemination of ideas targeted for nurses and entry level students. Topics can span classroom, recitation, and/or laboratory contexts but will focus primarily on the classroom.

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|------|--------------------|--|
| 9:00 | | introduction |
| 9:05 | Karen Timbrlake | P85: LecturePLUS |
| 9:25 | Joseph Kinsella | P86: Implementation of PLTL in a course for nursing majors |
| 9:45 | Ashley | P87: Can Small Groups Work in Large Classes? |

| | | |
|-------|------------------|--|
| | Mahoney | |
| 10:05 | | break |
| 10:15 | Laura Frost | P88: The Molecule Project: Linking Concepts in a One-semester GOB Course |
| 10:35 | Brenda Harmon | P89: The Use of Case-Studies in Teaching GOB |
| 10:55 | Robin Shropshire | P90: Incorporating Thinking Skills Development into Nursing Chemistry Curriculum |
| 11:15 | | panel discussion |

P85: LecturePLUS

Karen Timbrlake (Los Angeles Valley College, USA)

Learning is enhanced when students are engaged in the processing of information. Our challenge as teachers is to design dynamic learning environments that involve students in doing and thinking about chemistry. The LecturePLUS environment integrates collaborative learning activities, mini-lectures using PowerPoint slides, formative assessment strategies, and peer instruction to provide instant feedback to both students and instructor as the class progresses. The discussion will focus on techniques that can be utilized to convert from a traditional lecture setting to a student-centered classroom.

P86: Implementation of PLTL in a course for nursing majors

Joseph Kinsella (Purdue University, United States), **Pratibha Varma-Nelson** (Northeastern Illinois University, US)

Peer-Led Team Learning (PLTL) is a successful approach to curriculum design in college science and mathematics courses. It provides students with opportunities for intellectual and personal development as well as a restructuring of their content knowledge. This paper will describe implementation and evaluation of PLTL in Principles of Organic and Biological Chemistry, the second course of a one-year sequence designed primarily for students planning careers in nursing. Course structure, examples of appropriate materials, peer leader selection and training will be discussed. In addition to student comments, data on student performance in the course and the standardized ACS exams will be provided.

P87: Can Small Groups Work in Large Classes?

Ashley Mahoney (Bethel University, USA)

Classes with more than 50 students have traditionally posed more of a challenge for incorporating alternative pedagogical approaches. Student-centered learning activities (a POGIL approach) have been used as the basis of small group work in class. These activities lead students through a series of questions based on a given model. The critical thinking questions are organized to move from directed (observations), to convergent (assimilation of data), to divergent (open-ended). Students are assigned groups and given roles within the group to complete their activities. Material will be presented on the POGIL method, facilitation of group work, and initial assessment data.

P88: The Molecule Project: Linking Concepts in a One-semester GOB Course

Laura Frost (Georgia Southern University, USA)

A molecule project has been instituted in a one-semester GOB course in an effort to link course concepts. Each student receives the name of a different biologically active molecule during the first

week of class. Over the course of the semester topics covered in the class apply to the molecule assigned. These topics include Lewis structure, three-dimensional ball and stick representation, functional groups, chiral centers, solubility in water, chemical reactivity, and biological relevance. Preliminary portions of the project are submitted during the semester to monitor progress. A final written project is submitted near the end of the semester containing all topics. This project was inspired by Tracy's Molecular Model Project (Tracy, H.J. J. Chem. Educ. 1998, 75, 1442-1444.). The results of a student survey assessing whether students thought the molecule project helped them make connections between material throughout the course as well as other student comments will be presented.

P89: The Use of Case-Studies in Teaching GOB

Brenda Harmon (Oxford College of Emory University, USA)

Pre-nursing students need to learn chemistry not just to be able to better understand biochemistry but also to be able to make important health and consumer decisions. If we only teach the chemistry concepts, how will students learn to apply these concepts in real world situations? We run the risk that the concepts will be de-contextualized and therefore become inert knowledge. In an attempt teach the critical thinking involved in applying chemistry concepts to making consumer and health decisions, I employed a case-study methodology which I have adapted for use in my GOB classroom. This talk will describe the incorporation of several case-studies (currently available at ChemCases.com), discuss the limitations and advantages of the approach, and present guidelines for future use of case-study methodology in the GOB classroom. The results of student surveys, assessments, and reflective responses will be presented.

P90: Incorporating Thinking Skills Development into Nursing Chemistry Curriculum

Robin Shropshire (University of Montana - Helena , US), **Mark Cracolice** (The University of Montana, USA), **Candace Pescosolido** (University of Montana - Helena , US)

A new Associate Registered Nursing degree program was offered by The University of Montana-Helena College of Technology (UM-Helena) beginning in Fall Semester 2005. The first semester of the General, Organic, and Biochemistry (GOB) sequence is a required core curriculum course in this program. Beginning in Fall 2006, all Practical Nursing students will also be required to complete the first semester of GOB as part of their core course requirements. As a consequence of students enrolling in or preparing to enroll in these nursing programs, the number of students in the first semester of GOB at UM-Helena has more than doubled in the last year. The first semester of GOB is designed to provide a base foundation of chemistry topics for nursing students in addition to other non-science majors seeking a general education science with lab credit. The majority of students enrolled in the first semester of GOB, however, are nursing students. Preliminary pre-test and post-test scientific reasoning scores for these students suggest that incorporating thinking skills development into the chemistry curriculum is needed. Incorporation of thinking skills development into the chemistry nursing curriculum and feedback of nursing faculty and nursing students will be presented, including preliminary assessment of students' performance and attitudes. Future plans for implementing thinking skills development into chemistry curriculum, course sequencing, and course prerequisites will be discussed.

9:00 AM - 12:05 PM STEW 214C

S13: Inorganic Teaching Experiences - Session 1 of 2

Tim Zauche (Univ. of Wisc. - Platteville, USA), **Dave Finster** (Wittenberg University, USA)

This symposium will focus on innovative ways of presenting topics in lecture and lab for inorganic classes. The symposium will have two sub themes: Part A will discuss the non-physical based (“sophomore”) descriptive course and Part B will discuss the “senior” course which generally has physical chemistry as a pre- or co-requisite. Part A will include papers on innovative teaching practices implemented at the lower level sophomore inorganic course. These topics/concepts include, but are not limited to, the following subjects: student presentations, innovative worksheets, molecular modeling, laboratory developments, a specific inorganic concept, community service projects, or Scholarship of Teaching and Learning projects. Part B will focus on new ideas and pedagogy in the senior-level inorganic classes and labs; topics will include using active-learning strategies, integrating computational chemistry in the classroom and lab, new methods of teaching the “standard” content, and novel lab experiments.

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| 9:00 | | introduction |
| 9:05 | Barbara Reisner | P91: Development of chemical intuition in the sophomore-level inorganic chemistry course |
| 9:25 | Geoff Rayner-Canham | P92: Making inorganic chemistry a visual experience |
| 9:45 | Erik Gustafson | P93: Predicting products of main group inorganic reactions: A study of performance by students and professionals |
| 10:05 | | break |
| 10:15 | Tim Zauche | P94: Using SoTL training to introduce new material into the classroom |
| 10:35 | Ann Macintosh | P95: Bioinorganic chemistry as the first inorganic chemistry course |

P91: Development of chemical intuition in the sophomore-level inorganic chemistry course

Barbara Reisner (James Madison University, USA), John Gilje (James Madison University, USA)
At James Madison University, we offer a sophomore-level inorganic chemistry course to students with varied chemistry backgrounds. Completion of general chemistry is the only prerequisite for this course. We have found that our students have retained some basic concepts from general chemistry but do not appreciate subtleties and interrelationship of these ideas. In general, they are unable to integrate their knowledge and apply it to new situations. Periodicity is one of the major areas where they can recite the facts found in the general chemistry text, but they cannot use them to make chemical arguments. Our challenge has been to devise exercises that facilitate the development of chemical intuition. In this paper, we will discuss some of the classroom and homework activities that we are using in an effort to increase the sophistication of students’ chemical models. Specifically, we will address exercises that assist our students in understanding and applying chemical principles when discussing electron configuration, ionization potential and aqueous solution chemistry.

P92: Making inorganic chemistry a visual experience

Geoff Rayner-Canham (Grenfell College, Canada), Tonia Churchill (Sir Wilfred Grenfell College, Canada), Christina Smeaton (University of Windsor, Canada), Amy Snook (Sir Wilfred Grenfell College, Canada)

Descriptive Inorganic Chemistry cannot be truly descriptive unless it has a visual component. Over the last three years, we have been creating video clips that show inorganic chemical reactions happening. Students have a much better recall if they have actually seen the reaction performed

than if they simply memorize the chemical equation. They also enjoy the course more. The video segments match the content of a text co-authored by one of us. We will describe our experiences in creating the video clips and show some examples of them.

P93: Predicting products of main group inorganic reactions: A study of performance by students and professionals

Erik Gustafson (Purdue University, United States), George Bodner (Purdue University, US)

This study examines the thought process of chemistry students and professors working on tasks that ask them to predict the product(s) of various main-group inorganic reactions. Students for the study were selected from a 300-level inorganic course, and had taken one semester of descriptive inorganic chemistry at the sophomore level. Other participants came from the incoming class of first-year graduate students to the same university, all of whom had earned a Bachelor degree in chemistry. Additionally, professors from a small Midwestern university participated in the study. A survey given to the participants identified those with varying levels of confidence in the areas related to descriptive inorganic chemistry, and students for the study were selected to represent a range of abilities. Participants were asked to predict the products of a series of inorganic reactions using paper and think-aloud protocol, while their responses were tape-recorded and videotaped. Analysis of these interviews revealed patterns for successful and unsuccessful prediction of products. Based upon these patterns, a new method for helping the students learn to predict the products of inorganic reactions is being developed.

P94: Using SoTL training to introduce new material into the classroom

Tim Zauche (Univ. of Wisc. - Platteville, USA)

Having been to a workshops on the Scholarship of Teaching and Learning, I can more thoughtfully introduce new teaching methods into my classroom and determine their effectiveness at learning. Two items that will be specifically discussed are "Calibrated Peer Review" in writing lab reports and the systematic solving of unknown salts.

P95: Bioinorganic chemistry as the first inorganic chemistry course

Ann Macintosh (Morehead State Univ., USA)

The course, taught using a standard bioinorganic textbook, was designed to replace a sophomore-level descriptive inorganic chemistry course. The new bioinorganic chemistry course covers many of the same topics that had been taught in the descriptive inorganic course, but uses biological systems or model complexes for these systems to introduce the key concepts of inorganic chemistry. For example HSAB properties are introduced in the context of the toxicology of the elements, crystal field splitting is discussed in the context of oxygen binding to an iron porphyrin and molecular orbital diagrams for homonuclear diatomic molecules are covered when discussing the binding mode of oxygen in a variety of oxygen-binding proteins.

9:00 AM - 12:00 PM STEW 306

S4: Research in Chemical Education - Session 2 of 6

Janet Bond-Robinson (Arizona State University, USA), **Christopher Bauer** (Univ. of New Hampshire, USA)

This symposium, sponsored by the CHED Committee on Chemical Education Research, is a forum for research conducted on the teaching and learning of chemistry at any level. Presentations will address: 1) the motivation for the research and the theoretical bases in which it is grounded, 2) the

methods used to gather and interpret data, and 3) the findings and their significance interpreted in light of theory and method. Authors are being strongly encouraged to bring copies of an extended abstract to share with the audience.

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| 9:00 | Selcuk Calimsiz | P96: How undergraduates solve organic synthesis problems: A problem-solving model approach |
| 9:20 | Jason Anderson | P97: Reacting to organic chemistry reactions: How students solve reaction mechanisms |
| 9:40 | Adrian George | P98: Organic chemistry: You either 'get it' or you don't |
| 10:00 | | break |
| 10:10 | Sara Krull | P99: Learner's mental model of chemical equilibrium |
| 10:30 | Kimberly Schurmeier | P100: General chemistry: Topics that discriminate between A, B, C, D and F students |
| 10:50 | John Deming | P101: Tutoring condition as a predictor of student success in college preparatory chemistry |
| 11:10 | | break |
| 11:20 | Hans-Dieter Barke | P102: Chemical Equilibrium - Diagnosis of Misconceptions and Cure |
| 11:40 | Lisa Dysleski | P103: Students' use of representations in solving a chemistry transfer problem and implications for students' understanding of chemistry |

P96: How undergraduates solve organic synthesis problems: A problem-solving model approach

Selcuk Calimsiz (Purdue University, USA), George Bodner (Purdue University, US)

It has been argued that “we can teach and teach well, without having the students learn.” This raises the question: How can we, as educators, determine whether students learn the necessary skills to solve problems? More importantly what do students do when they encounter a novel problem? To understand what happens when undergraduates try to solve problems in the domain of organic chemistry, we investigated sophomore students' problem-solving process while working on organic “transformation” problems – predicting the product of a reaction that involved relatively few steps or predicting the starting materials that would generate a given product. The following research questions guided this study: “What do students do while solving an organic synthesis task, and when do they use a particular gap-closing strategy?” We concluded that undergraduate students displayed a very complicated non-linear problem-solving process, which can be explained by using a slightly modified version of an anarchistic problem-solving model first proposed by a mathematics educator.

P97: Reacting to organic chemistry reactions: How students solve reaction mechanisms

Jason Anderson (Purdue University, US), George Bodner (Purdue University, US)

Organic chemistry is required by students majoring in chemistry and chemical engineering as well as students majoring in health-related scientific disciplines such as pre-medicine. These students must take organic chemistry to provide a foundation of knowledge for subsequent traditional science courses in chemistry, biology, and related fields. Without a basic understanding of how the molecules of life interact, it is difficult for students to move on to higher levels of thinking that

more advanced coursework requires. This makes organic chemistry a pivotal course. As the subject is highly conceptual, such that there is little algorithmic problem solving, students generally find the course difficult to follow. It also presents various new skills, symbolisms, and conventions that are unique to this domain. The most problematic of these conventions is often the arrow pushing formalism used in describing reaction mechanisms. The research program described focuses on problem solving in organic chemistry; specifically, how students solve organic chemistry reaction mechanisms. This paper will outline our current efforts to explore the approaches that students take when solving mechanism problems. Emphasis will be placed on elucidating how prior knowledge and motivation influences problem solving for both graduate and undergraduate students with various backgrounds and chemistry emphasis.

P98: Organic chemistry: You either ‘get it’ or you don’t

Adrian George (University of Sydney, AUSTRALIA), Michael King (The University of Sydney, Australia), Anthony Masters (The University of Sydney, Australia), Justin Read (The University of Sydney, Australia)

Anecdotal evidence suggests that many students find organic chemistry difficult to comprehend when they first encounter the topic. The examination results of first year chemistry students at the University of Sydney have been examined in units which include both general chemistry and organic chemistry. This covers approximately 1400 students, spread across eight units of study. Analysis of marks shows that a normal distribution is a suitable model for the questions involving general chemistry topics, but is not suitable for organic chemistry topics, where trimodal distributions are observed. This suggests that distinct levels of understanding of organic chemistry exist within the student cohort of each unit. Qualitative examination script analysis, coupled with student interviews, allows identification of common characteristics for students at each level of understanding. Reasons for this will be suggested.

P99: Learner's mental model of chemical equilibrium

Sara Krull (Indiana University of PA, USA)

What are you thinking about right now? The mind is an amazing tool that makes humans different from other species. As conscious beings we are constantly thinking about and processing ideas and information. The objective of our research is to observe and analyze the thought processes that are used by learners when performing a thought revealing activity in chemical equilibrium. Currently we are analyzing results from the thought revealing activity that we designed and we will present significant findings in a new model of how students construct the concept of chemical equilibrium.

P100: General chemistry: Topics that discriminate between A, B, C, D and F students

Kimberly Schurmeier (University of Georgia, USA)

Item Response Theory (IRT) analysis has been applied to the previous five years of computerized general chemistry exams from the University of Georgia's JExam program to determine both question difficulty and discrimination. Preliminary results show that questions containing concepts and images discriminate between the higher level students whereas those containing chemical equations and calculations separate the less knowledgeable chemistry students. We now have the ability to know which concepts discriminate A from B students and so on. With this knowledge, we can try to help students overcome these specific conceptual barriers so that they can obtain better understanding of these topics. This in turn will increase their ability in chemistry and presumably their grade. Through further analysis and subsequent modifications to examinations,

we will better assess our students' abilities and understanding of chemistry.

P101: Tutoring condition as a predictor of student success in college preparatory chemistry

John Deming (The University of Montana, United States), Mark Cracolice (The University of Montana, USA)

This study explores the relationship between tutoring condition and success on chemistry content questions in a college preparatory chemistry course. Vygotsky argued that instruction must target tasks that a learner is only able to complete with assistance from an adult or more experienced peer. These tasks form a learner's zone of proximal development (ZPD). The treatment group received ZPD tutoring, while the control group received traditional didactic tutoring. Results indicate that treatment students showed significantly greater gains in content knowledge than control students. The results of this research and their implications for instruction will be discussed.

P102: Chemical Equilibrium - Diagnosis of Misconceptions and Cure

Hans-Dieter Barke (Didaktik der Chemie, Germany)

"Equilibrium, considered one of the more difficult chemical concepts to teach, involves a high level of students misunderstanding" [Bergquist and Heikkinen, 1990]. The presentation will show an overview over many misconceptions according to chemical equilibrium, specially of students in the US and in Germany. These misconceptions have no source in every day life, they are "home made": not the students themselves are responsible for their misunderstanding, but the teacher or the way to teach this topic. Therefore a curriculum will be proposed how to teach the idea of chemical equilibrium, how to succeed in developing images of structure of matter to help students to understand. Experiments shall visualize equilibrium, calculations of experimental data will specify equilibrium according to solubility (calcium sulfate) and to gas reactions (carbon/carbondioxide/monoxide). All reflections are taken from my new book on "students misconceptions of basic concepts in chemistry - diagnosis and cure". The German written book will be presented with the offer to complete it with further research and translation in the English language.

P103: Students' use of representations in solving a chemistry transfer problem and implications for students' understanding of chemistry

Lisa Dysleski (Colorado State University, USA), Dawn Rickey (Colorado State University, United States)

As part of a larger investigation of facilitators and barriers to transfer problem solving in general chemistry, this study examines the symbolic language and molecular-level representations that students employ during think-aloud problem solving and what the representations imply about students' understandings. Analyses of students' use of symbolic language reveal internal inconsistencies across different representational modes (e.g., pictures, chemical equations, algebraic representations and molecular-level drawings) as well as a high proportion of incorrect representations. Students who drew correct molecular-level representations after attempting the transfer problem were more likely to solve the transfer problem compared with students whose molecular-level drawings were incorrect.

9:00 AM - 12:00 PM STEW 318

S14: Research in Chemical Education Using Computers - Session 1 of 2

Michael Sanger (Middle Tennessee State University, USA)

This symposium, jointly sponsored by the Committee on Chemical Education Research and the Committee on Computers in Chemical Education, will describe the use of computers and other forms of technology in performing chemical education research. Presenters will describe research studies where computer use was an integral part of the instructional lesson and not merely used to analyze the data or present the results

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| 9:00 | | introduction |
| 9:05 | Brian Postek | P104: What are the effective aspects of multiple visualizations for students in learning chemistry? |
| 9:25 | Michael Sanger | P105: Concept learning versus problem solving: Does particle motion have an effect? |
| 9:45 | Resa Kelly | P106: Effects of a computer animation on secondary students' understanding of the crushing can demonstration |
| 10:05 | Peter Garik | P107: Using computers to visualize and reason with quantum concepts |
| 10:25 | | break |
| 10:35 | Katherine Jennings | P108: Physical Chemistry in Practice DVD: Development and implementation |
| 10:55 | John H. Penn | P109: Tools for performing organic reaction mechanisms over the web |
| 11:15 | Nathan Barrows | P110: Isn't this supposed to be the easy way? Design and implementation issues for online research tools |

P104: What are the effective aspects of multiple visualizations for students in learning chemistry?

Brian Postek (Purdue University, United States), Mary Nakhleh (Purdue University, USA)

The purpose of this investigation is to determine what aspects of a computer visualization program in chemistry students perceive to be the most useful in constructing an understanding of the concept of limiting reagents. For the study, the Synchronized Multiple Visualizations of Chemistry program (SMV Chem) was used. The SMV Chem program is user interactive, where the user may chose to view and / or listen to up to 5 representations (video, animation, graph, text, and an accompanying audio track for each) at one time. Studies have shown that the use of visualizations in chemistry do promote understanding, but none investigated what aspects students perceive to make them useful, or what aspects make a given type or combination of representation(s) most useful, as we seek to determine. Our Phase I data analysis indicated specific preferences in the use of representations. In order to investigate the preferences more in depth, Phase II of this study is currently underway. Results of the data analysis from Phase II will also be presented.

P105: Concept learning versus problem solving: Does particle motion have an effect?

Michael Sanger (Middle Tennessee State University, USA)

In 1987, Nurrenbern and Pickering reported students' responses to a conceptual gas law question which asked how the distribution of particles changed when the gas sample was cooled. These students had difficulty answering this question. One problem with the question is that the property that changed as the gas was cooled (particle motion) cannot be seen in the static pictures. This study reports students' answers to the static picture and how their answers changed after they saw an animated version of the question. It also describes qualitative data regarding why their answers

changed as a result of viewing the animation.

P106: Effects of a computer animation on secondary students' understanding of the crushing can demonstration

Resa Kelly (San Jose State University, United States)

Understanding chemistry requires the ability to think at three different levels: submicrochemistry, macrochemistry, and representational chemistry. Students often have difficulty making connections among these three areas due to the abstract nature of many chemistry concepts. The purpose of this research was to investigate how computer animations affected secondary students' understanding of the Crushing Can Demonstration. This investigation compared two groups of chemistry students at a large, suburban high school. The treatment group viewed the animation after seeing and discussing the crushing can demonstration, while the control group received the same instruction as the treatment group but did not see the animation. A posttest was administered to both groups. The results indicated that the treatment group had better understanding than the control group in all three levels.

P107: Using computers to visualize and reason with quantum concepts

Peter Garik (Boston University, USA), Dan Dill (Boston University, USA), Alexander Golger (Boston University, USA), Morton Hoffman (Boston University, USA)

We are investigating how to teach quantum concepts early in the chemistry curriculum. Our method relies on interactive computer visualization, coupled with lecture and laboratory demonstrations. Specifically, we tested software modules with which students can learn about the interaction between light and matter. The modules cover the spectroscopy of the hydrogen atom, and the mixing of atomic orbitals by light to produce dipole oscillations. To assist students in understanding the wave properties that give rise to quantum behavior, we provided them with bridging analogies. One module provides an introduction to the properties of waves, a topic more often covered in physics. We report the results of pre- and post-tests of nearly six hundred students who used our software, and the results of interviews to explore students' understanding of the interaction of light with atoms. Our results support the thesis that students can learn to reason about the interaction of light and matter at the quantum level using computer visualization tools.

P108: Physical Chemistry in Practice DVD: Development and implementation

Katherine Jennings (Purdue University, USA), Erik Epp (Purdue University, USA), Marcy Towns (Ball State University, USA), Gabriela Weaver (Purdue University, USA)

A multimedia DVD has been under development for several years with the goal of creating teaching material to show the application of physical chemistry theory and methods to current research topics. The DVD contains textual theory and sample problem sections in addition to video and animations. It allows students to view information in any order they believe necessary and as often as they want. The DVD was used as a laboratory activity in an undergraduate physical chemistry course during the fall 2005 and spring 2006 semesters. Students were observed and content and attitudinal data were collected throughout each semester. Findings from our analyses will be presented.

P109: Tools for performing organic reaction mechanisms over the web

John H. Penn (West Virginia University, USA)

Web-based instructional methods have shown constant advancements in recent years. In the world

of organic chemistry, on-line structure drawing has become possible through a variety of applets and 3-D visualization techniques are beginning to become highly commonplace. The next mountain to be climbed is that of drawing organic reaction mechanisms, and then to have the computer evaluate its correctness. This contribution will focus on the progress towards that goal and the various techniques that might be used to help students draw and to understand reaction mechanisms.

P110: Isn't this supposed to be the easy way? Design and implementation issues for online research tools

Nathan Barrows (Arizona State University, USA), Daniel Barr (Arizona State University, USA), Janet Bond-Robinson (Arizona State University, USA), Scott Thompson (Arizona State University, USA)

Technological advances over the past 30 years have provided chemical education researchers with new areas of inquiry (e.g. molecular visualization) and new research tools (e.g. student response systems). Often, new technologies have augmented existing research methods as in the cases of web-based surveys and videotaped classroom observations. However, technology-enhanced techniques may present research design issues for investigators. In this presentation we will describe our positive and negative interactions with two online research instruments. First, we employed the Questionmark™ Perception™ assessment management system for two studies: 1) a Delphi survey to identify unifying themes across the chemical disciplines, and 2) an interactive pre-assessment survey of biochemistry students' misconceptions. Second, we examined the help-seeking behaviors of organic chemistry students with an online retrosynthesis tutorial. Through the web interface, we monitored students' behavioral patterns over a semester by recording the pages viewed, the hints selected, and the amount of time spent on each page and hint. In each study we identified design, implementation, or analysis issues that illustrated both the advantages and disadvantages of online research instruments.

9:00 AM - 12:00 PM STEW 310

S15: Teaching Bioanalytical Chemistry and Biochemistry Laboratory - Session 1 of 1

Harvey Jian-Min Hou (Gonzaga University, USA)

A great portion (70%) of the most cited research papers in analytical chemistry focus on biological problems. Bioanalytical chemistry at the chemistry-biology interface is one of the most promising enhancements in undergraduate chemical education. At least three layers of bioanalytical chemistry content may be developed and implemented in undergraduate chemistry curriculum: (1) introduction to bioanalytical chemistry; (2) (intermediate) bioanalytical chemistry; and (3) advanced topics in bioanalytical chemistry. Presentations will touch on all of these levels and include innovations being done in biochemistry teaching laboratories.

9:00 introduction

9:05 Peter Kissinger P111: What is bioanalytical chemistry and how is it used in industry and academe?

9:25 Abiodun Ojo P112: Using traditional analytical chemistry methodology to study the correlation between cardiovascular disease and the levels of magnesium and calcium

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|-------|-------------------------|---|
| 9:45 | Harvey Jian- Min Hou | P113: Teaching introductory bioanalytical chemistry |
| 10:05 | | break |
| 10:15 | Susan Olesik | P114: Environmental chemistry research in the quantitative chemical analysis course |
| 10:35 | Greg Muth | P115: Design, isolation and characterization of mutant cystathionine-beta lyase |
| 10:55 | Douglas Beussman | P116: Teaching a lab-intensive bioanalytical chemistry course |
| 11:15 | | discussion |

P111: What is bioanalytical chemistry and how is it used in industry and academe?

Peter Kissinger (Bioanalytical Systems, Inc,)

The first problem for students to recognize is that today BIOLOGY IS CHEMISTRY ORGANIZED IN UNIQUE WAYS AND BEHAVING IN UNIQUE WAYS. The goal of analysis is to understand what is going on from the genome to the transcriptome to the proteome to the metabolome and then to correlate the chemistry with other aspects including behavior, disease, drugs, food/nutrition, athletic performance, crime&. Bioanalytical chemistry is best organized by first defining the question to be answered in some detail. The second step is to define the biological system and how it is to be provoked or if it is to be sampled in a particular environment. A good rule for bioanalytical chemistry is that if the sample is not properly obtained there will be a high probability that the data will be of little value. Most biological systems are both dynamic and fragile. The third step is to select a methodology or to invent one. The fourth step is to validate that methodology for the situation at hand. Finally, samples can be processed and decisions made. One of the largest activities for bioanalytical chemistry is in the area of drug discovery and development, the goal being to ensure that pharmacological mechanisms are understood and that approved drugs are relatively safe, relatively effective and relatively cheap compared to allowing disease to proceed unimpeded. While only narrow aspects can be approached in undergraduate laboratories, students can see the bigger picture when they are exposed to it.

P112: Using traditional analytical chemistry methodology to study the correlation between cardiovascular disease and the levels of magnesium and calcium

Abiodun Ojo (Bainbridge College, USA)

Traditional methodology of analytical chemistry using EDTA titrimetric analysis can be utilized for research in a two-year college to the beneficial understanding of the students laboratory experience and the general community at large. The study deals with the opportunity to demonstrate the correlation between the levels of mineral ions of magnesium and calcium in drinking water and the possible risks of cardiovascular diseases in the college area location. Several epidemiological studies have documented evidence of the relationship between the levels of magnesium and calcium in drinking waters and mortality from cardiovascular diseases (CVD). In this study we are reporting the magnesium and calcium concentrations, as well as the hardness of drinking waters obtained from surface, underground, municipal and bottled water sources in Decatur County Georgia were analyzed by using the EDTA titrimetric method. When these concentrations are compared to a ten year (1994 -2003) cardiovascular diseases (CVD) occurrence in Decatur County, it does appear that there is a general correlation with the variations in the

content of Ca and Mg. Bainbridge township in Decatur County, receives its drinking water solely from the municipal water, and it showed evidence of high cardiovascular deaths correlating with the soft water and low concentrations of Ca and Mg found in the drinking water. In the suburbs of Decatur County where their drinking waters are obtained from underground water sources, and these were analyzed to contain higher Ca and Mg contents, there is a general decrease in cardiovascular deaths recorded.

P113: Teaching introductory bioanalytical chemistry

Harvey Jian-Min Hou (Gonzaga University, USA)

To enhance undergraduate education and better prepare our students for their professional development, a novel chemistry course was recently developed and implemented in the curriculum of the Chemistry Department at Gonzaga University. The title of the new chemistry course is "Introduction to Bioanalytical Chemistry (CHEM 240 & 240L)" which is a sophomore year course with a focus on biological applications using chemical methods and serves as a prerequisite for Biochemistry (CHEM 440). The introductory bioanalytical chemistry (CHEM 240 & 240L) was offered in the springs of 2005 and 2006. The majority of the student population was biology majors. The course covered the key components in Physical Chemistry, such as electrochemistry, chemical thermodynamics, and kinetics, as well as the classic contents in Analytical Chemistry, for example, acid-base chemistry, atomic and molecular spectroscopy, and chromatography. Eleven laboratory experiments were well designed to emphasize the applications of a variety of analytical spectroscopy and biochemical skills in biology or medical sciences. Some of the experiments using biophysical techniques such as Fourier transform infrared spectroscopy (FTIR) and differential scanning calorimetry (DSC) are perfectly fit for Biochemistry Laboratory courses at other undergraduate institutions.

P114: Environmental chemistry research in the quantitative chemical analysis course

Susan Olesik (The Ohio State University, USA), Ted Clark (the Ohio State University, USA)

The NSF-REEL Program, Research Experiences to Advance Learning, has goals of deeply interweaving research into the chemistry courses taught in the first two years of the College Chemistry College Curriculum in the State of Ohio (see REEL poster for more details the program). As part of this program, students are doing research in the quantitative analysis course at Ohio State University. To learn concepts of chemical equilibrium and activity, we observe and interact with the on-going chemical equilibrium that happens in natural waters (rivers and wetlands). The environmental chemistry concepts are deeply woven into the course with early visits to the rivers and wetlands to start taking water samples and to observe the environment. During the last third of the course the students use their understanding of equilibrium chemistry and environmental chemistry to propose and do research projects that further our understanding of the environmental chemistry in local area rivers and wetlands. Results to date on the students' research efforts will be highlighted in this talk. We plan to expand this model across the state of Ohio starting next academic year.

P115: Design, isolation and characterization of mutant cystathionine-beta lyase

Greg Muth (St. Olaf College, USA), Joe Chihade (,)

The experimental biochemistry course at St. Olaf College provides an environment for students to participate in a hypothesis based laboratory study of a single enzymatic reaction using a variety of biochemical methods. We have chosen to use cystathionine b-lyase (CBL), a bacterial enzyme

catalyzing the penultimate step in the pyridoxyl 5'-phosphate (PLP) dependent hydrolysis of L-cystathionine to L-homocysteine, pyruvate and ammonia. This enzyme was chosen 1) because the kinetic assays are robust, reproducible and can be monitored by visible spectroscopy 2) the enzyme utilizes several commercially available substrates allowing for comparison of specificity between different molecules and 3) there is a published crystal structure of the enzyme. Two goals of the course are to provide an environment for creativity and to encourage intellectual and physical continuity between experiments. To meet these goals, over the course of a thirteen-week semester up to eight junior and senior biochemistry students have studied the chemical mechanism of CBL through its organic reaction mechanism from substrate to product. This analysis paired with study of the crystal structure of the protein lead students to develop unique hypotheses regarding how a change in the sequence of the protein may lead to an altered function of the protein. The isolated proteins were analyzed physically by SDS-PAGE electrophoresis and functionally by kinetic assays. Rigorous calculation and presentation of the kinetics data allowed the students to compare the affects of their mutant as well as the other mutant proteins developed and analyzed by their classmates.

P116: Teaching a lab-intensive bioanalytical chemistry course

Douglas Beussman (St. Olaf College, USA)

The application of analytical chemistry techniques to biological systems continues to be a rapidly growing field, especially with new methods of analysis being developed and recent advances in instrumentation. Entire new fields, such as proteomics, genomics, and metabolomics, have been established based, in part, on new analytical tools. While the importance of these fields of study and the related techniques is obvious, the formal training of students in these areas is lagging behind research and job demand. A search for institutions that teach bioanalytical chemistry courses yields only a handful of locations, many at the graduate school level. In this presentation, a lab-intensive bioanalytical chemistry course will be presented. This course was developed for upper-level undergraduate students, but could also reasonably be used as a graduate level course. Outside of regular classroom lectures, students work on several investigative lab projects, including several electrophoresis experiments, various affinity separations, and mass spectral analysis of proteins and peptides. The final project involves students analyzing a gel-separated protein band by enzymatic digestion, followed by mass spectrometric analysis and database searching. Examples of various lab experiences will be presented as part of this talk.

9:00 AM - 12:00 PM STEW 214B

S16: Teaching to the National Science Standards: Science in the Personal and Social Perspectives - Session 1 of 1

Linda Weber (Natick High School, USA)

Have your students ever asked "I'm not going to be a scientist, why do I need to know this?" This symposium will help high school chemistry teachers answer that question and make connections between what students are learning in the classroom to what is happening in the world today. Ideas will be linked to national standard F: Science in the Personal and Social Perspectives. Activities, labs, and readings that make connections between chemistry concepts and things students experience everyday will be shared. Presenters will also include suggestions on how to squeeze these important elements into an already full curriculum.

9:00

introduction

| | | |
|-------|-------------------|---|
| 9:05 | Susan Hershberger | P117: Environmental health choices and chemistry |
| 9:25 | Angela King | P118: Fuel from the fryer |
| 9:45 | Erica K. Jacobsen | P119: Linking science to real life: Easy-to-use experiments from the Journal of Chemical Education |
| 10:05 | | break |
| 10:15 | Jean Mihelcic | P120: Use of web quests concerning environmental, ethical and diversity issues to enrich the Chemistry 1 curriculum |
| 10:35 | Carrie Hohl | P121: Pathfinder science: Promoting investigative science education through inquiry-based student experiences |
| 10:55 | Mary Harris | P122: Polymers in the field and track |
| 11:15 | Mary Cunningham | P123: Chemistry in the middle |
| 11:35 | Kelly Deters | P124: How teaching in an applied, need-to-know format affects student opinions and attitudes towards chemistry |
| 11:55 | | discussion |

P117: Environmental health choices and chemistry

Susan Hershberger (Miami University, USA), Lynn Hogue (Miami University, USA), Mickey Sarquis (Miami University, USA)

Chemistry is central to understanding environmental risks and healthy choices. Activities and investigations with personal drinking water preferences, UV light exposure, indoor air quality, disease transmission, and product safety will be described. These attention getting activities were initially developed for informal science venues, such as 4H, camps, and museums. Everyday materials involve students in science and chemistry investigations while challenging their assumptions of health safety and risks. A collection of the activities will be demonstrated and described, their chemistry discussed, as well as their connections to Science in the Personal and Social Perspectives Standards. These materials developed with an NIH-SEPA grant don't preach. Students are challenged to assess risks from natural and human induced hazards themselves.

P118: Fuel from the fryer

Angela King (Wake Forest University, US), Marcus Wright (Wake Forest University, USA)
 Fuel from the Fryer is a two-day content-based hands-on workshop developed for high school science teachers developed through SCIMAX, a community driven NSF-funded partnership. Fuel from the Fryer utilizes student (and teacher) interest in saving money by powering cars on used French fry grease as a motivating force for the mastery of chemical concepts such as reaction chemistry, intermolecular forces and heats of combustion. Participating teachers reviewed content knowledge on fossil fuels, the need for alternative sources of energy and combustion. Participants then produced biodiesel from vegetable oils and evaluated their product. The workshop content and evaluation data will be presented.

P119: Linking science to real life: Easy-to-use experiments from the Journal of Chemical Education

Erica K. Jacobsen (Univ. of Wisconsin-Madison, U.S.), Linda Fanis (University of Wisconsin-

Madison, USA)

Implementing experiments and activities that integrate real world topics with standards-based chemistry curriculum can be difficult. Both time and resources are in limited supply in the average classroom. This presentation will share several easy-to-use experiments from the Journal of Chemical Education that can lessen the burdens of limited time and resources. The experiments mainly use materials that are available in the home, and grocery and hardware stores, and are often suitable for use as take-home experiments. The experiments include topics such as the characterization of student-collected soil samples, the relation of the concentration of powdered-drink-mix beverages to air pollution, and others. Attendees will receive copies of the presented experiments.

P120: Use of web quests concerning environmental, ethical and diversity issues to enrich the Chemistry 1 curriculum

Jean Mihelcic (Conestoga High School, USA)

In order to enrich the Chemistry 1 curriculum, a series of web quests were developed concerning the environment (acid rain, hydrogen powered cars, PVC piping), ethics and chemistry (Bhopal), and cultural diversity in chemistry. Students were asked to research the issue using a variety of web resources in order to enhance their understanding of the connections in chemistry to the real world. The web quests were based on resources from diverse sources, including governmental agencies, trade and lobbying groups, media sources, and the Chemical Heritage Foundation. Examples of web quests and student reactions will be presented.

P121: Pathfinder science: Promoting investigative science education through inquiry-based student experiences

Carrie Hohl (University of Kansas, USA), Steve Case (University of Kansas, United States), Dennis Lane (University of Kansas, United States)

The Pathfinder Science group has established an online network of investigative and inquiry-driven projects that develop a means of providing elementary, middle, and high school educators with the opportunity to integrate applied learning into their existing curriculum. These methodologies give educators the ability to effectively address the National Science Education Standards for inquiry while directly complementing current chemistry, biology, and natural sciences curricula. Pathfinder provides professional development to participating teachers focusing on technology skills, science content knowledge, and pedagogy. The website features a variety of different ongoing classroom-based research projects in a multitude of different scientific fields of study (chemistry, environmental sciences, physics, biology, geology, and geography). Students learn about atmospheric chemistry by investigating ground level ozone (Keeping and Eye on Ozone), particulate matter (Particulate Monitoring), greenhouse gases (Global Warming), and sulfur dioxide (Lichens and SO₂). Pathfinder's newest module (Green Clean, scheduled to be introduced to the public by March 1, 2006) introduces the concepts of green chemistry and sustainability by evaluating the chemical processes used by both conventional and green dry cleaners. Pathfinder projects are designed to allow students to make authentic contributions to science and their communities, while developing a strong understanding of scientific inquiry. By sharing and discussing their results and observations with a geographically diverse network of schools, students gain valuable team building and communication skills. At the conclusion of their projects students can present and publish their results online.

P122: Polymers in the field and track

Mary Harris (John Burroughs School, USA)

Playing or watching sports are of interest to most students. Playing on artificial surfaces adds even more interest. The Prestige System of artificial turf and Mondo Track were installed during the summer of 2005 at my school. I took advantage of the engineers to learn more about the polymers in both and how temperatures on the field compare with air temperatures. The turf is made of polyolefine fibers embedded in rubber granules with an under layer of sand. The track is two layers of rubber adhered to asphalt. Temperature probes were used to collect data on the surface and in the air above the field.

P123: Chemistry in the middle

Mary Cunningham (Argo Community HS, US)

In the discussion of high school science curriculum there is a growing movement to place physics first. How will this projection enable the connection of big concepts such as energy, kinetics, thermodynamics and other to be enhanced? What are the implications for high school chemistry change in this movement.

P124: How teaching in an applied, need-to-know format affects student opinions and attitudes towards chemistry

Kelly Deters (Shawnee Heights High School, US)

Results will be shared of a pre and post-survey given to HS students around the country as part of a real-life chemistry curriculum field-test. Teachers surveyed their classes that used the curriculum and those that followed the "traditional" curriculum on their opinions and attitudes about science, chemistry and the importance/application of these subjects to their life. See the difference that teaching in an applied, need-to-know format can make. Examples of how the curriculum achieves this approach using consumer based topics will also be shared.

9:00 AM - 12:00 PM STEW 206

S17: Teaching to the National Science Standards: What is Inquiry and How Can We Implement Inquiry in the Chemistry Classroom and Lab? - Session 1 of 2

Kathy Kitzmann (Mercy High School, USA)

The National Science Education Standards and AAAS Benchmarks have brought inquiry to the forefront of science education. NSES Content Standard A states: "For students to develop the abilities that characterize science as inquiry, they must actively participate in scientific investigations, and they must actually use the cognitive and manipulative skills associated with the formulation of scientific explanations." Although chemistry educators value inquiry instruction for the potential it has to impact students' understanding and thinking about science, many have concerns and questions about implementing inquiry in the classroom and laboratory. Presenters will share models for science inquiry and methods for implementing inquiry, as well as specific inquiry activities, lessons, and labs.

9:00 introduction

9:05 Mark Cracolice P125: Why should we use inquiry in the chemistry classroom

9:25 Ellen Yeziarski P126: Strategies, materials, and resources for high school inquiry activities

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|-------|--------------------|--|
| 9:45 | David Hanson | P127: Process-oriented guided-inquiry learning (POGIL) in the high school science classroom |
| 10:05 | Eric Malina | P128: Designing inquiry activities: Balancing open-endedness and background knowledge |
| 10:25 | | break |
| 10:35 | William Donovan | P129: Collaborative development and implementation of inquiry-based lesson plans |
| 10:55 | Rebecca Krystyniak | P130: Teacher and student reflections on using guided inquiry to teach high school chemistry |
| 11:15 | | discussion |

P125: Why should we use inquiry in the chemistry classroom

Mark Cracolice (The University of Montana, USA), John Deming (The University of Montana, United States)

The American Heritage Dictionary defines a skill as a “developed talent or ability,” such as the ability to play a piano without looking at the keys. Skills must be developed over time, and their rate of development can be influenced by coaching or teaching, appropriate equipment and learning materials, and quantity of meaningful practice. Thus, scientific thinking skills are a mental processing ability that can be developed through an appropriate teaching and learning environment, such as a science classroom. The Swiss psychologist Jean Piaget (1896–1980) originated the practice of measuring such thinking skills. Other researchers have extended Piaget’s work, identifying measurable skills that are vital for success in scientific inquiry, the modern workplace, and in a democratic society. Inquiry-based curricula provide a classroom environment that facilitates the growth of students’ thinking skills. Scientific thinking skills must be developed in harmony with science content—they are inexorably linked. As a result of development of their thinking skills, students will possess the life-long ability to think critically and independently, as well as satisfy the shorter-term goals of enhanced academic achievement and higher test scores.

P126: Strategies, materials, and resources for high school inquiry activities

Ellen Yeziarski (Grand Valley State University, USA)

Designing an inquiry-based laboratory program for high school chemistry can be a daunting task. Fortunately, there are incremental curricular reforms teachers can implement to begin transforming verification-style experiments to guided-inquiry ones. For teachers planning major laboratory curriculum overhauls, identifying or designing appropriate guided-inquiry activities is crucial. Whether you plan to take “baby steps” toward inquiry or are ready to “take the plunge,” this talk will address specific resources and curriculum materials necessary for reform. Several strategies for modifying verification labs along with examples will be presented. In addition, learning cycles in chemistry (precursors to guided-inquiry labs) will be shared and offered as core activities to launch your curriculum development. Lastly, Target Inquiry, a new inquiry-focused professional development program for high school chemistry teachers, will be briefly discussed.

P127: Process-oriented guided-inquiry learning (POGIL) in the high school science classroom

David Hanson (Stony Brook University - SUNY, USA), Linda Padwa (Stony Brook University, USA)

POGIL (Process-Oriented Guided-Inquiry Learning) is a student-centered method of instruction that is based on contemporary cognitive learning theory and results from classroom research that suggest most students experience improved learning when they are actively engaged, working together, and given the opportunity to construct their own understanding. The POGIL methodology has been successful in college classrooms and is being adapted for use in high school chemistry classes. POGIL activities employ the Learning Cycle to guide student inquiry and a learning-research model, which is similar to the 5E's (Engage, Explore, Explain, Elaborate, Evaluate), for lesson design. Sample activities will be presented during the session, and other classroom-ready activities will be described.

P128: Designing inquiry activities: Balancing open-endedness and background knowledge

Eric Malina (Southern Illinois Univ. Edwardsville, USA), Eric J. Voss (Southern Illinois University Edwardsville, USA)

Inquiry is the buzz word of science education today; students need to think about the processes of science to appreciate the nature of science and to gain better understanding of scientific concepts. Laboratory experiences are ideal for adding inquiry to the curriculum, but how should inquiry activities be developed and implemented? As part of an Excellence in Undergraduate Education Grant through Southern Illinois University Edwardsville, we designed three inquiry activities for the general chemistry laboratory. This presentation will address the action research process of the development of these activities based on student surveys and in-lab observations. Copies of the activities will be available.

P129: Collaborative development and implementation of inquiry-based lesson plans

William Donovan (The University of Akron, USA), Kim Calvo (The University of Akron, USA), Diana Williams (Firestone High School, USA)

The Northeast Ohio Center of Excellence (NEOCEX) in Mathematics and Science Teacher Education encourages collaboration among faculty and administrators at regional higher education and K-12 institutions to promote the effective teaching and learning of mathematics and science. Inquiry-based lesson plans are developed by university faculty and high school teachers, and piloted in introductory college chemistry courses. The content of each lesson is aligned with specific national and state content standards and outcomes. Middle-school science teachers attend workshops (facilitated by the high school teachers) where they run the tested lessons as students. The teachers take the lessons back to their schools for continued implementation. The lesson plans are also shared state- and world-wide through the Ohio Resource Center. We will discuss our experiences in development and implementation of the inquiry-based lesson plans and will also discuss several samples of lesson plans.

P130: Teacher and student reflections on using guided inquiry to teach high school chemistry

Rebecca Krystyniak (St. Cloud State University, USA)

Living by Chemistry (LBC) is a high school chemistry curriculum project that uses guided inquiry, among other techniques, to teach chemistry. Formative evaluation of the project has been ongoing. In addition to investigating the mechanics of the implementation, the change in the role of the instructor as well as the classroom environment were identified. Student response to the curriculum and the guided-inquiry format were documented. Data sources included written evaluations of the lessons from the teachers, classroom observations, and focus groups of both teachers and students. Teacher's views on inquiry before and after the implementation of the

curriculum will be presented as well as student's reflections on learning through guided inquiry and its perceived effect on their achievement.

Workshops

Monday, July 31 morning

W10: Chemistry is Everywhere: Integrating Chemistry into the K-8 Curriculum

9:00 AM - 12:00 PM BRWN 2124

Kathryn Wagner (Princeton University, USA)

The purpose of this workshop is to show that much can be done in K-8 science with little time and few resources. Participants will practice simple, inexpensive chemistry-related hands-on activities that have multiple uses across grade levels and subject areas. They will learn ways to combine a science activity with a history lesson, introduce a scientific concept with an art project, and look for the science in their own favorite activities. They will discuss directions of inquiry that are suitable for different grade levels. They will also discuss how the activities can be used to meet national benchmarks for science and technology.

Capacity: 25 Fee: \$5

W11: Hands-on Models in Chemistry

9:00 AM - 12:00 PM STEW 311

Anne-Marie Nickel (Milwaukee School of Engineering, USA)

The spatial arrangement of atoms is central to the understanding of chemistry. Even with the availability of increasingly sophisticated computer displays, we believe the hands-on manipulation of physical models is fundamental to understanding the three-dimensional nature of chemistry. During the workshop we will make use of four different physical model kits based on hub and spoke (especially useful for covalent bonding), sphere packing (especially useful for ionic structures), polyhedral coordination (especially useful for oxides and environmental chemistry), and magnetic attraction (especially useful for showing energetics of bond formation and addressing the common misconception among chemistry students that all bond formation requires energy.) These representations provide complementary views. Is a tetrahedron four spokes from a central atom, the space between four close-packed spheres, or a structural unit used to assemble larger structures? This workshop is partially supported by the Center for Biomolecular Modeling at the Milwaukee School of Engineering (<http://www.rpc.msoe.edu/cbm/>) and the Materials Research Science and Engineering Center on Nanostructured Interfaces at the University of Wisconsin-Madison (<http://mrsec.wisc.edu/edetc>).

Capacity: 40 Fee: \$25

W12: Molecules of Life: Exploring Chemical Principles in a Biological Context

9:00 AM - 12:00 PM WTHR 212

Trace Jordan (New York University, U.S.A.)

Molecules of Life is a non-majors science course that examines the intersection of chemistry, cell biology, and pharmaceutical design. A central theme throughout the course is how chemical principles can illuminate our understanding of the structure and function of biological molecules. For example, the principles of solubility are explored through the examples of water-soluble and

fat-soluble vitamins. The course has been offered within the general education curriculum at New York University and is now the subject of a dissemination project involving seven other schools, several of which enroll large numbers of minority students. This workshop will provide an overview of the Molecules of Life curriculum, text materials, and laboratory projects. It will also include a hands-on investigation of molecular graphics exercises that have been designed using JMOL. Finally, we will present student assessment data on content knowledge, attitudes towards science, and the development of 3D visualization skills.

Capacity: 30 Fee: none

W13: Teaching Chemistry with Models and Simulations; Section 1

9:00 AM - 12:00 PM SC 231

Dr. Jurgen Schnitker (Wavefunction, Inc., USA)

By invoking the tremendous power of three-dimensional visualization, molecular modeling fosters an understanding of chemical concepts that is intuitive and thorough. Attend this hands-on workshop and learn how to add this new dimension to your lecture demonstrations as well as to your laboratory and homework assignments. Two suites of software will be featured: Odyssey, a new chemistry learning tool that allows for realistic simulation of molecular motion, and Spartan, Wavefunction's industry-leading molecular modeling application that is used in teaching and research laboratories worldwide. A variety of examples from the standard curriculum for General, Organic, and Physical Chemistry will be given--from the gas laws to chemical reactivity, from bond polarity to basic thermodynamics. Find out for yourself why molecular modeling is uniquely effective in engaging students!

Capacity: 50 Fee:

W14: Vernier Hands-on Chemistry with Handhelds

9:00 AM - 12:00 PM BRWN 2125

Dan Holmquist (Vernier Software & Technology, USA)

This hands-on workshop will allow participants to collect and analyze chemistry data using Vernier LabPro with TI graphing calculators and Palm Powered handhelds. Data will be collected using sensors such as Temperature, Pressure, pH, Conductivity, and Colorimeters. A variety of experiments from the popular Vernier lab manuals Chemistry with Calculators and Advanced Chemistry with Vernier will be offered.

Capacity: 40 Fee: \$0

Monday, July 31 afternoon

Plenary Speakers

Monday, July 31 afternoon

1:15 PM - 2:05 PM

L1: A Look at the 'Drivers' of Science Education Reform

Gerald Wheeler (National Science Teachers Association, USA)

Science Education is moving into the spotlight. After "Reading First," "Math Now," we're finally

hearing “Science.” Does this mean that science education has come off the back burner? If it does, we need to be prepared to answer why previous reforms did not “stick.” This presentation will address the necessary components to creating real reform in science education for all our nation’s students.

1:15 PM - 2:05 PM

L2: Beginning Chemistry: Firing Their Imaginations

Richard Zare (Stanford University, USA)

Everyone knows a good teacher, but few know how a teacher becomes good. What are the tricks of the trade? Can they be learned? The need for good chemistry teaching is nowhere more apparent than in beginning courses -- for it is in these courses that students most often decide whether to continue studies in the field or flee to seemingly greener pastures. Thus, the future of the chemical profession is truly in the hands of those who offer introductory chemistry courses. Today, chemistry is more important than ever. Molecular processes form the basis of so much science and technology that is part of the modern world. Yet, while more people do chemistry, a smaller fraction of those who do chemistry call themselves chemists. Why is that so, and what do we wish to do about that fact? How do we capture some of the best and brightest minds to pursue careers in the chemical sciences, whether or not they call themselves chemists? This kickoff lecture will try to provide some answers to these questions. It will be argued that the most important role of an instructor is to inspire rather than to inform.

1:15 PM - 2:05 PM

L3: How To Get Students Actively Involved In Learning, Even If You Have 200 Of Them In The Class

Richard Felder (North Carolina State University,)

If educational researchers agree about nothing else, they agree that people learn best by doing things and reflecting on what they have done, not by watching and listening to someone else telling them what to do. While a good lecture has the power to instruct and even motivate students, if lecturing is the only thing that happens in a class, the chances are that much less learning is happening than would happen if other more active methods were mixed in. The question is, what can instructors do to get students active in class without losing control of the class or of the syllabus, even if the class is large? This interactive presentation describes and illustrates several proven techniques for achieving this goal.

Poster sessions

Monday, July 31 afternoon

6:30 PM - 7:45 PM E Lounge 1st floor Union

Session 1 of 5: 1st Floor Union

Ann Cutler (University of Indianapolis, USA)

Poster presentations provide a unique venue for sharing ideas, learning about creative endeavors from colleagues, and highly personal one-on-one interactions. As such, the 19th BCCE will continue the long standing tradition of holding several poster sessions during the meeting.

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|--------------------|--|
| Kereen Monteyne | T1: Bridging macroscopic- to particulate-level representations of chemical concepts: A divide linked by thinking skills |
| Susan Hershberger | T2: Fiji or tap water? Tanning session or nap? Scrutinize your face or wash your hands? Acidic or basic? |
| Barbara A. Sawrey | T3: Hiring and promotion in chemical education |
| Donna Chamely-Wiik | T4: Integrated honors general chemistry and laboratory course based on a writing across the curriculum, WAC model |
| Leanna Giancarlo | T5: Just-in-time teaching in the chemistry classroom |
| Marcy Towns | T6: Mapping the dimensions of the undergraduate chemistry laboratory: Faculty perspectives on curriculum, pedagogy, and assessment |
| Deepa Perera | T7: PLTL at a small liberal arts institution |
| Rebecca Lindell | T8: Qualitative investigation non-science majors' understanding of spectroscopy |
| Nicole Hume | T9: Qualitative research: Lessons learned while investigating TA development |
| Brittland Winters | T10: Relationships between inquiry-based teaching and beliefs of self-efficacy in high school chemistry |
| Amy Lindsay | T11: Scaffolding in laboratory procedures as a means of promoting higher-order thinking |
| Jacob Schroeder | T12: Science writing heuristic and POGIL in the undergraduate organic chemistry laboratory |
| Forrest Towne | T13: Thinking skills as a predictor of students' ability to understand the macroscopic, particulate, and symbolic representations of matter in general chemistry |
| Laurie Langdon | T14: Use of multiple electronic homework systems in general chemistry: Student and instructor perspectives |
| Joel Detchon | T15: Use of the student assessment of learning gains (SALG) diagnostic tool to compare the responses of peer-led team learning (PLTL) and non-PLTL students |
| Diana Shem | T16: Using metacognitive instruction to enhance mathematical reasoning in introductory chemistry |
| Provi Mayo | T17: What are my students' perceptions of problem-centered lectures in organic chemistry? |
| Pat Meyer | T18: Why are organic chemistry tutoring sessions effective? A study of student performance, opinion, and affect |

T1: Bridging macroscopic- to particulate-level representations of chemical concepts: A divide linked by thinking skills

Kereen Monteyne (California State University Fullerton, USA), Giovanni Avila (California State University Fullerton, USA), Emily Lomont (California State University Fullerton, USA), Natalie Rogers (California State University Fullerton, USA)

Student-centered views of teaching and learning make the fundamental assumption that the student arrives in the classroom with a knowledge and thinking skill set that influences his/her ability to

learn new material. Many research studies have found that students often hold naïve ideas, or misconceptions, that are not congruent with what is currently known. While the nature of student misconceptions has been studied, an important connection between the skill set held by the student and misconceptions has not been extensively considered in the literature. This study examines the relationship between students' thinking skills and their understanding of chemical concepts assessed from both the macroscopic- and particulate-levels. Results of this study will be presented.

T2: Fiji or tap water? Tanning session or nap? Scrutinize your face or wash your hands? Acidic or basic?

Susan Hershberger (Miami University, USA), Lynn Hogue (Miami University, USA), Mickey Sarquis (Miami University, USA)

With all the choices students make everyday, is it surprising the chemistry choices get confusing? Chemistry can inform the personal environmental health choices our students make everyday. As students experiment with drinking water, sunscreens, skin bleaching agents, carbon dioxide, soaps and hand sanitizers they learn chemistry. Students also learn how understanding chemistry can impact the health decisions they make everyday. Stop at our poster to discuss activities to use: personal water choices, UV light protection and healthy skin, indoor air quality, disease transmission and product safety to grab student's attention in chemistry class. These activities are also great chemistry topics for community outreach.

T3: Hiring and promotion in chemical education

Barbara A. Sawrey (UCSD, USA), Christopher Bauer (Univ. of New Hampshire, USA), John Clevenger (Truckee Meadows C. C., U.S.A.), Renee Cole (Central Missouri State University, USA), Loretta Jones (University of Northern Colorado, USA), Paul Kelter (U of Illinois, US of A), Maria Oliver-Hoyo (North Carolina State University, United States)

What does a department need to think about when hiring or promoting a chemical education faculty member? What does a chemical education candidate need to ask when interviewing, or preparing for a promotion? The Division of Chemical Education's Task Force on the Hiring and Promotion in Research, Development, and Practice of Chemical Education will present a proposed list of questions that a department and candidate need to ask themselves when considering such a faculty appointment.

T4: Integrated honors general chemistry and laboratory course based on a writing across the curriculum, WAC model

Donna Chamely-Wiik (Florida Atlantic University, USA), Jeffrey Galin (FAU, USA), Jerome Haky (Florida Atlantic University, USA)

We have developed a model for a new Honors Chemistry course which employs the writing across the curriculum approach. This course will employ writing assignments: 1) in the lecture course which are focused on case studies in chemistry and 2) lab reports that employ critical thinking skills and structured writing in accord with published scientific writing guidelines. In collaboration between faculty members from our colleges of Science and Arts and Letters, we are structuring this course so that it combines the objectives and requirements of both the second semester college writing course and introductory chemistry courses. We intend to use this course as a model upon which to base the improvement of the mainstream General Chemistry course. This will be accomplished by employing aspects of the modified curricula that will be established for the honors course. The structure and specific examples of attributes of this course will be discussed.

T5: Just-in-time teaching in the chemistry classroom

Leanna Giancarlo (University of Mary Washington, USA), Kelli Slunt (University of Mary Washington, USA)

The past decades have seen a shift in pedagogy from “sage on the stage” delivered lectures to “guide by the side,” learner centered methods. Numerous approaches have been employed to help the student to become more of a participant in his/her own learning. Computer-assisted instruction has been at the forefront of these developments due to the organizational and transmission tools launched through classroom management programs. In this presentation, we describe the use of the learner centered approach Just-in-Time Teaching (JiTT). JiTT has been employed, to varying extents, in both the lower (General and Organic) and upper level (Physical and Biochemistry) courses at the University of Mary Washington with a measurable degree of success. This method allows for active engagement of the student in previewing and reviewing course material. For the most part, web-based classroom management systems have been utilized in this approach given their assessment features including the ability to construct quizzes, conduct statistical analyses on class performance, and compile student responses. The use of JiTT, ease of development and its utilization, and the benefits to both the student and the instructor will be discussed.

T6: Mapping the dimensions of the undergraduate chemistry laboratory: Faculty perspectives on curriculum, pedagogy, and assessment

Marcy Towns (Ball State University, USA), **Stacey Lowery Bretz** (Miami University, U.S.A.), Stacey Lowery Bretz (Miami University, U.S.A.), Michael Fay (Miami University, U.S.A.), Nathaniel Grove (Miami University, U.S.A.)

There exists a rich literature regarding the content and pedagogy of laboratory, both in chemistry and in related disciplines such as physics. This poster describes the first phase of research which ultimately seeks to characterize the gap between faculty goals for laboratory learning and the realities of student experiences in the undergraduate lab. Preliminary findings regarding the diversity of faculty goals for the undergraduate laboratory, the array of strategies faculty implement in the name of those goals, and the assessments faculty utilize to measure the extent to which they meet those goals will be presented.

T7: PLTL at a small liberal arts institution

Deepa Perera (Muskingum College, USA)

Peer-Led Team-Learning (PLTL) at a Small Liberal Arts Institution Peer-Led Team-Learning (PLTL) was implemented into both semesters of the General Chemistry curriculum during the 2004-2005 academic year, through a grant received from Workshop Project Associates (WPA), at Muskingum College, in New Concord, OH, a Liberal Arts institution of about 1,600 students. The model consisted of one general chemistry section taught with PLTL and another section taught by the same instructor without PLTL. One other section of general chemistry without PLTL was taught by a different instructor. Preliminary data reveals that there were more A grades in the section that required PLTL compared to the other sections, but this difference may not be statistically significant. (Student profiles, including High School GPA's and ranks, and ACT scores, were used to correct for differences between the students in the sections with and without PLTL. Evaluations of the PLTL experience completed by the general chemistry students revealed a great deal of satisfaction with the experience. PLTL has been continued in the general chemistry curriculum for the 2005-2006 academic year, and the data from this year will be available for

presentation at the end of the spring semester.

T8: Qualitative investigation non-science majors' understanding of spectroscopy

Rebecca Lindell (Southern Illinois University Edwardsville, USA), **Candice Miller** (Edwardsville High School, United States)

Without spectroscopy, scientists would not know nearly as much as they do about the universe. For being so fundamental, college astronomy students often struggle with this concept. Little research has been conducted in this area. Most studies only suggest that misconceptions exist and fail to correlate why students have difficulties in this area. To address this issue, we have performed a qualitative investigation that involves open ended, structured interviews of college astronomy students' understanding of this phenomenon both before and after instruction. These interviews were designed to determine college student's explanations of the cause of spectroscopic phenomena and to determine their understandings of spectral phenomena itself. In this poster we will present the analysis of these interviews revealing information about students' difficulties with this phenomenon.

T9: Qualitative research: Lessons learned while investigating TA development

Nicole Hume (Purdue University, USA)

While investigating the first year experience of teaching assistants in a general chemistry program, several lessons about conducting and designing qualitative research projects were learned. It has been our experience that Likert-scale surveys provide little useful information and offer no explanations for any patterns that may be seen in the data. A Likert-scale survey on self-efficacy, administered at various points in time to the participants, provided virtually no useful information. However, when interviews were conducted with the participants, we learned that the survey served the purpose of prompting the participants to consider the issues of interest at a level they might not have with the interviews alone. The results of this research will be discussed in the context of this qualitative study on teaching assistant training and teaching assistant professionalism.

T10: Relationships between inquiry-based teaching and beliefs of self-efficacy in high school chemistry

Brittland Winters (Grand Valley State University, USA)

Although inquiry instruction is promoted through the National Science Education Standards (NSES), most high school chemistry teachers still rely primarily on lecture/discussion instruction with occasional verification laboratory activities. A new professional development model, known as Target Inquiry (TI), has been designed to encourage and improve inquiry instruction. The study of TI and its impacts includes many measures, one of which examines teachers' beliefs of self-efficacy, a concept developed by Bandura's theory, and another determines the extent to which they use inquiry-based instruction. A correlation between a teacher's efficacy and the use of inquiry-based teaching strategies has already been shown; however, ensuring the construct validity of the overall study of TI calls for the comparison of scores on published instruments designed to measure these two constructs. Therefore, the goal of this study is to compare 10 high school chemistry teachers' sense of self-efficacy as measured by the Science Teacher Efficacy Belief Instrument (STEBI) and the extent to which they use inquiry instruction (as defined in the NSES) as measured by the Reformed Teaching Observation Protocol (RTOP). Results will be presented.

T11: Scaffolding in laboratory procedures as a means of promoting higher-order thinking

Amy Lindsay (University of New Hampshire, USA), Christopher Bauer (Univ. of New Hampshire, USA), Laurie Langdon (University of New Hampshire, USA)

As more inquiry-type investigations have been implemented in the UNH general chemistry laboratory, a need for a different type of note-taking has emerged that allows for more intellectual engagement. Many students have never used a laboratory notebook or have been taught a traditional format containing procedure, data, and conclusions, but no record of their thoughts as they engage in the investigation. In order to facilitate deeper thinking and discussion, we devised a scaffold structure in the written laboratory procedure that prompts students to pause, reflect on, and discuss explanations for their observations, and to plan their next step. Students write summaries of these discussions in their lab notebooks, in addition to recording data and observations. The scaffolding has been implemented for one year. Differences in classroom behavior of students and group dynamics and quality of lab notes and lab reports will be described. In addition, the observations of veteran teaching assistants who taught labs before and after the change have provided feedback on differences in student behavior, lab notes, and reports.

T12: Science writing heuristic and POGIL in the undergraduate organic chemistry laboratory

Jacob Schroeder (Iowa State University, USA)

The Science Writing Heuristic (SWH) is a collaborative inquiry-based format that is consistent with the approach used in POGIL, and is aimed at challenging students to do more than follow a procedure to get an answer in the laboratory setting. Implementation of the SWH in our general chemistry courses has shown significant gains in student test scores and logical reasoning ability. In addition, student attitudes toward laboratory work were generally improved. After being exposed to an inquiry-based lab, many of our general chemistry students enroll in the introductory organic chemistry course, along with a laboratory that follows the cookbook verification model found in most traditional organic chemistry courses. A pilot study analyzing student performance on in-class exams showed that despite being exposed to a concept in the organic laboratory, many students struggle conceptually when asked questions on in-class exams. Owing to the growing amount of criticism the cookbook verification model has been under, we are in the process of reformatting our organic laboratory to follow a POGIL/SWH approach. Specific examples of SWH inquiry-based organic chemistry experiments and sample student laboratory reports will be presented, as well as student performance data on quizzes and exams.

T13: Thinking skills as a predictor of students' ability to understand the macroscopic, particulate, and symbolic representations of matter in general chemistry

Forrest Towne (University of Montana, USA), Mark Cracolice (The University of Montana, USA)

Conceptual understanding of chemistry requires students to relate and understand the macroscopic, particulate, and symbolic representations of matter. However, chemistry instruction, in high school and college, primarily focuses on the symbolic level. Many students are unable to relate the familiar macroscopic world with the abstract symbolic one. This inability to connect the different representations of matter and its transformations is one of the primary reasons for students' difficulties in learning chemistry. This paper investigates the relationship between students' thinking skills and their ability to understand chemistry concepts on these three levels. Our study examined the hypothesis that student's ability to understand concepts at their macroscopic, particulate and symbolic levels are dependent upon their thinking skills. Results of this study will be presented.

T14: Use of multiple electronic homework systems in general chemistry: Student and instructor perspectives

Laurie Langdon (University of New Hampshire, USA), Christopher Bauer (Univ. of New Hampshire, USA)

ChemSkill Builder (CSB) has been used as an electronic homework system in General Chemistry for several years. We recently added a second electronic homework system—WebAssign—to complement (not duplicate) the types of questions and the feedback provided by CSB. Framing the implementation in terms of Bloom's taxonomy, we view CSB as a tool for helping students to learn and practice fundamental skills in a tutorial mode and WebAssign as a tool for encouraging students to apply that knowledge and skills to more difficult problems that are closely tied to those found in their textbook. We will share insights from both students and instructors regarding the use of these two electronic homework systems, including how instructors implemented and how students used each system. In addition, we will provide data regarding student choice of which system counts towards their chemistry grade, as students who used both systems in the Fall semester were provided with a choice in the Spring semester.

T15: Use of the student assessment of learning gains (SALG) diagnostic tool to compare the responses of peer-led team learning (PLTL) and non-PLTL students

Joel Detchon (Miami University, USA), Jerry Sarquis (Miami University, USA)

Historically, the PLTL learning model compares very impressively to the conventional lecture-only format when using such quantifiable measures as end-of-semester grades, ACS general chemistry exam scores, and retention of students. Using SALG, the PLTL model also compares very impressively to the lecture-only format. This poster tabulates the SALG data over several semesters at Miami University.

T16: Using metacognitive instruction to enhance mathematical reasoning in introductory chemistry

Diana Shem (University of Montana, USA), Mark Cracolice (The University of Montana, USA)

The high failure rate in general chemistry has often been attributed to a lack of preparation in mathematics, specifically algebra. Yet students who excel in mathematics do not necessarily excel in chemistry. Thus mathematical reasoning in a science context should be considered a more plausible factor in predicting success in the sciences than general mathematical ability. We propose an instructional method to improve chemistry achievement by targeting mathematical reasoning. IMPROVE, a metacognitive instructional method developed by Mevarech and Kramarski, consists of the following teaching steps: a) introducing new concepts, b) metacognitive questioning, c) practicing, d) reviewing, e) obtaining mastery on lower and higher cognitive processes, f) verification and g) enrichment. Research has shown that students exposed to metacognitive training through IMPROVE outperformed control groups on various measures of mathematics achievement. We will present our plans to implement metacognitive instruction into the introductory chemistry curriculum and the theories explaining why this method should be successful.

T17: What are my students' perceptions of problem-centered lectures in organic chemistry?

Provi Mayo (South Dakota State University, USA)

Organic chemistry has a reputation for being a challenging course with its own language and

culture. Many of the students are taking the course to satisfy a requirement and only the minority is pursuing a major in chemistry. Most organic courses use instructor-centered instruction in which students take a passive role while the instructor lectures and presents problems in lecture. In this project I assessed what was the students' perception of the effect problem-centered lectures in their organic chemistry understanding and learning. I changed the lecture from instructor centered to student centered in the spring semester of a two-semester organic course. Studies have been done in this area but the evaluation has been done by surveys and testing. In order to evaluate the students' experience and perceptions, I performed interviews after the spring semester was completed. The data gathered in these interviews as well as future changes for the spring of 2006 will be presented in this poster. The data gathered from the spring of 2005 was used to modify the problem-centered lectures for the spring of 2006. Some data from the spring 2006 course changes and interviews will also be presented.

T18: Why are organic chemistry tutoring sessions effective? A study of student performance, opinion, and affect

Pat Meyer (Western Michigan University, USA)

A mixed-methods qualitative and quantitative study of two sections of undergraduate organic chemistry with lab was performed to test the effectiveness of tutoring sessions emphasizing key concepts (electronegativity, bonding, acid/base behavior, electron density/resonance, and species stability) and to explore perceived obstacles to success. Statistical analyses of exam scores were performed on control groups and experimental groups in each of the two sections – one a survey course, the other the first semester of a year-long organic chemistry sequence, both taking place at a Midwestern United States Carnegie level one (research doctoral) university. Clinical semi-structured individual interviews were used to probe the subject's study strategies, academic strengths and weaknesses, and beliefs about their learning opportunities and environment. The tutoring method was found to have statistically significant effects in both sections. The guided practice of the application of key ideas was deemed valuable by the subjects. Also of high importance was the opportunity of an open forum to explore the subject with a tutor with whom the give-and-take of academic discourse was seen as less threatening than with the professor. Qualitative data was coded and grouped to illustrate subject perceptions on the role of the teacher and learner, office hours, lectures, labs, textbooks, assignments, peers, exams, studying, and the subject of organic chemistry itself. The investigator succeeded in gaining the confidence of the subjects; therefore these candid opinions may be quite useful to readers involved with designing and modifying organic chemistry courses.

7:50 PM - 9:05 PM E Lounge 1st floor Union

Session 2 of 5: 1st Floor Union

Ann Cutler (University of Indianapolis, USA)

Poster presentations provide a unique venue for sharing ideas, learning about creative endeavors from colleagues, and highly personal one-on-one interactions. As such, the 19th BCCE will continue the long standing tradition of holding several poster sessions during the meeting.

David Cartrette T19: Analysis of the undergraduate organic chemistry experience: A phenomengraphic approach

Nathan Wood T20: Effect of high school chemistry courses on students' attitudes toward science

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|----------------------|---|
| Judith Iriarte-Gross | T21: Effects of ConcepTests and use of student response systems on student understanding and achievement in general chemistry |
| Matthew Nance | T22: Families doing chemistry together |
| Mithra Beikmohamadi | T23: Investigating molecular geometry and visuospatial skills through a web-based VSEPR theory tutorial |
| James Engle | T24: Learning assistants in college chemistry classes |
| Roxanne Finney | T25: Novice categorization of general chemistry problems |
| Jacob Mathew | T26: Online data collection and database development for survey research in chemistry education |
| Kathleen Parson | T27: Overview of DUE programs at NSF |
| Hilary Eppley | T28: Rust, blood, and magnets: A first year interdisciplinary science seminar emphasizing chemistry |
| Darlene Slusher | T29: Study of how the use of a personal response system affects student learning in a general chemistry course |
| Diana McGill | T30: Teacher as the model learner |
| Nancy Grim Hunter | T31: Teacher quality enhancement: The associate of arts in teaching science degree |
| Andrea Martin | T32: Use of a math-pretest as a predictive tool for success in general, organic, and biochemistry for nursing majors |
| Norbert Pienta | T33: Using neural network analysis to probe Lewis structure drawing |
| Laurie Langdon | T34: Validated surveys for assessment of implementations of peer-led team learning (PLTL) and calibrated peer review (CPR) |
| Joseph Grabowski | T35: What is the demand for undergraduate research? A multi-year study of the NSF REU chemistry applicant pool |
| Vickie Williamson | T36: Writing as a tool in teaching undergraduate chemistry |

T19: Analysis of the undergraduate organic chemistry experience: A phenomengraphic approach

David Cartrette (South Dakota State University, United States), Provi Mayo (South Dakota State University, USA)

Even though the literature has covered some aspects of how organic chemistry students learn, there is still a lack of research reports that address this subject area. This presentation will discuss a study which was conducted for one academic year with fifteen participants from two organic courses: chemistry majors and pre-professional majors. During the study, the students were asked general questions about their experiences, learning methods, study habits, and attitude toward the class/instructors. The students were also asked to solve some problems on a variety of topics. Discussion will focus on the data gathered from the interviews, including: the differences in chemistry understanding between groups, what attitudes ensured their success and what students did in order to be successful at problem solving.

T20: Effect of high school chemistry courses on students' attitudes toward science

Nathan Wood (University of Minnesota, USA)

Do high school chemistry courses influence students' attitudes about science? Data are drawn from

a larger evaluation project to explore this question. Differential effects of traditional versus standards-based curricula are examined as well as relationships between achievement and attitudes.

T21: Effects of ConcepTests and use of student response systems on student understanding and achievement in general chemistry

Judith Iriarte-Gross (Middle Tennessee State University, USA), Debra Boehmler (University of Maryland, USA), Diane Bunce (Catholic University of America, USA), Katherine Havanki (Catholic University of America, USA), Maryann M. Jones (University of Maryland, USA)
Many novice students rely on memorization techniques to succeed in general chemistry. This approach to understanding is in contrast with the goal of most general chemistry courses which is to move students from memorization of a laundry list of chemistry topics to a deeper conceptual understanding of chemistry. In an effort to move students towards conceptual understanding, several different teaching innovations such as POGIL, ConcepTests, use of SRS and PLTL, have been used in chemistry courses. In this research project, the effect of two of these innovations, ConcepTests to facilitate conceptual understanding and SRS (clickers) as a technological innovation to deliver ConcepTests were analyzed. A collection of validated ConcepTest questions were developed for a nursing chemistry course and two such questions were used each day in class for a period of 8 weeks. The 56 students in the class used individual radio frequency SRS (clickers) to record their answers to the ConcepTests. Both correct and incorrect answers were discussed in class by the teacher. Students' logic used to determine their answers was surveyed and achievement scores on teacher written tests and a final exam were analyzed. Student attitudinal information was also collected and analyzed. Preliminary results of this study will be presented.

T22: Families doing chemistry together

Matthew Nance (Miami University (Ohio), USA), Lynn Hogue (Miami University, USA), Mickey Sarquis (Miami University, USA)

Have you been looking for ways to encourage parents and caregivers to be involved in their child's education at home and at school? How about doing this with fun and engaging chemistry activities? This poster will feature several of the free activities (downloadable from terrificscience.org) as well as provide ideas, suggestions, and insights for those interested in hosting a Family Science event.

T23: Investigating molecular geometry and visuospatial skills through a web-based VSEPR theory tutorial

Mithra Beikmohamadi (UW - Madison, USA)

In order to foster growth of visuospatial skills, as well as teach Valence Shell Electron Pair Repulsion (VSEPR) Theory, we have developed a web-based tutorial focused on VSEPR Theory for general chemistry students. We intend this tutorial to be a primary learning source, and thus have investigated, and continue to investigate, the ability of this tutorial to teach students to assess the geometry of molecules, as well as to promote development their spatial abilities.

T24: Learning assistants in college chemistry classes

James Engle (The University of Akron, USA), William Donovan (The University of Akron, USA), Pamela Hollinger (The University of Akron, USA), Charles Monroe (The University of Akron, USA)

The University of Akron has a well-established and growing Learning Assistant Program

employing trained undergraduate tutors who assist students in a wide variety of courses. Each learning assistant must complete the course(s) tutored with at least a B+ and complete comprehensive training. We have developed a methodology for determining the effectiveness of the learning assistant in improving student learning in general chemistry and shown that students who use the learning assistant program continued to improve throughout the semester. This poster will discuss the program, student reaction and feedback to the program, and the method findings of the study of student improvement in learning in general chemistry.

T25: Novice categorization of general chemistry problems

Roxanne Finney (University of Northern Colorado, USA), Loretta Jones (University of Northern Colorado, USA), Jerry P. Suits (Univ Northern Colorado, United States)

One distinguishing characteristic between expert and novice problem solvers is that experts tend to conceptually categorize problems as part of the problem-solving process. When asked to categorize problems in an interview setting, experts tend to group problems from similar concepts.

Furthermore, experts tend to label their groups of problems with conceptual terminology, such as “stoichiometry” and “kinetics”. In the same setting, novice problem solvers tend to use non-conceptual categorization schemes to group chemistry problems. In addition, novices tend to label their groups of problems with non-conceptual terminology, such as “bomb calorimeter”, “no math”, or “easy to solve”. Here, we present an investigation into non-conceptual categorization by novice problem solvers. With respect to novices’ tendency to group and describe problems non-conceptually, we will report on the following: the impact of figures and diagrams in the problem statement; whether the problem is algorithmic or conceptual; and the novice’s perception of each problem’s cognitive load.

T26: Online data collection and database development for survey research in chemistry education

Jacob Mathew (Miami University, U.S.A.), Stacey Lowery Bretz (Miami University, U.S.A.), Nathaniel Grove (Miami University, U.S.A.)

The use of surveys in chemistry education research is widespread as such versatile instruments allow researchers to quickly gather large amounts of data regarding many aspects about teaching and learning chemistry. When used on a large scale, however, data entry into a program such as Excel or SPSS can be time consuming and prone to input errors. The current work describes the development of an interactive website and an online database to automate both the data collection and data analysis across multiple institutions. Results of these efforts will be presented regarding the use of CHEMX, an instrument developed to measure students' cognitive expectations with regard to learning chemistry.

T27: Overview of DUE programs at NSF

Kathleen Parson (NSF, U.S.A.), Susan Hixson (National Science Foundation, USA), Hal Richtol (NSF, USA), Harry Ungar (NSF, US)

Undergraduate education is central to the National Science Foundation's mission in human resource development. The Division of Undergraduate Education (DUE) serves as the focal point for agency-wide support for undergraduate education. The program activities of DUE aim to strengthen and continuously improve the vitality of undergraduate education for all students in science, technology, engineering and mathematics (STEM) courses in all U.S. institutions of higher education. This poster includes information on the DUE programs that are most likely be of

interest to chemists involved in undergraduate education, including NSF Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM), a revised program that now supports scholarships for qualified students in all STEM degree programs, and an update on the new Course Curriculum, and Laboratory Improvement (CCLI) solicitation after a full year's cycle of implementation.

T28: Rust, blood, and magnets: A first year interdisciplinary science seminar emphasizing chemistry

Hilary Eppley (DePauw University, USA)

A first year course emphasizing the bioinorganic chemistry, entitled "Rust, Blood, and Magnets," was offered at part of DePauw University's First Year Seminar program. This course was an interdisciplinary science seminar course with a short laboratory period each week. A variety of teaching methods were employed in this course such as a debate and student-led discussion. While quite a bit of the chemistry of transition metals (starting with discussions of atom structure and periodic properties), these ideas were related to geology, physics, astronomy, environmental science, biology, and medicine. The semester was divided up into roughly three equal parts. The first month or so was designed to get students thinking about Fe and its chemistry. After an exam on the first material, we had a period when the students read chapters out of the book *Iron the Universal Element*. and had a series of student led discussions on each topic that included reading assignments, developing and answering discussion questions and recording the group discussion. During the last third of the class, students read a medical non-fiction book about thalassemia and then the students presented their research topics on the role of iron in medical applications. Labs were interspersed throughout the semester including ones that focused on chemistry, biology, biochemistry, and geology. We were able to tackle some very interesting scientific problems such as acid mine drainage, the debate on life on Mars, and the origin of life on Earth that are currently being investigated, and we were able to do it using real scientific literature such as articles from *Nature* and *Science* as well as material aimed more at a non-specialist.

T29: Study of how the use of a personal response system affects student learning in a general chemistry course

Darlene Slusher (Coastal Carolina University, USA), Jason Fuller (Coastal Carolina University, USA), Brett Simpson (Coastal Carolina University, USA)

We compared the learning outcomes of students in a general chemistry section which used a personal response system (clickers) to those in a section without the personal response system. There were roughly 50 students in each section, and an identical set of questions was asked before and after the material was covered in both sections. Performance on specific exam questions linked to these pre- and post-lecture questions was used to quantify the difference between the two sections. Pre-/post-lecture learning gains were calculated for the section with the clickers. We looked for retention of material in the class with the clickers by comparing the short-term gains to performance on related exam questions. We also monitored differences in attendance and student attitudes between the two sections.

T30: Teacher as the model learner

Diana McGill (Northern Kentucky University, USA)

Most often, instructors try to teach material to students merely by presenting the material to be learned. We offer quizzes, homework assignments, study guides, and other aids, but in the end, the

student is expected to learn the material without actually being shown how to learn the material. A different model of teaching was attempted wherein the instructor became a student, learning new material in front of the class. The method first involved the instructor showing the students how to pick and present a topic to the class over a two week period of time. At the conclusion of the first week, the instructor distributed a detailed homework assignment that had to be completed by the end of the two week session. This same process was followed for the second two weeks, but the topic that was chosen was purposely unfamiliar to the instructor. In this way, the instructor demonstrated to the class how to approach the learning of new material. Subsequently, every two weeks, a new student chose a topic, presented the work, led discussions, and wrote and graded a homework assignment. The instructor had to complete homework assignments and submit them to be graded by the student-instructor. Student evaluations reflected a great satisfaction with this classroom method in spite of the very heavy work load.

T31: Teacher quality enhancement: The associate of arts in teaching science degree

Nancy Grim Hunter (Chicago State University, USA)

The Teacher Quality Enhancement Project was instrumental in leading a system-wide group of educators to develop and approve the first Associate of Arts in Teaching Degree in Science in Illinois. The AAT degree model was designed to promote seamless transfers and provide assurance that all candidates are prepared to the same level of standards whether through the community college pipeline or as native university students. This poster will describe the development process, articulation agreements, and unexpected benefits of working across institutional systems to benefit all students across the State of Illinois.

T32: Use of a math-pretest as a predictive tool for success in general, organic, and biochemistry for nursing majors

Andrea Martin (Widener University, USA)

A 20-question math quiz has been developed to test the math skills that appear frequently in chemistry problem-solving. This quiz has been given to incoming freshman students as a pre-test that does not count towards their grade, but which is scored and returned to the students. Students scoring poorly are encouraged to take the test to a math tutor to work on their weaknesses. Based on limited data, there is a small correlation between the math pre-test grades and the final chemistry grades. However, it appears that certain specific questions have higher predictive value. This poster will review the basis for the content of the test and show results for both the test as a whole and for specific questions.

T33: Using neural network analysis to probe Lewis structure drawing

Norbert Pienta (University of Iowa, USA)

Students access a web-based tool and are assigned a formula from which they instructed to draw a Lewis structure. The free-form tool allows atoms, bonds, electrons and charges to be added, moved or deleted. After submission, the tool "grades" the structure and submits the student pathway to a database. The poster includes analysis of these paths use neural network methods.

T34: Validated surveys for assessment of implementations of peer-led team learning (PLTL) and calibrated peer review (CPR)

Laurie Langdon (University of New Hampshire, USA), Christopher Bauer (Univ. of New Hampshire, USA)

Terse, rigorously-validated survey instruments to assess student response to implementations of PLTL and CPR have been developed. This effort was a response to a need to find brief but strong probes regarding student perspectives where many different assessments were being done. These evolved from earlier survey instruments used in these projects and were refined over several years in a large general chemistry course. Factor analysis was used to hone the Likert portions of the surveys. Thematic analysis was used to improve the open-ended portions. Aspects of the development will be presented, and examples of survey use and data for general chemistry will be presented. These instruments are generally useful for any class implementing either instrument. Copies will be available.

T35: What is the demand for undergraduate research? A multi-year study of the NSF REU chemistry applicant pool

Joseph Grabowski (University of Pittsburgh, USA)

The National Science Foundation's REU (Research Experiences for Undergraduates) program has been in existence since 1987 and is an effort to attract undergraduates to careers in science. In 1990 and again in 2001, Workshops of current Chemistry site directors were held to discuss the REU program. Both Workshops resulted in reports while the 2001 Workshop also led to the creation of a Leadership Group (LG) tasked to pursue some of the recommendations and to otherwise advertise, promote and strengthen the REU program in Chemistry. One LG task was to examine the "demand" for Chemistry REU positions. In a pilot year (2001) and for three consecutive years (2003-2005), records on applicants to the nation-wide set of Chemistry REU programs were collected, collated, refined, and analyzed to answer a number of questions including: (1) Do REU site directors all make offers to the same students? (2) How big is the pool of students seeking a Chemistry REU experience? (3) How broadly do students apply for Chemistry REU programs? (4) Do the applicants to REU Chemistry sites attend PUI or RII schools? The data provided will assist the discussion of whether the REU program should be expanded.

T36: Writing as a tool in teaching undergraduate chemistry

Vickie Williamson (Texas A&M University, USA), **Travis Gilbreath** (Texas A&M,)

A large variety of methods and strategies are often used in teaching chemistry. One of the oldest and most integral methods of teaching this subject is writing. Obviously given the importance of writing to the work done by chemists in the field, writing should be a large part of the curriculum in chemistry. However, it can also be important in helping to teach students many of the complex ideas and concepts related to this field. This seminar will present many of the problems and solutions to implementing writing in the chemistry curriculum and detail the importance of the process of writing to learn.

Symposia sessions

Monday, July 31 afternoon

2:15 PM - 5:10 PM STEW 302

S1: About the General Chemistry Laboratory - Session 3 of 4: General

Rudolph W Kluiber (Rutgers University, USA)

General Chemistry Laboratory provides a major hands-on introduction to college chemistry for

many science and engineering students. In practice, the mode of teaching and academic success of this course varies greatly. It is the purpose of this symposium to share course variables such as philosophy, content and execution which can improve a student's interest in, as well as understanding of, chemistry.

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|------|---------------------|--|
| 2:15 | | introduction |
| 2:16 | Guy Ashkenazi | P131: Theory vs. experimental evidence: Undergraduate students' laboratory practice illuminated by the philosophy of science |
| 2:35 | David Sanabria-Ríos | P132: An ethnographic study of how newly designed inquiry-based organic experiments that address different learning styles affect the teaching-learning process in the laboratory course |
| 2:55 | Dan Bedgood | P133: Ideals for chemistry laboratories - a project to improve the learning environment for all students |
| 3:15 | | break |
| 3:25 | Michael Columbia | P134: Combining colligative properties and statistical evaluation in the General Chemistry Laboratory |
| 3:45 | Estel Sprague | P135: Web-based storage, manipulation, and sharing of electronic data from the chemistry lab. |
| 4:05 | Amy Lindsay | P136: Implementation of group lab reports |
| 4:25 | Michael Jordan | P137: Writing and self-publishing a laboratory manual |
| 4:45 | E. Christian Wells | P138: Archaeology through soil chemistry, soil chemistry through archaeology: Interdisciplinary approaches to teaching |

P131: Theory vs. experimental evidence: Undergraduate students' laboratory practice illuminated by the philosophy of science

Guy Ashkenazi (Hebrew University of Jerusalem, Israel), **Rachel Havdala** (The Hebrew University of Jerusalem, Israel)

Students' ideas about the nature of science, either explicit or tacit, may guide the way they learn science and influence their response to classroom events. In the philosophy of science there are trends which apply different relative weights to theoretical knowledge claims vs. experimental knowledge claims, as the source of knowledge and as means for justification of knowing. This study investigates the interplay between students' bias for theory vs. experimental evidence, and their performance in lab activities. Our findings show that this 'personal philosophy' plays an important role in their lab performance – for example in the way they draw conclusions in a case where the experimental results contradicted the expected outcome.

P132: An ethnographic study of how newly designed inquiry-based organic experiments that address different learning styles affect the teaching-learning process in the laboratory course

David Sanabria-Ríos (University of Puerto Rico-Ríos Piedras Campus, Puerto Rico), Ingrid Montes (University of Puerto Rico-Rio Piedras Campus, USA)

Many controlled studies have been reported about the effects that nontraditional laboratory experiences (open-inquiry, guided-inquiry and problem-based) have in the improvement of the teaching-learning process. It is well documented that these nontraditional experiences promote the

development of higher order cognitive skills. However, no ethnographic studies related to how newly design inquiry-based experiments that address different learning styles affect the teaching-learning process have been reported to date. Our hypothesis is that inquiry-based laboratory experiences that address different learning styles affect positively the teaching-learning process in the organic chemistry laboratory course. With these experiences, we performed an ethnographic study of how the students with different learning styles respond toward this type of experience. Due to the limitation of not having a control group, an ethnographic framework was selected for this qualitative study. This study includes different qualitative data collection methods to generate results that have internal and external validity, where triangulation was selected as a cross-validation method. This method correlates data obtained from qualitative data such as critical comparative essays, scores in exams/quizzes, one-minute papers and interviews. In this way, we can perform a general description about how the students' learning styles affect the students' achievement in the laboratory course and perhaps the teaching-learning process. Some interesting results will be discussed.

P133: Ideals for chemistry laboratories - a project to improve the learning environment for all students

Dan Bedgood (Charles Sturt University, Australia)

The Chemistry Teaching Team (CTT) has engaged in an action research project to improve the learning environment in first year laboratories at Charles Sturt University. This presentation will introduce the core ideals devised as reasons to teach laboratories, the process by which we have evaluated the learning environment present in our laboratories, changes we have made, and results of evaluation of the changes.

P134: Combining colligative properties and statistical evaluation in the General Chemistry Laboratory

Michael Columbia (Indiana University Purdue University Fort Wayne, USA)

General chemistry courses for science and engineering majors are under constant pressure to expand content to include meaningful coverage of ancillary material while not sacrificing attention to core concepts. An effective way to deal with these demands lies in the modification of existing experiments to highlight multiple concepts. This presentation will describe such an experiment based on molecular weight determination using the colligative property of freezing point depression. This experiment had already been adapted to utilize a digital data acquisition system described at the 2004 BCCE; using that system, students perform the same experiment using varying data sampling rates and periods, then download their results to a searchable database. Outside of lab, the students mine the data to determine the effect of these experimental parameters on the accuracy and precision of the molecular weight determined. The exercise continues to emphasize the original chemical concept while introducing students to database searching techniques and statistical optimization of experimental parameters.

P135: Web-based storage, manipulation, and sharing of electronic data from the chemistry lab.

Estel Sprague (University of Cincinnati, USA)

The purpose of this presentation is to describe a convenient system for storing, manipulating, and sharing the large amounts of electronic data often generated in modern chemistry lab experiments using MeasureNet® data collection equipment. The system allows data sets to be easily and

automatically uploaded directly from the laboratory into one or several individual, password-protected student accounts on a remote server. Students retrieve their uploaded data sets later using any web-connected computer. When desired, the instructor can provide data analysis assistance by means of Excel workbooks containing macros written for specific types of data. Sharing of data by groups of students is greatly facilitated, since data sets can be saved for all members of a group, giving each student access to all of the data sets uploaded by the group. Illustrative examples of the use of this system will be presented.

P136: Implementation of group lab reports

Amy Lindsay (University of New Hampshire, USA), Christopher Bauer (Univ. of New Hampshire, USA), Laurie Langdon (University of New Hampshire, USA)

Guided inquiry labs often involve students in group discussion and group work. As a natural extension, we have experimented with group lab reports in which the students use their collective data to create a single report. This creates an opportunity for social loafing, where some group members slack off and others continue to do most of the thinking and writing. To counter this, we have explored various ways to include individual accountability- from anonymous evaluations of team members to completion and sign-off on a participation grid submitted along with the report with consequences for non-participation. A modified grading rubric (without answers) presents the evaluation criteria and is used to prepare their report. Students and teaching assistants were surveyed and interviewed. In many cases, both groups have previous experience with individually-written reports with which to compare to the group approach. Data were gathered on ways students shared their responsibilities and how they produced their reports.

P137: Writing and self-publishing a laboratory manual

Michael Jordan (Oklahoma Baptist University, USA)

Currently, it is possible for most people to develop their own lab manual using the technology in their offices. In the past, it has been common to produce lab manuals for use in-house, but the distribution of such works more widely has been difficult. The arrival of publish-on-demand companies has opened up new ways to distribute published works, however. The development of a general chemistry laboratory manual, its production, and its distribution in electronic and printed format will be discussed.

P138: Archaeology through soil chemistry, soil chemistry through archaeology: Interdisciplinary approaches to teaching

E. Christian Wells (University of South Florida, USA), Donald Storer (Southern State Community College, USA)

By answering social science questions using natural science methods, archaeology maintains an inimitable position in the academic world, because it provides information at a scale and resolution that allows us to address problems transcending the narrow confines of unidisciplinary research. Rapid advancements in chemistry and analytical instrumentation over the past decade have enabled archaeologists to offer unique and compelling arguments about human/environment interplays in prehistory. This paper describes the ways in which two college professors—one an archaeologist and one a chemist—collaborate in the field of archaeological soil chemistry in the context of teaching and learning.

2:15 PM - 5:00 PM STEW 310

S18: Best Practices in e-learning Design and Delivery. - Session 1 of 2

Nancy Konigsberg Kerner (University of Michigan, USA)

Faculty and students are realizing the benefits of technology in the learning experience and improvement of learning. What lessons have we learned relative to effective implementation of technology? This session will offer practical tips for teaching with technology to enhance student learning based on your experiences. Sources of high quality materials with documented learning outcomes will also be shared.

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|------|-----------------|--|
| 2:15 | | introduction |
| 2:20 | Prem Sattsaangi | P139: Choosing and using web resources for teaching general chemistry |
| 2:40 | Keith Anliker | P140: Creating web-ready movies to model problem solving strategies |
| 3:00 | Zangyuan Own | P141: Integrating the theory of Multiple Intelligences in the chemical web course to improve student learning achievements |
| 3:20 | | break |
| 3:30 | Mark Ott | P142: Podcasts, screencasts, and blogs: Using new technology in the teaching of chemistry |
| 3:50 | Conrad Trumbore | P143: Tools for testing comprehension of interactive animations |
| 4:10 | Michael Abraham | P144: Laboratory experiments at the molecular level using computer simulations |
| 4:30 | | discussion |

P139: Choosing and using web resources for teaching general chemistry

Prem Sattsaangi (PennState Univ. Eberly Campus, USA)

Availability of peer reviewed on-Line teaching and learning materials has been of great help in teaching freshmen general chemistry classes and making them more interesting. However, simply supplying the student the link to the website of the material does not work. Best practices leading to amalgamation of the online material into the curriculum will be discussed. A brief list of most useful general chemistry links available on MERLOT will be shared and their merits will be explained. Highlights of a few criteria that I use in selecting or developing my own online materials will be provided.

P140: Creating web-ready movies to model problem solving strategies

Keith Anliker (IUPUI (Indiana Univ.-Purdue Univ. Indianapolis), USA)

Macromedia Captivate is a software package that allows relatively easy creation of short, web-ready movies. Using this package on a tablet PC allows me to create “chalk talks” with an audio track that students can access from my course web site. In addition to modeling problem solving approaches, movies have been used to discuss syllabus details and to deliver other technical and administrative information to the students outside of the normal class period. Students with varied learning styles and backgrounds like this delivery method because they can pause, rewind and review the information being presented when they are struggling with a concept, or they can fast forward or skip ahead if they are already familiar with the content. This session will describe features and use of the software, design and production considerations, student feedback and

implementation of this technology in my elementary chemistry course.

P141: Integrating the theory of Multiple Intelligences in the chemical web course to improve student learning achievements

Zangyuan Own (Providence University, Taiwan)

The purpose of this study is to set up a tele-education chemistry learning environment on the web that is based on multiple intelligences (MI) theory, as applied to the internet. We are trying to find out the most suitable web design style for the students. Students of this experiment are divided into two groups of learning environments, i.e. the Multiple Intelligences learning web site and general learning web site. The students' cognitive style and Multiple Intelligences are identified by questionnaire. The ACS test and SPSS are used as research tools to analyse the data obtained. After analyzing all the factors, we discovered that MI web-based learning site has very positive effects on student learning, especially field-independent students shown better achievements in the MI learning environment web site.

P142: Podcasts, screencasts, and blogs: Using new technology in the teaching of chemistry

Mark Ott (Jackson Community College, USA), Jean-Claude Bradley (Drexel University, USA)

In recent times, the internet and podcasting have made quite an impact on the digital society. The concept of on-demand downloading of audio and video information using software such as iTunes has made it such that anyone can get digital content of almost anything, from sports, news, etc. Higher education is starting to embrace this medium for the delivery of educational material. For many years, tutorials and even lectures notes for specific courses have been appearing on the internet. But now the technology has presented itself to allow for much smoother dissemination of audio, video and other educational pieces to augment the traditional lecture style class. The authors will present two different yet effective uses of this technology. In one case, live lectures have been completely removed, with recorded lectures from previous semesters being assigned outside of class and the 'lecture' time then being used for workshops and discussions. See <http://chem241.wikispaces.com/> In another example, pre-recorded screencasts of lecture material are made available before (and after) the traditional lecture. Since they are pre-recorded, these screencasts are much shorter and are meant to augment, instead of supplement, the material presented in lecture. They are also broken up into logical bite-size chunks for ease in navigation. See <http://docott.com/files.141/screencasts/> for examples. These examples will be shown and their advantages and disadvantages will also be briefly discussed. Focus will be placed on the simplicity of the required tools and implications for higher education.

P143: Tools for testing comprehension of interactive animations

Conrad Trumbore (Univ. of Delaware, United States)

Interactive animations help convert viewers into learners. However, students still can miss important lessons offered by an effective animation without prompt challenge and feedback on what they have learned. An interactive, cutting-edge question format incorporating both essay and multiple-choice questions allows an immediate, in-depth study of the highly-interactive animations contained in our Contemporary Chemistry Project (<http://contemporarychemistry.com/> ; username: conrad ; password: chemistry). These questions and animations serve as effective tools for classroom lecture as well as student group discussions. A custom slideshow tool has been developed that is based on a new database consisting of the animations taken from our Project and contains custom, as well as previously-prepared, essay and multiple choice questions. Optional,

text-based popup information windows can be created to accompany animations. Slideshows created with this tool can be used either in the classroom in a lecture or a small group format, or they can be delivered over the Web to the student's computer to preview or review a lecture, deliver graded homework, a quiz, and a complex set of instructions or a message to students. A sample slideshow is found at: <http://contemporarychemistry.com/protected/slideshow/viewer.swf> (username: conrad ; password: chemistry ; slideshow title: Sample)

P144: Laboratory experiments at the molecular level using computer simulations

Michael Abraham (University of Oklahoma, USA), John Gelder (Oklahoma State University, United States), Kirk Haines (osu, usa)

This talk will present and discuss the MoLEs (Molecular Level Laboratory Experiments) project. This NSF supported project uses computer simulations that model and link chemical phenomena at macroscopic, microscopic and symbolic levels. The simulations are written in JAVA and are accessed by students through a web browser. This software is used in conjunction with laboratory activities developed within the framework of a guided and open inquiry instructional strategy (the learning cycle approach). Features of the software and companion laboratory activities will be demonstrated.

2:15 PM - 5:10 PM STEW 202

S8: Biochemistry: The Science of Life - Session 2 of 2

Kari Clase (Purdue University, USA), **Anna Wilson** (Purdue University, USA)

Biochemistry is the union of biology and chemistry. Teachers from each field of study can benefit from recognizing how features from the other discipline help clarify and explain the various topics they teach. This symposium brings together instructors from all three disciplines--biochemistry, biology, and chemistry--to discuss what each discipline contributes to improving how we present concepts and materials to students. Examples from lecture topics and lab experiments that unite the three disciplines will be presented.

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|-----------------------|---|
| 2:15 | introduction |
| 2:20 Darren Stoub | P145: Discovery based laboratory projects in the Biochemistry laboratory |
| 2:40 Amber Charlebois | P146: Using undergraduate student research as an enhancement to the Biochemistry laboratory program |
| 3:00 Anna Wilson | P147: Why use commercial kits for lab exercises? |
| 3:20 | break |
| 3:30 Matthew Fisher | P148: Public health issues as a framework for connecting the Bio-, the – Chemistry, and other disciplines |
| 3:50 Kari Clase | P149: Integration of Biology, Biochemistry and Technology into an inquiry-based undergraduate Biotechnology Program |
| 4:10 | discussion |

P145: Discovery based laboratory projects in the Biochemistry laboratory

Darren Stoub (Rollins College, USA)

Discovery-based laboratory projects are common in lower division chemistry courses; however, due to the complexity and time constraints of many biochemistry experiments, such projects are

less common in the biochemistry laboratory courses. In this presentation, we will discuss the pros and cons of using and designing discovery-based or student-initiated laboratory projects in the biochemistry laboratory. Two such projects will be discussed: Probing the structure of DNA using DNA melting experiments and Investigation of Michaelis Menton rate constants on student designed point mutants of cAMP-dependent Protein Kinase (PKA).

P146: Using undergraduate student research as an enhancement to the Biochemistry laboratory program

Amber Charlebois (William Paterson University, USA)

Our university requires a senior level, one-semester research course, in which students chose a mentor and a project that they can complete during that semester. As a relatively new faculty member, I am interested in the development of new laboratory experiments for the biochemistry curriculum. I can simultaneously pursue both of these independent goals by offering the research students the opportunity to assist in the development of new undergraduate laboratory experiments. This arrangement allows the biochemistry program to continually grow and improve. The students also benefit from this in the following ways. Their project is “do-able” during the one semester course so they can be involved in the project from start to finish and take pride in the completion of the entire process. They take ownership of the project and are able to take it as far as they want. Finally the students provide a service to the university and to future students by enhancing the curriculum. I would like share two such projects that display the synergy between biology and chemistry. First is a DNA enzyme kinetic experiment and the second is exploration of the 3-D structure of a protein using HPLC.

P147: Why use commercial kits for lab exercises?

Anna Wilson (Purdue University, USA), Kari Clase (Purdue University, USA), Susan Karcher (Purdue University, USA)

Have you ever wanted or needed to use an experiment on a topic that you are not really knowledgeable about? Do you run out of time to prepare for an experiment and test it? One solution is to use a commercially available kit. An increasing number of companies sell kits that will supply the essential reagents and some of the disposable equipment needed for a complete laboratory exercise. If you are a Chemistry instructor who needs to present an experiment on Molecular Biology, this is an easy solution. We have taught laboratory classes for many years and have found that the commercial kits are very useful, helpful, and informative. If your lab isn't set up to prepare specialized material for experiments in other disciplines, this is the easy way to be ready. Most kits have detailed procedures, explanations, and student questions. What has been your experience with kits? This session will conclude with a general discussion among participants.

P148: Public health issues as a framework for connecting the Bio-, the –Chemistry, and other disciplines

Matthew Fisher (Saint Vincent College , USA)

Public health issues offer a unique and powerful framework to help students develop a better understanding of how two different disciplines – biology and chemistry – can inform and interact with each other to address societal challenges. I will provide an overview of how the two semester biochemistry sequence offered by the Chemistry Department at Saint Vincent College has been revised so that specific public health topics serve as both context and illustrative examples of traditional biochemistry content. Specific public health issues that are now examined in the course

include Alzheimer's Disease, diabetes/obesity, influenza pandemics and vaccine/antiviral development, tuberculosis, alcohol, and environmental factors related to cancer. Illustrative examples used in class as well as student assignments will be described. Finally, the incorporation of public health issues into the course has provided new opportunities to connect the study of biochemistry with courses outside the sciences that our students take. Some examples of these interdisciplinary and integrative connections will be described.

P149: Integration of Biology, Biochemistry and Technology into an inquiry-based undergraduate Biotechnology Program

Kari Clase (Purdue University, USA)

This paper will discuss the implementation of an interdisciplinary academic minor in biotechnology developed by the Department of Industrial Technology. This interdisciplinary biotechnology initiative is the result of a partnership among the College of Pharmacy, the College of Science, and the College of Technology. The purpose of the minor is to offer the graduates of these four-year programs the basic knowledge and understanding of life-science based products, processes, and product quality to seek employment opportunities in the area of biotechnology and biomanufacturing. Three courses within the biotechnology minor have been designed by faculty within the Department of Industrial Technology: Biotechnology Laboratory I, Biotechnology Laboratory II, and Introduction to Bioinformatics. The objectives of this paper are to describe the implementation and design of the new curriculum that reflects the integration of science and technology. Studies have shown that by actively engaging undergraduate students in research, their retention of scientific principles and learning retention increases. The educational objective of the biotechnology program is to create an interactive classroom learning environment and immerse undergraduate students within action-based research.

2:15 PM - 5:00 PM STEW 214C

S19: Chemistry Educators and Nanotechnology Development - Session 1 of 2

Lon Porter (Wabash College, USA), *Alireza Mansoub Basiri* (Farda Institute, Iran)

Educators play an important role in the development of new technology because they can positively affect students who may become the managers or policy makers in new technologies. We are now in the first step of nanotechnology development. If we help students understand what nanotechnology is and how it can affect their lives, we help improve nanotechnology development. This symposium will show how chemistry educators can acquaint their students with nanotechnology concepts such as manipulation and the nano scale and also generate informed interest in nanotechnology.

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|--------------------------|---|
| 2:15 | introduction |
| 2:20 Shanna Daly | P150: The NanoKids project |
| 2:40 Russell Larsen | P151: Navigating the labyrinth of nanotechnology |
| 3:00 William Vitori | P152: High school experiments in nanotechnology |
| 3:20 Jacqueline Whitling | P153: Nanotechnology laboratory modules in the undergraduate chemistry curriculum |
| 3:40 | discussion |

P150: The NanoKids project

Shanna Daly (Purdue University, USA)

James Tour's NanoKids project includes two animated video segments on DVD; an interactive CD with an electronic workbook and games for kids, and guidebooks for teachers and parents. This nanoscience educational package has been implemented in a number of middle schools over the past few years. The most recent data gathered from both the teachers and the students include information on their perceptions of the materials and how using these materials in the science classroom affect their views and understanding about science. This presentation will include a brief overview of the NanoKids materials, as well a discussion of the data from the most recent evaluation of the project.

P151: Navigating the labyrinth of nanotechnology

Russell Larsen (University of Iowa, USA)

Looking over the diverse set of applications that are being impacted by nanotechnology, at first it seems that it should be easy to find nuggets of nanotechnology that will serve to enrich the curriculum. However, to science educators the enormous scope of nanotechnology may sometimes seem more like a labyrinth than a goldmine. If the labyrinth is to be navigated, maps are needed that detail both nanoscience education objectives and their relationship to the other objectives of the chemistry program. To illustrate such a mapping, one example of how aspects of nanotechnology were incorporated into several levels of the chemistry curriculum in a large university setting using hands on activities and laboratory experiments will be presented.

P152: High school experiments in nanotechnology

William Vitori (Elizabeth Forward High School, USA)

This paper will show how a high school science teacher can investigate and perform "nanotech" activities in a high school science lab. These activities include: (1) the construction of dye-sensitized nanocrystalline solar cells, (2) the synthesis of ferrofluids, and (3) the creation of gold nanoparticle solutions. This information is meant to enlighten and apprise high school students of today's advanced technology and its relevance to modern society. A CD will be provide of these activities will be provided to participants.

P153: Nanotechnology laboratory modules in the undergraduate chemistry curriculum

Jacqueline Whiting (Lock Haven University, USA)

Through a Pennsylvania statewide collaborative initiative, nanotechnology education is being offered to students at the high school level, two-year colleges, and four-year institutions. These experiences constitute a variety of curricular and degree options, which include training at The Pennsylvania State University's Nanofabrication Manufacturing Technology Center. In an effort to introduce all undergraduates to nanotechnology, several upper division laboratory modules have been developed and integrated into the curriculum in both physics and chemistry. At Lock Haven University of Pennsylvania, one module, "Citrate Capped Gold Nanoparticles as Electrolyte Sensors" has been developed and tested in the biochemistry laboratory. A second module, "DNA Self Assembly and Hybridization on Gold", has been developed and will be piloted in the biochemistry laboratory (spring 2006). These modules have proved to be an effective method of increasing student interest in nanotechnology and for many students it has been their first introduction to this subject. Pre- and Post-lab questions indicate that students have a better understanding of the definition of nanotechnology and other related terms. Students are also more familiar with the applications of nanotechnology in a variety of scientific disciplines. These

modules have also been provided as kits to six other universities in the Pennsylvania State System of Higher Education and piloted with upper-level science students.

2:15 PM - 5:00 PM STEW 214D

S20: Chemistry from the Farmland - Session 1 of 1

Terry Brase (AgrowKnowledge, USA)

Agriculture is not often thought of as part of the chemical industry. When agriculture and chemistry are linked, it is often in a negative light. However, chemistry is an inherent part of agriculture, from the nutrients in the soil that producers must measure for efficient crop production, to the nutrient value of feedstuff in a livestock ration, and to the new low environmental-impact herbicides. Agriculturalists must have a fundamental knowledge of chemistry. This symposium will provide a basic understanding of the ways in which chemistry is used in agriculture and it will review curriculum materials that are available and discuss how high school and college chemistry faculty can work with agriculture faculty.

2:15 introduction

2:20 Donald Storer P154: The Chemistry of Soil Analysis: An instructional resource on soil analysis for agronomic purposes.

2:45 Terry Brase P155: Potential Collaboration between Agriculture Science and Chemistry Instructors

3:10 Bryan May P156: The Chemistry of Recirculating Aquaculture Systems

3:35 discussion

P154: The Chemistry of Soil Analysis: An instructional resource on soil analysis for agronomic purposes.

Donald Storer (Southern State Community College, USA)

A new book offering chemical technology educators with nine investigations covering the basics of soil analysis for agronomic purposes will be discussed. The book and accompanying CD were developed through the Partnership for the Advancement of Chemical Technology (PACT) project at the Center for Chemistry Education, Miami University, Middletown. Many of the procedures in this book reflect, or are modified from, actual industry procedures and are designed to teach soil analysis techniques while avoiding expensive instrumentation. The investigations include background information, material lists, step-by-step procedures, applicable calculations, and review questions.

P155: Potential Collaboration between Agriculture Science and Chemistry Instructors

Terry Brase (AgrowKnowledge, USA)

The chemistry that is inherent in agriculture should require that the current agriculture workforce have a strong fundamental knowledge of chemistry. Though bachelor degrees commonly require chemistry, only recently have technician level college agricultural programs started to require chemistry within a program of study. This presentation will provide an overview of the need for chemistry in technician education, ways of incorporating more chemistry into agricultural programs, and ways in which agriculture instructors can collaborate with their chemistry counterparts to make chemistry concepts more contextual

P156: The Chemistry of Recirculating Aquaculture Systems

Bryan May (Central Carolina Technical College, US)

Aquaculture is an important industry that is growing all over the country. Aquaculture can serve as an interesting and relevant topic of study in any science classroom. In particular recirculating aquaculture systems are ideal for educational purposes. The chemistry of these systems will be explained with particular emphasis placed on illustrating how these concepts can be utilized in the classroom and laboratory.

2:15 PM - 5:00 PM STEW 218AB

S21: Crystallographic Education-Applications and Methodologies - Session 1 of 1

Phillip Fanwick (Purdue University, USA)

X-ray diffraction methods as routine parts of a structural analysis repertoire have rapidly increased from a small molecule base to disciplines as diverse as structural biology and materials science. In spite of this growth in crystallography as a suite of research tools, education in crystallography remains scarce and out of the main stream. While there are many historical reasons for this situation, recent advances in hardware, software, and pedagogy mean that it is no longer warranted. This session will deal with ways in which single crystal and powder diffraction methods using X-rays, electrons, neutrons, and even whole molecules can be placed into the undergraduate curriculum. Special emphasis will be placed on what is currently being done in settings ranging from modules inserted into the freshman chemistry classes through dedicated lab-based courses. In addition, creative approaches for teaching diffraction methods will be presented ranging from single photon diffraction experiments through the Reciprocal Net distributed database.

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|------|--------------------|---|
| 2:15 | | introduction |
| 2:20 | Allen Hunter | P157: A review of the crystallographic/diffraction education literature |
| 2:40 | Phillip Fanwick | P158: Observations on Crystallographic Education |
| 3:00 | Jason Vohs | P159: Crystallography for undergrads: How computer software and collaborations can make it happen at a small college |
| 3:20 | Gary Trammell | P160: Applications of Powder X-Ray Diffractometry in Sophomore Organic Chemistry Laboratory: Host-Guest Chemistry of Urea Inclusion Compounds |
| 3:40 | | break |
| 3:50 | Eric J. Voss | P161: Powder X-ray Diffraction in the General Chemistry Laboratory |
| 4:10 | Maren Pink | P162: The Reciprocal Net – Web activities and tutorials utilizing our collection of molecules |
| 4:30 | Allen Hunter | P163: The STaRBURSTT - CyberDiffraction Consortium - Hands On Crystallography for Everyone |
| 4:50 | | panel discussion |

P157: A review of the crystallographic/diffraction education literature

Allen Hunter (Youngstown State University, USA)

Recent advances in crystallographic theory and software and data collection and computational hardware have facilitated the introduction of crystallographic/diffraction topics into an increasingly

broad array of instructional settings. These settings range from dedicated graduate level courses through modules suitable for preschool children. The Youngstown State University and Muskingum College hubs of the STaRBURSTT CyberDiffraction Consortium has been very active in developing, testing, and disseminating such educational materials. In excess of 500 papers have been published on the teaching of crystallography and diffraction methods. In spite of this, no comprehensive annotated review of this crystallographic/diffraction education literature is available. In this presentation, we report the results of such a review. Suggestions for areas where crystallography/diffraction methods topics are underutilized in the curriculum and for which new education research and materials development are needed will be presented.

P158: Observations on Crystallographic Education

Phillip Fanwick (Purdue University, USA)

There is little question that the two most widely used analytical chemistry techniques during the last fifty years are NMR and crystallography. While NMR has become an integral part of undergraduate chemistry education, crystallography has been largely ignored in this curriculum. Students get little instruction in the requirements, strength and weakness of crystallography or in interpreting crystallographic results. This is even more ironic in that crystallographic analysis today is easier and faster than ever. Reasons for why crystallography has been excluded, suggestions for what should be included and ideas on how various crystallographic concepts can be related to current chemical education will be presented.

P159: Crystallography for undergrads: How computer software and collaborations can make it happen at a small college

Jason Vohs (Saint Vincent College, US), Jennifer Aitken (Duquesne University, US)

Single crystal X-ray diffraction is essentially a required component to most synthetic endeavors in inorganic and materials chemistry. As such, undergraduate students should be exposed to this method both in terms of the theory behind it and in practical experience with data collection and structural solutions. To this end, the theory and practice of X-ray crystallography was presented to junior and senior undergraduate students in a 10 week special topics course at Saint Vincent College. Principles of X-ray generation and safety, lattice types, and crystallographic symmetry and space groups were presented along with hands-on data collection and structural solution experience made possible by collaboration with nearby Duquesne University. Herein is presented a summary of the course content, student hands-on activities, media resources, and a description of the collaborative activities that took place at Duquesne University.

P160: Applications of Powder X-Ray Diffractometry in Sophomore Organic Chemistry Laboratory: Host-Guest Chemistry of Urea Inclusion Compounds

Gary Trammell (University of Illinois at Springfield, USA), Harshavardhan Bapat (University of Illinois at Springfield, USA), Keenan Dungey (University of Illinois at Springfield, USA), Julia Edwards (Illinois State University,), Wayne Gade (University of Illinois at Springfield, USA), Rhet Gairani (University of Illinois at Springfield,), Eric Malina (Southern Illinois Univ. Edwardsville, USA), Masangu Shabangi (Southern Illinois University Edwardsville, USA), Michael Shaw (Southern Illinois University Edwardsville, USA), Eric J. Voss (Southern Illinois University Edwardsville, USA), Susan Wiediger (Southern Illinois University Edwardsville, USA) X-ray diffraction (XRD) is an extremely powerful tool for characterizing organic molecules, yet it has found little place in the standard undergraduate organic chemistry curriculum. Thanks to a NSF

CCLI/A&I grant, the University of Illinois at Springfield and Southern Illinois University Edwardsville were able to purchase Rigaku/MS MiniFlex+ powder X-ray diffractometers and collaborate in developing activities to incorporate solid-state chemistry throughout the curriculum. In my second semester organic chemistry course students prepare a variety of urea inclusion compounds to explore the steric requirements for the guest molecules. The crystalline products are characterized by a variety of methods including IR, NMR, crystal morphology and powder XRD. The stoichiometry of the host/guest molecules is also determined. Student results of this experiment and an assessment of their understanding of X-ray diffraction will be presented.

P161: Powder X-ray Diffraction in the General Chemistry Laboratory

Eric J. Voss (Southern Illinois University Edwardsville, USA), Harshavardhan Bapat (University of Illinois at Springfield, USA), Keenan Dungey (University of Illinois at Springfield, USA), Wayne Gade (University of Illinois at Springfield, USA), Eric Malina (Southern Illinois Univ. Edwardsville, USA), Masangu Shabangi (Southern Illinois University Edwardsville, USA), Michael Shaw (Southern Illinois University Edwardsville, USA), Gary Trammell (University of Illinois at Springfield, USA), Susan Wiediger (Southern Illinois University Edwardsville, USA) Although elementary X-ray diffraction theory is often covered in general chemistry courses, actual student use of diffractometers is rare, especially in introductory laboratories. Hands-on powder X-ray diffraction experiments have been incorporated into general chemistry courses at Southern Illinois University Edwardsville (SIUE) and the University of Illinois at Springfield (UIS) in an NSF-sponsored project using “Twin” Rigaku/MS MiniFlex+ powder X-ray diffractometers. First-year students at SIUE and UIS synthesize compounds, load samples, collect diffraction data, plot powder patterns, and analyze results. Simple instrument design, automated sample changers, and user-friendly software allow high throughput of samples in a short period of time. Over the past year, over 1000 general chemistry students have performed hands-on powder X-ray diffraction analysis of their own samples. Experimental details, strategies for managing multiple laboratory sections, the preparation of teaching assistants, training of students on instrument use, and results from student assessment will be presented.

P162: The Reciprocal Net – Web activities and tutorials utilizing our collection of molecules

Maren Pink (Indiana University, USA)

The well-established Reciprocal Net, funded by the DUE at NSF, is a distributed molecular database that allows researchers to have immediate access to their crystallographic results and provides for the exchange of crystallographic results among laboratories. Currently, 18 laboratories in the U.S. and abroad are using the software in their daily operations. Reciprocal Net also offers online information and tutorials to students of all ages and the interested public. Parts of the didactic effort of the Reciprocal Net are the Common Molecules Collection (part of the National Science Digital Library), a Symmetry Tutorial, and, most recently, web activities describing “chemicals” found in house and garden. Additional content and web development is underway for educational pages on crystallization, crystallography, and structural chemistry. Reciprocal Net and its associated interactive web applications provide an ideal base for students to explore crystal structures. The collection and web activities design around it will be discussed.

P163: The STaRBURSTT - CyberDiffraction Consortium - Hands On Crystallography for Everyone

Allen Hunter (Youngstown State University, USA)

Continuing advances in hardware and software are making it increasingly easy to both collect and process data from single crystal diffractometers and integrate it into the undergraduate curriculum. This presentation will emphasize a range of new curriculum materials developed and tested by members of the STaRBURSTT CyberDiffraction Consortium (i.e., Science Teaching and Research Brings Undergraduate Research Strengths Through Technology - CyberDiffraction Consortium), including: computer labs on structure determination, local and remote access labs for unknown structure determination, and mini- and full scale student research projects. Specific topics include: safety procedures; crystal growth; the selection, mounting, and evaluation of crystals; data collection strategies for point and area detector systems, structure solution using SHELX, powder diffraction for bulk phase confirmation, using crystallographic data bases, and writing and evaluating crystallographic papers. The collection of crystallographic data remotely over the internet will be emphasized.

2:15 PM - 5:00 PM STEW 218CD

S22: POGIL: Process-Oriented Guided Inquiry Learning - Session 1 of 4

Rick Moog (Franklin and Marshall College, USA)

POGIL is a student-centered instructional paradigm that combines a group learning approach with specially designed guided inquiry activities. The goal is to not only enhance student mastery of course content, but also to develop important learning process skills such as communication, problem solving, and critical thinking. This symposium will include presentations dealing with the implementation and evaluation of this approach across a wide array of disciplines and institutional types and levels.

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|--------------------------|--|
| 2:15 Rick Moog | P164: POGIL and the POGIL Project |
| 2:35 Frank Creegan | P165: The POGIL Laboratory |
| 2:55 David Hanson | P166: POGIL Activities - The Next Generation |
| 3:15 Andrei Straumanis | P167: Can POGIL have an impact on minority student attrition? |
| 3:35 | break |
| 3:45 Michael Garoutte | P168: Allied Health Chemistry: A Guided Inquiry |
| 4:05 Tom Eberlein | P169: POGIL at Penn State: A Tale of Two Sites |
| 4:25 Christina Mewhinney | P170: Using Pen-Based Wireless PC Conferencing Software to Facilitate Group Interaction in a POGIL Classroom |
| 4:45 | discussion |

P164: POGIL and the POGIL Project

Rick Moog (Franklin and Marshall College, USA)

This presentation will describe the fundamental principles of POGIL and describe the activities of the POGIL Project, a National Dissemination effort funded by the National Science Foundation CCLI program (DUE - 0231120)

P165: The POGIL Laboratory

Frank Creegan (Washington College, USA)

In a POGIL laboratory, students, in advance of any classroom work on underlying principles, work

in self-managed teams to conduct experiments rather than exercises that verify previously taught principles. The instructor poses a focus question or Question of the Day (How is the structure of a molecule related to its boiling point?), and students propose a set of tentative answers. To test these hypotheses, students run reactions and/or collect data, which are pooled and then analyzed with the aid of in-lab and post-experiment or post-laboratory guided-inquiry questions. This Learning Cycle Approach (Exploration phase, Concept Invention phase, and Application phase) not only guides students to construct their own understanding of important chemical concepts but also helps them to develop valuable learning process skills. The application of the POGIL approach to courses in General and Organic chemistry will be described as will the process for submitting experiments to the POGIL Project for inclusion on the POGIL website.

P166: POGIL Activities - The Next Generation

David Hanson (Stony Brook University - SUNY, USA)

POGIL activities are structured around the learning cycle of exploration, concept invention or formation, and application. Some designs incorporate a "Why?" statement, specification of learning objectives and success criteria, and metacognition consisting of reflection on learning and self-assessment of performance. Research on learning reveals that more is needed to help students develop the knowledge structures that are required to solve problems and use their knowledge in new contexts. The research base for a 15 point instructional design methodology will be described, and the methodology will be illustrated with an applicaion.

P167: Can POGIL have an impact on minority student attrition?

Andrei Straumanis (College of Charleston, USA)

Our research seeks to investigate the issue of minority student attrition in organic chemistry. The following is, unfortunately, typical: attrition and grade data for the past five years indicate that students entering chemistry classes at the College of Charleston who self-identify as "Black/of African decent" are about twice as likely, as compared to White or Asian students, to fail or withdraw prior to the completion of the freshman-sophomore sequence. Furthermore, a White or Asian student is ten times more likely to get an A in Organic II than a Black student. The literature indicates that a key feature that many minority students are missing is a sense of belonging to a community of scientific scholars (e.g. Treisman, 1992). Using qualitative methods, we are investigating the possibility that the POGIL teaching method may be of use in attenuating some race-related barriers, giving students of all backgrounds an opportunity to participate in such a learning community.

P168: Allied Health Chemistry: A Guided Inquiry

Michael Garoutte (Missouri Southern State University, USA)

Complete sets of published, field-tested POGIL activities are available for courses in general chemistry, physical chemistry, and organic chemistry. For the past several years, the author has been developing POGIL activities for a chemistry course designed primarily for nursing and other allied health majors, commonly called the GOB (general-organic-biochemistry) course. These activities are scheduled to be published in 2007. Using POGIL in the GOB course presents unique challenges in terms of topic selection, activity design, time management, and facilitation techniques. The author will explore the selection and design process, and relate classroom techniques that have aided the transition to POGIL in this course.

P169: POGIL at Penn State: A Tale of Two Sites

Tom Eberlein (Penn State Harrisburg, USA)

During the academic year 2005-2006 I had the unusual opportunity to teach the two semester organic chemistry sequence at two of Penn State's branch campuses: Penn State Schuylkill (PSS) and Penn State Harrisburg (PSH). Students at PSS knew me from previous courses, and many of them were familiar with student-centered active learning techniques (SCALTs), which are used heavily in teaching general chemistry. By contrast, lower division programming is relatively new to PSH, and the use of SCALTs for teaching chemistry was untried. I hoped to use this opportunity to gather information related to two very different questions: (1) Would students at PSS be more receptive than the PSH students to the POGIL methodology, given their prior experience with SCALTs? (2) There are inherent and measurable differences between the PSH and the PSS student cohorts. Could the use of POGIL for both groups be correlated with a narrowing of the ability gaps between these two sets of students? This paper will examine the outcomes of this year-long experience, including several unexpected findings.

P170: Using Pen-Based Wireless PC Conferencing Software to Facilitate Group Interaction in a POGIL Classroom

Christina Mewhinney (Eastfield College, USA)

Much of the student learning gains in a POGIL classroom result from the process in which groups of students postulate answers to posed "critical thinking questions", and discuss and defend their solutions. This inter-student discussion is not only a valuable part of the learning process, but it also encourages development of important skills such as problem solving, communication, and critical thinking. However, "reporting out" group solutions can consume valuable class time. This presentation discusses the results of a pilot study using tablet PC's, a wireless network, and conferencing software to facilitate effective and efficient team management, team reporting, inter-group and class discussions, as well as monitoring student progress in a POGIL classroom.

2:15 PM - 5:00 PM STEW 306

S4: Research in Chemical Education - Session 3 of 6

Diane Nutbrown (University of Wisconsin - Madison, USA), **Christopher Bauer** (Univ. of New Hampshire, USA)

This symposium, sponsored by the CHED Committee on Chemical Education Research, is a forum for research conducted on the teaching and learning of chemistry at any level. Presentations will address: 1) the motivation for the research and the theoretical bases in which it is grounded, 2) the methods used to gather and interpret data, and 3) the findings and their significance interpreted in light of theory and method. Authors are being strongly encouraged to bring copies of an extended abstract to share with the audience.

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|--------------------------|--|
| 2:15 Chris Smith | P171: Relating macroscopic observations of melting and mixing to microscopic explanations |
| 2:35 Barbara L. Gonzalez | P172: Effect of multimodal delivery of macroscopic and particulate level visualizations on understanding chemical and physical changes |
| 2:55 Vicente Talanquer | P173: Emergent properties: A challenge for the intuitive chemist |
| 3:15 | break |

- 3:25 John H. Penn P174: Early predictors of performance in organic chemistry: Who will survive and who will not survive
- 3:45 George Bodner P175: “Out of the blue it just pops into my mind!”: Making connections and transferring knowledge in general chemistry courses
- 4:05 Stacey Lowery Bretz P176: CHEMX: Assessment of cognitive expectations for learning chemistry

P171: Relating macroscopic observations of melting and mixing to microscopic explanations

Chris Smith (Purdue University, USA), Mary Nakhleh (Purdue University, USA)

Our study investigated how freshman university chemistry students and chemistry graduate students viewed the microscopic behavior of common compounds in relation to their macroscopic properties. We conducted individual semi-structured interviews during which the students made predicted and experimental observations on the melting of four everyday room-temperature solids: sugar, salt, butter, and chalk. The students also made predicted and experimental observations on the interactions of these four solids with two common liquids: water and cooking oil. In addition, we had the students provide microscopic-level explanations and drawings to support their observations. Our analysis indicates that students tend not to consider particle motion in undisturbed systems, such as sugar simply sitting in a beaker or salt settled at the bottom of a beaker of water; conversely, students tend to consider particle motion in systems affected by external factors, such as heating and stirring. Further results from our analysis will also be presented.

P172: Effect of multimodal delivery of macroscopic and particulate level visualizations on understanding chemical and physical changes

Barbara L. Gonzalez (California State University Fullerton, USA)

The Physical and Chemical Change Assessment (PCA) instrument consisting of ten-items with a two-tier multiple choice and explanation format, involving graphic, symbolic, and mathematical representations at the macroscopic and particulate levels was developed to measure students' understanding of the distinction between chemical and physical change in matter. One aim of this study is a cross-age analysis of how students from middle school through graduate school explain the difference between chemical and physical changes when macroscopic and particulate representations are provided. The second aim of this study is to investigate how an instructional intervention that involves macroscopic and particulate depictions delivered in still, animated, or a combination of still and animated modes affect students' ability to recognize and explain their understanding of physical and chemical changes as measured by PCA. A significant difference between a control group and a group that received the animated intervention, and between the control group and a group that received the still intervention, ($F=6.1$, $df=1$, $p<0.05$) was found for sixth-grade subjects. Results for high school and college subjects will be presented. The results from this study will be compared and contrasted to the literature on chemical and physical change and implications for instruction will be discussed.

P173: Emergent properties: A challenge for the intuitive chemist

Vicente Talanquer (University of Arizona, US)

We explored college students' predictions and explanations about the color, smell, and taste of chemical compounds resulting from the chemical reaction of elemental substances with well-defined properties. We specifically targeted student thinking based on microscopic (particulate)

and symbolic representations of chemical systems. To this end, we used qualitative and quantitative methods of research based on interviews, short-response, and multiple-choice questions collected over one semester in an introductory general chemistry course for science and engineering majors. Our results indicated that most students at this level used an additive framework to predict the properties of chemical compounds, overlooking the possibility of emergent properties resulting from the interaction of the atoms which compose the system. Many students in the study seemed to construct explanations based on an “essentialist” assumption: different atoms or elements have intrinsic properties that are inherited by its compounds in an additive way.

P174: Early predictors of performance in organic chemistry: Who will survive and who will not survive

John H. Penn (West Virginia University, USA)

A key goal in education is to improve the performance of students in a class. An important part of this goal would be to identify those students, where the performance is at risk at the earliest possible point in a class, so that appropriate interventions could be provided to these students. Use of the WE_LEARN system allows identification of at-risk students, even as early as 1-2 weeks into the class. Data from two classrooms will be presented and discussed for their accuracy in predicting problem students.

P175: “Out of the blue it just pops into my mind!”: Making connections and transferring knowledge in general chemistry courses

George Bodner (Purdue University, US), **Amy Johnson** (UNC Pembroke, USA)

During this presentation I will discuss data collected from a project designed to explore the beliefs and practices of students and faculty members about knowledge transfer in general chemistry courses. Of particular interest in this study was if the participants believed that knowledge transfer did in fact occur and, if so, was important to the success of students in a two-semester general chemistry sequence for science and engineering students. I will compare and contrast interview and survey data from these groups as it pertains to such issues as: What are the most important concepts for students to take from the courses? How important is it for students to make connections between the course concepts? How can you know if a student has made a connection and/or knows a concept? Should students be able to transfer knowledge and skills from one course to another and, if so, how can this be facilitated?

P176: CHEMX: Assessment of cognitive expectations for learning chemistry

Stacey Lowery Bretz (Miami University, U.S.A.), Nathaniel Grove (Miami University, U.S.A.)

Much research has investigated the effects of students' prior knowledge upon learning chemistry, e.g., the tenacity of alternative conceptions. However, student expectations about the cognitive processes required to learn chemistry also shape learning outcomes. This research describes the development of CHEMX, a survey instrument which measures cognitive expectations for learning chemistry. Evidence for both the reliability and validity of CHEMX will be presented, as will data from undergraduate chemistry students. Results include changes in expectations from freshmen to seniors, comparisons between majors and non-majors, and a profile of faculty expectations in comparison to students.

2:15 PM - 5:00 PM STEW 314

S23: Research with Teachers and Federal Initiatives - Session 1 of 1

Jason Steward (Purdue University, USA), **Willy Hunter** (Illinois State University, USA)

This symposium of general interest to the Chemical Education community will focus primarily on research with in-service teachers and upon federal government initiatives.

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|----------------------|--|
| 2:15 | introduction |
| 2:20 Kira Padilla | P177: College teachers' pedagogical content knowledge about 'amount of substance' |
| 2:40 Kathleen Parson | P178: NSF update: What's new at DUE? |
| 3:00 Lawrence Kaplan | P179: Center for workshops in the chemical sciences (CWCS) |
| 3:20 Susan Wiediger | P180: Pattern languages for chemical education |
| 3:40 | break |
| 3:55 Jason Steward | P181: Inquiry is...: Secondary science teachers' conceptions of inquiry |
| 4:15 Vickie Geisler | P182: NSF-STEP grant generating enthusiasm for math and science (GEMS) |
| 4:35 Charles Cox | P183: Strategy stabilization: A study of factors affecting student strategies using IMMEX software |

P177: College teachers' pedagogical content knowledge about 'amount of substance'

Kira Padilla (Facultad de Química, UNAM, MEXICO), Andoni Garritz (UNAM, MEXICO)

Pedagogical content knowledge is an extensively studied item within many different contents, including the unit 'mole' (Dawkins and Butler, 2001; Sánchez and Valcárcel, 2000). We studied the PCK of a group of college teachers related to the concepts 'amount of substance' and 'mole'. To design a proper set of questions that covered all facets of knowledge (teaching objectives, epistemology, concepts, abilities, learning difficulties, didactic strategies, evaluation, etc.) we took as reference the content representation (CoRe) proposed by Loughran, Mulhall and Berry (2004), and modified it ourselves. Before making the teachers answer the designed eight questions of CoRe, we did a consensus survey asking them their central ideas to teach these themes. With those consensus ideas we built a matrix placing the eight questions as rows and the central ideas as columns. Afterwards we compared their answers and concluded about the different focuses given by each teacher.

P178: NSF update: What's new at DUE?

Kathleen Parson (NSF, U.S.A.), Susan Hixson (National Science Foundation, USA), Hal Richtol (NSF, USA), Harry Ungar (NSF, US)

Undergraduate education is central to the National Science Foundation's mission in human resource development. The Division of Undergraduate Education (DUE) serves as the focal point for agency-wide support for undergraduate education. The program activities of DUE aim to strengthen and continuously improve the vitality of undergraduate education for all students in science, technology, engineering and mathematics (STEM) courses in all U.S. institutions of higher education. This presentation includes a brief description of the DUE programs that are most likely be of interest to chemists involved in undergraduate education, including NSF Scholarships

in Science, Technology, Engineering, and Mathematics (S-STEM), a program that supports scholarships for qualified students in all STEM degree programs, and an update on the new Course Curriculum, and Laboratory Improvement (CCLI) solicitation after a full year's cycle of implementation.

P179: Center for workshops in the chemical sciences (CWCS)

Lawrence Kaplan (Williams College, US), Emelita Breyer (Georgia State University, USA), David Collard (Georgia Institute of Technology, U.S.A.), Jerry Smith (Georgia State University, USA)

The Center for Workshops in the Chemical Sciences (CWCS) was established with funding received from an NSF-DUE grant. CWCS provides a series of intensive, five-day workshops designed to provide a modern perspective on selected topics and an approach for including these topics in the undergraduate curriculum. Each workshop consists of lectures and some form of hands-on experience. The workshops are open to faculty who teach at the undergraduate level and to graduate and postdoctoral students who plan to teach at the undergraduate level. In the past 5 years CWCS has organized 58 workshops at 25 locations on 21 different topics across the nation, attracting 835 participants. Nine additional workshops are scheduled for the summer of 2006. Topics of the workshops include forensic science, molecular genetics and proteomics, nuclear magnetic resonance, chemistry and art, teaching guided-inquiry organic labs, modeling biomolecules, green chemistry, and environmental chemistry. The program covers all workshop and participant subsistence expenses. The structure, scope, content, participant comments, and pictures of a few recently conducted workshops will be presented. (Supported by NSF-DUE 0089417 and 0341138; see the web site <http://chemistry.gsu.edu/cwcs>).

P180: Pattern languages for chemical education

Susan Wiediger (Southern Illinois University Edwardsville, USA)

Patterns and Pattern Languages are ideas from architecture that would enable pedagogical content knowledge to be captured in a format accessible to educators non-linearly and just-in-time.

Patterns define a format for problems and solutions that is readily adaptable to different settings.

An important characteristic of Patterns for educators will be clear connections to the original research literature which will provide evidence of the pattern testing and provided directions for further study for interested readers. Patterns are linked together to form the hierarchical Pattern Language. Once a Pattern is identified as being a solution to a particular issue in instruction, the Pattern Language links reveal "ripple effects" that could result from implementing the Pattern.

This talk introduces Patterns and Pattern Languages and presents examples of Chemical Education Patterns.

P181: Inquiry is...: Secondary science teachers' conceptions of inquiry

Jason Steward (Purdue University, USA), Gabriela Weaver (Purdue University, USA)

Within science education, there is a renewed effort to bring a more authentic view of science to the classroom with the use of inquiry. Inquiry allows students greater ownership of ideas within their learning environments through student-centered labs and projects. But how do individual teachers define inquiry? Although the idea of inquiry is codified within state and national standards, how do secondary level science teachers decipher and translate this meaning? This talk will present data and findings concerning teachers' ideas of inquiry during their participation in the E-2020 program, an in-service teacher enrichment program focused on the exposure to and the use of

inquiry.

P182: NSF-STEP grant generating enthusiasm for math and science (GEMS)

Vickie Geisler (University of West Georgis, USA)

The University of West Georgia has been awarded an NSF-STEP grant to increase retention and graduation rates of our STEM majors. A major part of our effort involves a first-year seminar course entitled, "Frontiers in Science and Technology." This interdisciplinary course combines instruction and hands-on activities where students work collaboratively to seek solutions to problems set in real-world contexts. We have offered this course with two different themes: forensics (CSI:UWG) and Science in Space. Selected students in their first year will take this innovative course, pre-calculus, calculus, chemistry and or biology all with peer-lead team learning groups. During the summer, following successful completion of their first year, students will be eligible for a paid summer research experience. We will report on the extent to which a discovery based interdisciplinary seminar, math and science peer intervention, and undergraduate research in the first-year of college positively influences students to engage and to persist in STEM degree programs.

P183: Strategy stabilization: A study of factors affecting student strategies using IMMEX software

Charles Cox (Clemson University, United States), *Melanie Cooper* (Clemson University, United States), *Ron Stevens* (UCLA, USA)

With regard to problem solving, research has shown that three phases of strategy development are observed. The first stage is framing in which students are putting the problem into perspective, the second stage is strategy transitioning in which students are refining their strategies, and the final stage is stabilization in which students' strategies stabilize and remain constant for subsequent performances. This talk will discuss strategy development and trajectories observed for IMMEX problems which are Internet case-based type problems that have a tracking feature enabling representation of student strategies. The three problem sets will be included in the discussion focusing on organic mechanisms, spectroscopy, and qualitative organic analysis. The factors affecting the trajectories such as gender and familiarity with the problem concepts will be discussed.

2:15 PM - 5:10 PM STEW 214A

S24: Science Education: Vital Connection of Science to the Public Sphere - Session 1 of 3

Rainer Glaser (University of Missouri-Columbia, USA)

Pervasive connections exist among science and the political, economic and sociological foundations of society and the interactions between societies. Every modern society must constantly review and negotiate the moral, ethical, and philosophical aspects of these connections. All societies face the central challenge of achieving successful progress in light of "inform & consent"-based interdisciplinary collaboration. In an environment of disciplinary specialization and increasing discipline-based competition, systematic change can only be achieved with interdisciplinary approaches that are designed with respect for society's true complexity. The symposium brings together speakers with expertise in various science disciplines, the theory and practice of education, sociology, political science, journalism, and art. The speakers represent all ranks and various types of institutions and share a common interest in interdisciplinary science

education. The speakers will share their insights and experiences, present and argue their ideas, and provide guidance to improving “science communication.”

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| 2:15 | introduction |
| 2:20 Penny J. Gilmer | P184: Public Understanding of Science – Past, Present & Future |
| 3:00 Bassam Z. Shakhashiri | P185: Initiative for Science Literacy |
| 3:40 | break |
| 3:50 Bethany Halford | P186: Can I Quote You? - A reporter's perspective on science in the news |
| 4:10 Kathleen Carson | P187: Science Education as an International Mandate |
| 4:30 Elke Schoffers | P188: Beyond The Lab Coat – Scientists As Citizens |
| 4:50 John Kotz | P189: The Future Of Chemical Communications Here And Abroad |

P184: Public Understanding of Science – Past, Present & Future

Penny J. Gilmer (Florida State University, USA)

For years the NSF has funded survey research on the public understanding of science. The National Science Board summarizes this research in alternate years. Basically, adults in the US do not get high marks (8.2 answers correct out of 13 asked) on knowledge of science, and it is not improving. For instance, only 53% of Americans agree with the theory of evolution (although this is a slight improvement). Two-thirds of adults in the US do not clearly understand the scientific process. Adults learn about science from watching TV, reading print media, visiting science museums, and using the Internet. The question is: how can we improve the public understanding of science? First, we can improve K-12 education, so that children when they become adults can construct new knowledge based on good understandings of science. Also the necessity of teaching evolution in our K-12 biology, geology, and physics classes needs to be resolved in our country. Second, with adults we can start with college-aged students who are taking science courses. A course like Rainer Glaser’s Organic Chemistry that includes Chemistry Is In the News projects helps students connect the science content to real-world issues, thereby allowing students to see relationships among ideas, observe patterns in what they are learning, and construct more complex understandings of the world. Also reaching out to preservice K-12 science teachers to help them have a firmer understanding of the nature of science and scientific inquiry will help them become better K-12 teachers. Many of these efforts are ongoing. Using sociological theories of human activity, such as cultural-historical activity theory and Sewell’s theory of the structure-agency dialectic may help scientists and science educators learn better how to help their students and other adults learn science with deeper understanding.

P185: Initiative for Science Literacy

Bassam Z. Shakhashiri (UW-Madison,)

Society is becoming increasingly dependent on science and technology. It is essential for the well-being of our society that all citizens develop an appreciation of science, the benefits of technology, and the potential risks associated with advances in both. Citizens must gain "science literacy." I make a distinction between scientific literacy, expertise in a particular field, and science literacy, which refers to a broad appreciation and understanding of science and its practitioners, of what science is capable of achieving and what it cannot accomplish. Science literacy enlightens and

enables people to make informed choices, to be skeptical, and to reject shams, quackery, unproven conjecture, and to avoid being bamboozled into making foolish decisions where matters of science and technology are concerned. Science literacy is for everyone—chemists, artists, humanists, all professionals, ordinary people, the young and adults alike.

P186: Can I Quote You? - A reporter's perspective on science in the news

Bethany Halford (C&EN, USA)

Popular media outlets such as newspapers, magazines, radio, and television are among the best places for science to reach the public sphere. But scientists and journalists often see news in different lights. A news reporter (and former scientist) gives her perspective on reporting science and offers advice on how to communicate effectively with journalists.

P187: Science Education as an International Mandate

Kathleen Carson (,)

Science is, by its nature, international; however, many of the decisions regarding the use of science, the policies regulating it, and the interests influencing it are not. The increasing prevalence of transnational issues vis-à-vis science (i.e. energy production, food production, pharmaceuticals) has brought to light the necessity to not only better educate students about scientific principles, but also about the nature of science, its impact on the broader world, and how to ethically conduct science. Key to educating students about the nature of science in a broader world is to establish that while there may be definitive data, it is possible to have multiple, valid interpretations of that data and that interpretations can be influenced and informed by local circumstances. In addition, conducting science ethically involves taking into account these multiple interpretations and the concerns of the lay community. Illustrating this concept for students requires introducing students to many of the issues producing conflict in the world from a scientific standpoint and examining the various interpretations as well as collaboration with students from other backgrounds, particularly international.

P188: Beyond The Lab Coat – Scientists As Citizens

Elke Schoffers (,)

It is paramount to understand the public's perception of scientists in order to understand and promote the vital connection of science to the public sphere. Improved science literacy enables ordinary people to understand the message of the scientist as well as the benefits of science and technology. However, the image of the scientist substantially influences how effective that communication is. This presentation will focus on scientist stereotypes, public perception management and the role of scientists as experts and non-experts in order to develop effective tools for public discourse.

P189: The Future Of Chemical Communications Here And Abroad

John Kotz (SUNY, United States)

Two issues in chemical communications are described. First, how is education in chemistry changing, particularly with regard to how we communicate to our students the necessary information as well as the essence of chemistry in particular and science in general? We want to consider textbooks as well as online materials, iPods, cellphones, and other devices. What changes can be foreseen in textbooks and ancillary materials and in methods of delivery? The second issue is chemical education at the international level. The author has been involved with the International

Chemistry Olympics and the U.S. program and will discuss the importance of that program and how to become involved. Finally, the author has also worked recently in a program for science teachers in South Africa and will describe that program and its impact on southern Africa.

2:15 PM - 5:00 PM STEW 214B

S25: Scientific and Professional Ethics in the Chemistry Curriculum - Session 1 of 1

Jeffrey Kovac (University of Tennessee, USA)

This symposium will discuss the teaching of scientific and professional ethics as part of both the undergraduate and graduate education of chemists. Papers will address issues in ethics and the teaching of ethics.

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| 2:15 | | introduction |
| 2:20 | Janet Stemwedel | P190: "Magic hands" and reproducible results |
| 2:40 | Provi Mayo | P191: Ethics: Are my students prepared to make the right decision? |
| 3:00 | Amy Gottfried | P192: An ethics assignment: Comparing the American Chemical Society code of ethics with the Hippocratic oath |
| 3:20 | | break |
| 3:30 | Dawn Del Carlo | P193: Lessons from the lab: Students' thoughts on 'right' and 'wrong' |
| 3:50 | George Bodner | P194: Chemistry component of the LANGURE research ethics project |
| 4:10 | Jeffrey Kovac | P195: Chemistry and casuistry: Using case studies to teach scientific ethics |
| 4:30 | | discussion |

P190: "Magic hands" and reproducible results

Janet Stemwedel (San Jose State University, USA)

An ideal of science is that experimental findings be reproducible. A reality of science is that some have better technique (and luck) in the lab than others. I discuss the challenges presented by researchers with "magic hands" to the project of building scientific knowledge that is reliable and usable by other scientists. I consider both practical issues (keeping good notebooks, reporting experimental methods completely in the literature, etc.) and broader issues like the importance of the norm of organized skepticism in the process of building objective knowledge.

P191: Ethics: Are my students prepared to make the right decision?

Provi Mayo (South Dakota State University, USA)

Competition in the academic and research setting are often tied with ethical decisions which our students have to make. Sometimes students are not prepared to face those ethical dilemmas. Most of the time we assume our students have our same idea of ethics and will make the appropriate decision. This project explores what considerations science students use when resolving moral and ethical issues involving coursework and research. In this presentation I will discuss the data gathered in a pilot as well as currently gathered open ended survey data. The pilot study consists of an open ended survey. The survey asked students their definition and ideas on ethics and it also

contained two hypothetical cases which the students had to read and discuss how they would resolve each situation considering their ethical values. I will discuss the students' answers and how these could influence future research projects and courses in ethics for graduate as well as undergraduate students.

P192: An ethics assignment: Comparing the American Chemical Society code of ethics with the Hippocratic oath

Amy Gottfried (University of Michigan, USA)

Violations of good ethical practices in scientific research are making the headlines more often than one would hope. Thus, it is important to include a discussion of ethics in a chemistry course that serves as an introduction to the sciences and scientific research. Most of the students enrolled in these courses will not have careers in the field of scientific research, but they will be connected to the medical sciences. One model for introducing ethics in a general chemistry course along with the follow-up assignment asking students to compare and contrast the Hippocratic Oath with the American Chemical Society Code of Ethics will be presented.

P193: Lessons from the lab: Students' thoughts on 'right' and 'wrong'

Dawn Del Carlo (University of Northern Iowa, USA)

It has only been recently that issues of dishonesty within the classroom laboratory have gained attention. In the past it has been assumed that whatever ethics student exhibit in the teaching lab, necessarily transfer over into the research setting and beyond. However, recent research at the high school, undergraduate, and graduate levels indicates otherwise, with looser ethical standards being applied in the classroom, rather than the "real world". This talk will discuss results from these recent studies in addition to the implications they have for how the curriculum of the classroom laboratory can be shaped to help students exhibit ethical behavior in all circumstances, "real world" or otherwise.

P194: Chemistry component of the LANGURE research ethics project

George Bodner (Purdue University, US)

This paper will describe the NSF funded LANGURE (Land Grant University Research Ethics) project (<http://www.chass.ncsu.edu/ethics/langure/>). In addition to the core content on research ethics, in general, the LANGURE project will have modules that focus on agricultural biotechnology, agricultural extension, chemistry, computer science and engineering, chemical and industrial engineering, field research in plant biology, microbiology, nanotechnology, nuclear engineering, physics, and statistics. It will also contain modules that deal with women and under-represented minorities in graduate education; the use of animals for food, fiber and research; authority and power in social sciences research; intellectual property; ethical business communication and community representatives in clinical trials. This paper will describe efforts being coordinated by the author to develop the chemistry content for the LANGURE project.

P195: Chemistry and casuistry: Using case studies to teach scientific ethics

Jeffrey Kovac (University of Tennessee, USA)

All interesting real-life ethical problems are complex. Ethical choices are always made in context of people's lives, not in the abstract situation of the philosophical seminar. There might be a conflict between two strongly-held moral principles, or there might be several stakeholders with different interests so that it is difficult to balance the relative costs and benefits, or the fact situation

may be so complicated that it is hard to sort out the issues. The best course of action might not be obvious, or easy to implement. The consideration of cases, the ancient and much-abused art of casuistry, provides the best method to teach ethical problem solving. In this presentation, I will show how the discussion of hypothetical cases, such as those included in my recent book, *The Ethical Chemist* (Pearson Prentice Hall 2004) can be used as the basis for a course in scientific ethics for chemists.

2:15 PM - 5:10 PM STEW 206

S17: Teaching to the National Science Standards: What is Inquiry and How Can We Implement Inquiry in the Chemistry Classroom and Lab? - Session 2 of 2

Debbie Herrington (Grand Valley State University, USA), **Kathy Kitzmann** (Mercy High School, USA)

The National Science Education Standards and AAAS Benchmarks have brought inquiry to the forefront of science education. NSES Content Standard A states: "For students to develop the abilities that characterize science as inquiry, they must actively participate in scientific investigations, and they must actually use the cognitive and manipulative skills associated with the formulation of scientific explanations." Although chemistry educators value inquiry instruction for the potential it has to impact students' understanding and thinking about science, many have concerns and questions about implementing inquiry in the classroom and laboratory. Presenters will share models for science inquiry and methods for implementing inquiry, as well as specific inquiry activities, lessons, and labs.

| | | |
|------|-----------------|---|
| 2:00 | Michelle Walden | P196: Controlled chaos |
| 2:20 | John Deming | P197: Development of teachers' understanding of inquiry and its impact on students' thinking skills |
| 2:40 | Les McSparrin | P198: Effects of guided inquiry on student misconceptions in chemistry |
| 3:00 | Cianán Russell | P199: Undergraduate research-based laboratory implementations |
| 3:20 | | break |
| 3:30 | Kelly Deters | P200: Teaching inquiry the "backwards" way |
| 3:50 | Shawn Kellie | P201: Electrolytes, solutions, and race cars: A freshman chemistry lab |
| 4:10 | Herb Fyneweaver | P202: Measuring enthalpy of phase transitions with inquiry |
| 4:30 | Jeong H Hwang | P203: Pennies and eggs: Initiation into inquiry learning for preservice elementary teachers |
| 4:50 | | discussion |

P196: Controlled chaos

Michelle Walden (Purdue University, United States), Mary Nakhleh (Purdue University, USA)

Through both my undergraduate and graduate programs at Purdue University, I have had the opportunity to be exposed to and learn about a particular method of instruction being used in the chemistry department of a local high school. This particular teaching method, for the purposes of my research, has been termed Student Focused Interactive Learning (SFIL). The current study focuses on answering the following questions: (1) How is SFIL implemented in this course?, (2)

What are students' and the teacher's attitudes and perceptions of SFIL?, and (3) What do the students understand of the nature of science? Three main findings from this study are (a) SFIL allows students to take control of their learning by checking some assignments for completion only and allowing them the time to complete assignments as they see fit, (b) SFIL encourages a better understanding of concepts by allowing students to take their time on assignments due to relaxed due-dates, and (c) SFIL encourages a deeper understanding of concepts by promoting active learning which helps students see connections within the material, build confidence in their ability to learn science and receive immediate feedback due to more one-on-one time with the teacher.

P197: Development of teachers' understanding of inquiry and its impact on students' thinking skills

John Deming (The University of Montana, United States)

High school chemistry is an extremely difficult subject to teach. This is because almost every topic covered in the course is what we term formal content. Formal content is subject matter that requires formal thinking ability to understand. Modern high school chemistry textbooks are filled cover-to-cover with formal concepts, yet research shows that only about 25% of high school juniors have well-developed formal thinking abilities. Thus, many teachers resort to teaching for memorization rather than understanding in the chemistry classroom because they are frustrated when students cannot learn formal concepts. A collaborative partnership was formed between university faculty and high school science teachers to attempt to break this cycle by developing teachers' understanding of inquiry and its impact on students' thinking skills. First, teachers' content knowledge was enhanced by exploring historical data from which scientists developed chemical principles. Second, teachers' pedagogical knowledge was enhanced by learning about inquiry methods of education such as the Learning Cycle and the types of thinking skills targeted with this teaching approach. Preliminary results indicate that teachers' knowledge increased as a result of the treatment. Results also indicate that the curriculum materials developed and the inquiry strategies targeted during the first year had a meaningful impact on students' formal thinking skills.

P198: Effects of guided inquiry on student misconceptions in chemistry

Les McSparrin (Sharpsville Area High School, U.S.A.), Stacey Lowery Bretz (Miami University, U.S.A.)

High school students enrolled in AP Chemistry, Chemistry I, and Conceptual Chemistry courses were taught using guided inquiry across two units: light/atomic emissions and acid/base chemistry. Students responded to two-tiered multiple choice tests both before and after completing the units. Responses were coded using a scale to indicate the nature of the misconceptions. Findings from this research will be presented, including reduction of misconceptions for students across all three courses.

P199: Undergraduate research-based laboratory implementations

Cianán Russell (Purdue University, United States), Gabriela Weaver (Purdue University, USA)

The Center for Authentic Science Practice in Education is host to multiple institutions implementing research-based laboratory practice into the mainstream first- and second-year undergraduate curricula. In this program, research-based laboratories focus on long-term experiments wherein students collect and analyze data directly associated with the current research of a scientific practitioner. This study focuses on the implementations of this program at these

institutions, specifically citing the different ways that the program can be used to access the material and how those differences affect students. Qualitative data were collected from student interviews at each institution to assess the nature and effects of the implementation from the students' perspective. The specific impacts that will be addressed in this talk are student attitudes about the components of the implementations of this model and a comparison analysis of the same students' attitudes about more traditional laboratory styles.

P200: Teaching inquiry the "backwards" way

Kelly Deters (Shawnee Heights High School, US)

My research on the barriers to inquiry use in the high school science classroom has shown that teachers are aware of the "theory" of inquiry but lack the practical understanding of how to actually use it with their students. Come learn how to lead students through the lab designing process the "backwards" way that teachers and scientists use without even realizing it. Once students are familiar with this process, lab designing will be much more efficient and effective, which cuts down on class time needed for inquiry and allows teachers to use it more often in their classrooms!

P201: Electrolytes, solutions, and race cars: A freshman chemistry lab

Shawn Kellie (Elizabethtown Community & Technical College, USA)

A common freshman chemistry lab is comparing the strength of different electrolytes. These labs often make use of a pair of electrodes attached to a light bulb. The light bulb lights, fails to light, or glows at different levels based on the strength of an electrolyte solution. While these labs are quick and easy, they often fail to excite students. Also, these labs are more demonstration than experiment. Because of these problems, the standard electrolyte lab has been reformatted into an inquiry-based lab that also teaches basic solution stoichiometry. This was accomplished by replacing the light bulb electrolyte indicator with Hot Wheels Formula Fuelers Race Cars. Hot Wheels Formula Fuelers Race Cars have fuel tanks that must be filled with an electrolyte in order for the car to work. The more electrolytes in a solution, the faster and farther the car will go. Therefore, the cars are perfect for comparing the strengths of different electrolytes and for explaining the definition of electrolytes. By filling the tanks of the Hot Wheels Formula Fuelers Race Cars with different substances students can determine their own definition of an electrolyte.

P202: Measuring enthalpy of phase transitions with inquiry

Herb Fynewever (Western Michigan University, United States), Hang Hwa Hong (Mallinson Institute for Science Education, WMU, USA), Pat Meyer (Western Michigan University, USA)

In our Physical Science for Elementary Educators course we ask the students to measure the enthalpy of phase transitions. We have conducted a controlled study comparing the use of inquiry methods and direct instruction. Findings from this study indicate that the amount of learning from this one day's worth of instruction was not significantly different for the two different approaches. However, student comments regarding the inquiry and direct instruction shed light on what aspects of inquiry are useful and what aspects are frustrating. This talk will focus on the key differences between the inquiry and direct instruction methods as well as student perceptions of the two different methods.

P203: Pennies and eggs: Initiation into inquiry learning for preservice elementary teachers

Jeong H Hwang (University of Illinois at Chicago,), **Donald Wink** (UIC,)

Two experiments, involving the change in composition of pennies and the change in density of eggs with time, have been adapted for the specific purpose of introducing scientific inquiry lab methods to students. This occurs in the context of a course for pre-elementary education majors and uses the Science Writing Heuristic for lab inquiry. The way in which these labs have evolved from previously reported discovery investigations of the same phenomena will be presented. These procedures have also proven useful in other venues, including introducing students to research and the epistemology of science.

2:15 PM - 5:00 PM STEW 318

S26: Web-Based Applications for Chemical Education - Session 1 of 3

Bob Hanson (St. Olaf College, USA), **Robert E Belford** (University of Arkansas at Little Rock, USA)

In this symposium, developers of web-based applications will come together with chemical educators to share experiences and innovations from the perspectives of development and implementation. Presenters will cover specific web-based applications, creative solutions to web-based issues in the context of chemical education, reports of the impact of web-based applications on pedagogy and learning, or visions of the future.

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|------------------------|--|
| 2:15 | introduction |
| 2:20 Jeff Hansen | P204: Using Shockwave to Deliver Interactive Content: Energy Diagram and Spectroscopy |
| 2:40 Robert Lancashire | P205: JSpeView - A Java-Based Spectroscopy Viewer |
| 3:00 Jennifer Muzyka | P206: Web Accessible Student Generated Spectra |
| 3:20 Barbara Stewart | P207: Lab Curriculum Development and Evaluation Using InterChemNet |
| 3:40 | break |
| 3:50 Joseph Grabowski | P208: Teaching Mass Spectrometry via Virtual Instrumentation Combined with Case Studies |
| 4:10 Saksri Supasorn | P209: Using an Interactive Web-Based Learning Course: NMR Spectroscopy as a Means to Improve Problem Solving Skills for Undergraduates |
| 4:30 Stewart Mader | P210: The Science of Spectroscopy: A Wiki for Chemical Education |
| 4:50 | discussion |

P204: Using Shockwave to Deliver Interactive Content: Energy Diagram and Spectroscopy
Jeff Hansen (DePauw University, USA)

In this presentation I will discuss my vision of delivering interactive chemistry application via the web and describe two applications that were developed using Macromedia Director. Energy Diagram allows students to explore energy diagrams (reaction coordinate diagrams) by varying the energy of reactant, product, and transition state and observing the change in delta G, equilibrium constant, and rate constants. The spectroscopy application helps students develop their spectroscopy problem solving skills by modeling the process of determining the structure of an

organic compound from its spectra.

P205: JSpecView - A Java-Based Spectroscopy Viewer

Robert Lancashire (UWI, Jamaica, JAMAICA)

JSpecView, a JAVA based JCAMP-DX spectroscopy viewer, was released as Open Source via Sourceforge (<http://jspecview.sf.net>) in March 2006. It can be run as an applet from a web page or as a standalone application. From a teaching perspective it can be used in combination with a molecular graphics viewer such as MDL Chime, Jmol or Marvin for display of links between spectra and molecule such as IR vibrational mode animations. The ability to highlight areas on the spectrum with simple JavaScripts is a powerful visual feature that significantly improves identification of key features for interpretation. It can be also used in combination with other JAVA applets for example, interpretation of visible spectra with Tanabe-Sugano diagrams. A number of these areas will be demonstrated in the presentation.

P206: Web Accessible Student Generated Spectra

Jennifer Muzyka (Centre College, USA), Lucas W. Hatcher (Centre College, USA), Ian M. Kaster (Centre College, USA)

Students save their IR and NMR spectra as JCAMP files in folders accessible to our web server. The directory listing of spectra is converted into a web page using PHP. The spectra are displayed and printed using a java applet. This approach allows instrument time to be dedicated to acquisition of spectra rather than time consuming integration and printing.

P207: Lab Curriculum Development and Evaluation Using InterChemNet

Barbara Stewart (University of Maine, USA), **Francois Amar** (University of Maine, USA), Mitchell Bruce (University of Maine, USA), Matthew Leland (University of Maine, USA)

InterChemNet is a web-based laboratory management and curriculum delivery system that incorporates spectroscopic instrumentation, student choice, and assessment of student learning. We present several models of curriculum development including multi-campus assessment and parallel curriculum improvement. Data from these studies help inform our perspective on the use of InterChemNet as a tool for action research. We discuss protocols for intervention and assessment in the laboratory, focusing on student understanding of spectroscopy.

P208: Teaching Mass Spectrometry via Virtual Instrumentation Combined with Case Studies

Joseph Grabowski (University of Pittsburgh, USA)

Recently developed technology has greatly expanded the utility of mass spectrometry as an essential analytical tool in many areas of 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 created 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, 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. Selected aspects of the design, implementation, and utilization of the VMSL will be presented.

P209: Using an Interactive Web-Based Learning Course: NMR Spectroscopy as a Means to Improve Problem Solving Skills for Undergraduates

Saksri Supasorn (Mahidol University, Thailand)

An Interactive Web-Based Learning NMR Spectroscopy course is developed to improve and facilitate students' learning as well as achievement of learning objectives in the concepts of multiplicity, chemical shift, and NMR problem solving. This web-based learning course is emphasized on NMR problem solving skills, but the concepts of multiplicity and chemical shift, basic concepts for practice problem solving, are also emphasized. Most of animations and pictures in this web-based learning are new created and simplified to explain processes and principles in NMR spectroscopy. With meaningful animations and pictures, simplified English language used, step-by-step problem solving, and interactive test, it can be self-learning website and best on the students' convenience. The web-based learning was evaluated in three main issues: usefulness, informational quality, and students' learning. The results are that the web-based learning supports for development of learning process and problem solving skills, and contents are reliable and relevant, understanding as well as achievement of learning objectives and problem solving skills of students after use the web-based learning course were improved significantly.

P210: The Science of Spectroscopy: A Wiki for Chemical Education

Stewart Mader (Brown University, US)

A wiki is a web site whose content can be edited using just a web browser. Recently I've transformed "The Science of Spectroscopy", a site I co-created in 1999, into a wiki that can be expanded by a community of users. I'll briefly present ways a wiki can be used in chemical education, show how my site is benefiting from the contributions of educators around the world, and invite you, the audience, to share your chemistry knowledge and build the site into something useful for your students. Before the BCCE, please visit <http://www.scienceofspectroscopy.info> to see the wiki. If you'd like to edit the wiki, please request an account by emailing Stewart Mader (slmader@gmail.com).

2:15 PM - 5:00 PM STEW 322

S27: Women in Chemistry Education - Session 1 of 2

Janet Clark (St. Mary-of-the-Woods College, USA)

The purpose of this broad symposium is to share the experiences of women currently involved in chemistry education, either as researchers, instructors, or mentors. Presenters will explore barriers faced by women in the field, models for overcoming such barriers, and the overall situation and outlook for women in chemistry education. Research and insights into how women learn science will also be shared.

2:15

introduction

| | |
|-----------------------------|---|
| 2:20 Jeannette Brown | P211: History of African American chemists |
| 2:40 Geoff Rayner-Canham | P212: Education of women chemists: Past and present |
| 3:00 Jodye Selco | P213: Is the climate still chilly? |
| 3:20 Ann Nalley | P214: Problems women face in academics around the world |
| 3:20 | break |
| 3:40 Shirley Oberbroeckling | P215: Working with women authors |
| 4:00 Judith Iriarte-Gross | P216: Ten years of programming for women in science |

P211: History of African American chemists

Jeannette Brown (,)

The paper will discuss the History of African American Women Chemists. I would like to encourage faculty members to include these women in their study of the history of chemistry. It is my experience that many such courses do not include any women I plan to even though some students attempt to have one of them included.

P212: Education of women chemists: Past and present

Geoff Rayner-Canham (Grenfell College, Canada), *Marelene Rayner-Canham* (Sir Wilfred Grenfell College, Canada)

Many problems that were faced by the pioneering women chemists are still challenges for the education of women chemists today. Using historical quotes from our own research together with contemporary comments, we will see how little has really changed for young women planning a career in chemistry. In particular, we will look at the reward system and why the Nobel Prize in Chemistry has become even more elusive for women.

P213: Is the climate still chilly?

Jodye Selco (Cal Poly Pomona, USA)

Has anything changed for females in Chemical Education in the last 20 years? Ever wonder why some “minorities” are so hyper-sensitive to seemingly innocuous remarks? Come hear some of those “you’ve got to be kidding” stories gleaned from 20 years in the chemistry classroom.

P214: Problems women face in academics around the world

Ann Nalley (Cameron University, USA)

The low number of academic female professors in the United States is quite well-known. However, this situation is not unique and could quite possibly be worse in other areas of the world. This paper will address some of these areas and discuss the similarities and differences between the United States.

P215: Working with women authors

Shirley Oberbroeckling (McGraw-Hill, USA)

Women face many challenges to authoring texts and ancillaries. I will discuss what the challenges are and how various authors overcome the challenges. The presentation will also include various stages of working on a text and the different challenges each stage represents to an author.

P216: Ten years of programming for women in science

Judith Iriarte-Gross (Middle Tennessee State University, USA)

As a former non-traditional student in chemistry, I valued being able to talk with and ask questions of other women in science. Mentoring and networking were words not often heard during my undergraduate and graduate years as a chemistry major. Student organizations for women in science were rare. However, today there are many opportunities for women who are interested in science to find a mentor, to network and to learn about the current climate for women in different scientific careers. More importantly, girls and women who are interested in science should learn how to navigate this sometimes slippery ladder to success. In this talk, I will present the programs that we have developed at Middle Tennessee State University for girls and women, beginning in middle school, who are looking for that supportive network and guidance along the path to a satisfying career in science.

Workshops

Monday, July 31 afternoon

W15: Awesome Demos and Labs

2:15 PM - 5:15 PM BRWN 1164

Robert Becker (Kirkwood High School, USA)

Participants will construct and conduct a number of demos and micro-scale labs. These will include hydrogen-oxygen rockets with piezo launchers, cartesian divers, coffee-stirrer molecular models and soap-film frames, kinetic bouncers, and the CO₂ triple point lab

Capacity: 24 Fee: \$15

W16: Custom Publishing Your Original Labs: What Do I Really Want In My Lab Manual and Lab Program?

2:15 PM - 5:15 PM STEW 320

Nathan Wilbur (Pearson Custom Publishing, USA)

Brainstorming workshop to explore options for designing custom-published laboratory manuals, complementary websites, and media-based instructional tools. Includes (1) an overview of custom lab manual print options, (2) demonstrations of custom websites and media projects used in chemical education, and (3) open-ended team discussion of the value to be found in printed, online and media solutions for driving new designs for labs, team projects, data collection, and assessment.

Capacity: 40 Fee: None

W17: The Science Writing Heuristic: An Advanced POGIL Workshop

2:15 PM - 5:15 PM WTHR 217

Tom Greenbowe (Iowa State University, USA)

Implementation of the Science Writing Heuristic, SWH, in the introductory general chemistry laboratory is a process incorporating collaborative inquiry activities, cooperative negotiation of conceptual understanding, and individual writing and reflection. Participants will learn about the SWH by doing two collaborative science activities and keeping an SWH lab notebook. Materials provided along with access to an interactive web-site should enable participants to implement the SWH in their general chemistry laboratory course. The SWH is consistent with POGIL's goals and objectives.

Capacity: 24 Fee: \$12.45

W18: Using Electronic Response Systems and ConcepTests: Formative Assessment

2:15 PM - 5:15 PM WTHR 214

Margaret Asirvatham (University of Colorado-Boulder, U.S.A)

The transition from traditional lectures to student-centered teaching and learning environments is facilitated by the use of ConcepTest questions coupled with electronic response systems (clickers). The clicker technology places a powerful assessment tool in the hands of the instructor who can provide real-time feedback, address misconceptions, survey student attitudes about chemistry, and enhance the pedagogical benefits of lecture demonstrations. In this workshop, participants will use both IR and RF clickers from at least two different companies and examine the benefits and drawbacks of each. In addition, participants will develop and test their own ConcepTest questions that can be used with or without clickers in their classrooms. The workshop instructors will share their experiences using electronic response systems in classes ranging from 90-400 students, for both general and organic chemistry.

Capacity: 30 Fee: \$10

W19: Using Probeware to Promote Inquiry in Chemistry Labs

2:15 PM - 5:15 PM BRWN 2125

Dan Holmquist (Vernier Software & Technology, USA)

This hands-on workshop will give participants the opportunity to conduct a true inquiry lab using Vernier equipment. Experience inquiry from the students' point of view and gain the confidence to try it in your own labs.

Capacity: 40 Fee: \$0

Tuesday, August 1 morning

Plenary Speakers

Tuesday, August 1 morning

8:00 AM - 9:05 AM

L4: Chemistry for the Public - The Final Frontier

David Harpp (McGill University, Canada)

In the late 1800s and before, disreputable hucksters attempting to deceive the general public in areas of health, medications, and food, were prevalent in many countries. Despite 1906 legislation establishing the Food and Drug Administration in the United States and more explicit laws enacted in following years, illegal practices in these areas are more prevalent than ever. With the ever-increasing popularity of the Internet, scam artists have an effective and relatively inexpensive mode of reaching the general public. The general public must be educated so that they can sort out the useful information from the nonsense. The Office for Science and Society at McGill University was created in 1999, in part to educate the public and combat these deceptive practices. While we realize that our battle may not make a large impact on its own, we hope that it will serve as a model for others to join the effort to educate the public on a number of levels including newspaper,

radio and television activities as well as courses designed for the public. It is our hope that such practices might be established in many locations by motivated academics in an effort to explain confusing issues using good science.

8:00 AM - 9:05 AM

L5: Chemistry in the Public Eye

Peter Atkins (Lincoln College, Oxford University, UK)

There are two principal challenges to communicating chemistry to the general public. One is their memory of bad experiences in high school. The other is the abstract nature of the subject's explanations. There is little that can be done in the short term for the former: we have to hope that revolutions in chemical education will bring about a change in attitude. There is a lot that can be done for the latter, and it could be effective immediately. Chemists have under their control access to extraordinary and striking graphics. They can represent structures and molecules of almost any complexity in a direct and informative way, and no longer do they have to give explanations in symbols. But graphical representation is not confined to the representation of structure: it is also possible to present the principles of chemistry graphically. I will argue that a graphical image is the best way of presenting chemistry to the public, and suggest the types of story that can be told by adopting this medium. In a perfect intellect-friendly media world, we would use television to convey the messages we want our public to appreciate, and with current and future graphics we are at the stage when that has become a viable proposition.

Symposia sessions

Tuesday, August 1 morning

9:15 AM - 12:00 PM STEW 302

S1: About the General Chemistry Laboratory - Session 4 of 4: Experiments

Rudolph W Kluiber (Rutgers University, USA)

General Chemistry Laboratory provides a major hands-on introduction to college chemistry for many science and engineering students. In practice, the mode of teaching and academic success of this course varies greatly. It is the purpose of this symposium to share course variables such as philosophy, content and execution which can improve a student's interest in, as well as understanding of, chemistry.

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|-------|-------------------|---|
| 9:15 | | introduction |
| 9:20 | Rudolph W Kluiber | P217: PlayChem: A series of short, simple, significant experiments used as extra-credit |
| 9:40 | Curtis Pulliam | P218: Using molecular models and advanced instrumentation (IR, NMR, HPLC, and AA) in the General Chemistry Laboratory to explore atomic and molecular structure |
| 10:00 | Steven Brown | P219: ISEs: A cost effective way to add ion selective electrodes to the general chemistry laboratory experience. |
| 10:20 | | break |

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|-------|-----------------------|--|
| 10:30 | Christer Gruvberg | P220: The laboratory, an environment for microscale experiments and small talk ? |
| 10:50 | Michael Seymour | P221: A two for one kinetics experiment |
| 11:10 | Justin Read | P222: The Australian Chemistry Enhanced Laboratory Learning project |
| 11:30 | Kristen Cacciatore | P223: Using inquiry and comparison in the general chemistry laboratory: A novel twist on an acid-base and equilibrium spectrophotometry experiment |

P217: PlayChem: A series of short, simple, significant experiments used as extra-credit
Rudolph W Kluber (Rutgers University, USA)

There are many experiments described in the literature, each taking only a short time to complete and each being simple to carry out. Yet they can provide significant insight into chemistry. We have taken about thirty of these and created a set of extra-credit experiments for use in our General Chemistry Laboratory. Each experiment is individualized and supervised by our computer, GenChem. The student comes in, gets directions from the computer, does the experiment, makes the necessary calculations/conclusions and enters these into the computer which grades the experiment. Each semester, five of these extra-credits are scheduled. Each may be done only during an announced one week period. The student is expected to finish in an hour. PlayChem exposes our students to a problem solving environment which can be both fun and rewarding for the student yet require only minimal faculty time and effort. The one hour time frame also makes them useful for High School.

P218: Using molecular models and advanced instrumentation (IR, NMR, HPLC, and AA) in the General Chemistry Laboratory to explore atomic and molecular structure

Curtis Pulliam (Utica College, USA), William Pfeiffer (Utica College, USA)

About 10 years ago, upon realizing that students neither believed nor understood molecular structure and bonding, we began de-emphasizing the need for correct numerical results and placed more emphasis on structure and bonding in the general chemistry lecture. We have also developed new activities and changed existing experiments in the laboratory. After using Darling Molecular Models in a standard study of Lewis and VSEPR structures, we run a discovery-based lab study of structural isomerism using organic and transition metal examples. IR is used to classify an unknown organic compound by functional group and a discovery-based activity is used to elucidate the basic principles of C-13 NMR. Older experiments we've amended include the synthesis of aspirin in which we're using IR and HPLC to evaluate the product and the titrimetric identification of an unknown organic acid which is correlated with a C-13 NMR spectrum of the same acid. Currently we are designing an AA experiment to accompany study of atomic structure. These changes will be discussed along with the logistics of using modern instrumentation in the general chemistry laboratory.

P219: ISEs: A cost effective way to add ion selective electrodes to the general chemistry laboratory experience.

Steven Brown (University of Arizona, USA), John Dunkle (Wyoming Public Health, US), Cynthia Runkel (University of Arizona, USA)

Having students make measurements using an ion selective electrodes in the general chemistry lab is a good way to introduce sensor technology and reinforce electrochemical concepts. However, due to the fragility and high cost of the electrodes, such experiments are not practical for many

programs. At the University of Arizona we have been using homemade PVC-membrane ion selective electrodes in courses with as many as 800 students. These electrodes are relatively inexpensive to make and easy to maintain. They have proved to be both sturdy and reliable and provide an effective introduction to electrochemical measurement. This presentation will include discussions of their manufacture, the economics of their use relative to “store bought” electrodes and the results obtained by students in a large general chemistry lab course.

P220: The laboratory, an environment for microscale experiments and small talk ?

Christer Gruvberg (Gothenburg University, Sweden)

The GIMMIK project investigates the value of laboratory work for students’ understanding of chemistry. Of particular interest is the comparison of traditional laboratory experiments to microscale work. The advantages of microscale, such as reducing chemical wastes and exposure to chemicals, are well known, but does microscale enhance the learning of chemistry? This presentation will share the results of my research and address such issues as the factors that contribute to increased understanding in the laboratory and whether these factors differ depending on the amounts of chemicals used.

P221: A two for one kinetics experiment

Michael Seymour (Hope College, United States), David Gorno (Hope College, United States)

The study of reaction rates through the spectrophotometric measurement of food color in the presence of bleach is a part of many laboratory programs because the absorbance measurements can be accomplished with a simple single wavelength diode based colorimeter. The physical observation of a colored solution becoming colorless readily shows the time-based conversion of products to reactants. With the availability of moderately priced scanning colorimeters students can investigate reaction rates of more than one component in a single solution and observe reactions that undergo a color change instead of simply the decrease in intensity of just a one color. In the binary system that has been studied the bleaching of red food dye has a rate constant that is approximately 10 times greater than that of the blue food dye. By appropriate adjustments of initial concentrations of the reactants, color changes from red to purple to blue to colorless can be observed and explained on the basis of the difference in reaction rates.

P222: The Australian Chemistry Enhanced Laboratory Learning project

Justin Read (The University of Sydney, Australia), Simon Barrie (The University of Sydney, Australia), Robert Bucat (The University of Western Australia, Australia), Mark Buntine (The University of Adelaide, Australia), Geoffrey Crisp (The University of Adelaide, Australia), Adrian George (University of Sydney, AUSTRALIA), Ian Jamie (Macquarie University, Australia), Scott Kable (The University of Sydney, Australia)

The Australian Chemistry Enhanced Laboratory Learning (ACELL) project aims to improve the quality of learning in undergraduate laboratories. One principal goal of the project is to construct a database of educationally sound, student-tested experiments, which will be freely available to all via the internet. Experiments submitted to the project are evaluated both educationally and chemically, using an educational template which has been developed by the project. Submitted experiments are also tested by academic staff and undergraduate students at workshops, prior to the collection of student feedback data at the submitting institution. In this way, it is possible to ensure that experiments do effectively assist students’ learning. The most recent ACELL workshop was conducted in February, 2006, and involved the collaborative efforts of academic staff and students

from 28 Australian and New Zealand universities. 34 different experiments were tested from across the chemistry disciplines and at all undergraduate levels. This presentation will describe the ACELL approach to improving the quality of undergraduate laboratory learning, and will discuss the achievements of the project.

P223: Using inquiry and comparison in the general chemistry laboratory: A novel twist on an acid-base and equilibrium spectrophotometry experiment

Kristen Cacciatore (University of Massachusetts Boston, usa), Hannah Sevian (University of Massachusetts Boston, USA)

This session will outline a novel experiment we have designed for and extensively field tested in the general chemistry laboratory at the university and Advanced Placement high school levels. This experiment integrates two critical general chemistry topics that students typically find difficult, chemical equilibrium and acid-base chemistry, while simultaneously introducing spectrophotometry principles and techniques. In this experiment students determine the value of the equilibrium constant for the aqueous dissociation of an acid-base indicator using a spectrophotometer and a pH meter. The class is split into two halves and each half studies a different indicator. Their two sets of results are used by all students to understand the significance of the equilibrium constant. We have based the design and content of the experiment on the most recent research findings about how students learn best, including the critical importance of inquiry, the need to address student misconceptions, and the power of comparison as a teaching and learning tool. The presentation includes discussion of the results of our field tests and strategies for training laboratory teaching assistants. Lastly we share insights about how we have begun to facilitate institutional change from a traditional laboratory curriculum to an inquiry-centered curriculum.

9:15 AM - 12:00 PM STEW 310

S28: Calibrated Peer Review in the Classroom - Session 1 of 1

Kevin Kittredge (Miami University, USA)

This symposium focuses on the current applications of Calibrated Peer Review (CPR) in the classroom. Discussions will focus on how CPR is being used in both high schools and universities, how it impacts student learning, and what effects it has on student writing.

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|-------|------------------------|--|
| 9:15 | | introduction |
| 9:20 | Wendy Keeney-Kennicutt | P224: CPR at Texas A&M University |
| 9:40 | Lawrence Margerum | P225: Pre- and Post-Lab Calibrated Peer Review (CPR) writing for experiments with an environmental chemistry focus |
| 10:00 | Kevin Kittredge | P226: Using CPR to teach significant figures to non-majors |
| 10:20 | Tim Zauche | P227: One Way to Introduce a New Teaching Tool to Your Campus. |
| 10:40 | Arlene Russell | P228: Student performance on Calibrated Peer Review writing assignments |

P224: CPR at Texas A&M University

Wendy Keeney-Kennicutt (Texas A&M University, USA)

TAMU is the first institution besides UCLA to have CPR on its own secure server: cpr.tamu.edu.

This occurred in 2003 to avoid FERPA issues and because UCLA and TAMU have a joint NSF project, WALs (Writing for Assessment and Learning in the Natural and Mathematical Sciences). The downside is the present lack of access to the growing list of UCLA library assignments, which should be solved in the next CPR version. The upside is the improved service and training available to local users. In the last 3 years, CPR at TAMU has been used by approximately 10,000 undergraduate and graduate students doing 320 new assignments in 200 courses spread over 30 majors in 7 colleges. CPR's popularity stems from (1) its recognized pedagogical strength as an instructional writing and peer assessment tool, (2) solid institutional support, and (3) the initiation of a writing course requirement for each major. CPR is now being evaluated in classroom assessment and education research; results will be shared.

P225: Pre- and Post-Lab Calibrated Peer Review (CPR) writing for experiments with an environmental chemistry focus

Lawrence Margerum (University of San Francisco, USA)

We describe laboratory projects using Calibrated Peer Review (CPR) for general and analytical chemistry that adapt experiments designed to detect heavy metals in environmental samples using flame atomic absorption spectroscopy (AAS). Each lab project consists of three short CPR-based writing assignments. The first assignment reviews atomic concepts and gives students practice with peer review. The second assignment is a pre-lab for the assigned experiment and the final assignment is a post-lab report. The entire project gives students practice in technical writing, reading for content and quantitative analysis at an early stage in their careers. In fall 2005, first semester general chemistry students generated more than 400 essays on our project called 'Is there Lead in my paint?' all of which were graded by the students. We will discuss student outcomes and share insights into laboratory-based writing projects in multiple sections.

P226: Using CPR to teach significant figures to non-majors

Kevin Kittredge (Miami University, USA)

Calibrated Peer Review (CPR) was used exclusively in a non-majors chemistry course to teach significant figures. Students were then examined and the results compared to courses that used traditional lecture and both lecture and CPR. Results should that students learned significant figures slightly less than when lecture was reinforced with CPR but better than just traditional lecture.

P227: One Way to Introduce a New Teaching Tool to Your Campus.

Tim Zauche (Univ. of Wisc. - Platteville, USA)

Applying for internal grants appears to be a very effective way of announcing to a campus that you are implementing a new "tool" in your teaching practice. This seminar will present a way to encourage a campus to accept CPR and to get faculty on your "team". A reflection will also be presented on how CPR can improve a professor's teaching as well as the student's learning.

P228: Student performance on Calibrated Peer Review writing assignments

Arlene Russell (UCLA, USA)

Since 1997, CPR has been implemented in thousands of classes in hundreds of schools. Many faculty have ample anecdotal evidence that CPR is effective in helping them meet their course goals. Several faculty, have carried out more rigorous studies and reported the results at professional meetings; a few have published their results. In this presentation, we will summarize

the collection of formal studies that we are aware of. These studies in courses using CPR assignments have evaluated student gains in course content knowledge, in writing performance, in reviewing skills, and in the role of peer feedback. Replication of several analyses at different institutions provides credence to the robustness of the student gains.

9:15 AM - 12:00 PM STEW 218AB

S10: Computation, Modeling and Molecular Visualization across the Chemistry Curriculum - Session 2 of 4

Shawn Sendlinger (North Carolina Central University, U.S.A.), **Elisabeth Bell-Loncella** (University of Pittsburgh at Johnstown, USA)

This symposium will highlight the various ways faculty have used visualization, simulation, molecular modeling, mathematical software, and related computational methods to enhance and expand the learning experience in the undergraduate chemistry curriculum – in the classroom, in the laboratory, and in research. Papers describing specific activities for individual courses as well as department initiatives to integrate computation across the curriculum will be included.

| | | |
|-------|------------------|---|
| 9:15 | | introduction |
| 9:20 | Shawn Sendlinger | P229: CSERD: the computational science education reference desk |
| 9:40 | Clyde Metz | P230: Computational chemistry on a shoestring budget |
| 10:00 | Charles James | P231: Molecular modeling in the physical chemistry particle in a box experiment |
| 10:20 | | break |
| 10:30 | Mark Ellison | P232: Visualization of the cutting edge: two examples |
| 10:50 | Gordon Purser | P233: Molecular modeling and kinetic simulations in physical chemistry |
| 11:10 | Carl Aronson | P234: Pedagogy across the polymer chemistry–engineering interface via computation and visualization |
| 11:30 | | discussion |

P229: CSERD: the computational science education reference desk

Shawn Sendlinger (North Carolina Central University, U.S.A.), Clyde Metz (College of Charleston, USA)

There are numerous educational resources available on the Web, but finding those that will be useful when covering a certain topic in a given class for a particular lecture or lab presentation can be a daunting task. If a good applet or other simulation IS located, questions about its accuracy or bounds of applicability may well remain. Also missing is information that discusses how others may have used a given resource and the degree of success they had with their students. The Computational Science Education Reference Desk, CSERD (See <http://www.shodor.org/refdesk/>), is providing a solution to these problems by collecting the best resources available and soliciting different types of reviews from the users so that the entire community benefits. Examples of resources available in Chemistry will be shown and the types of reviews being solicited will be discussed.

P230: Computational chemistry on a shoestring budget

Clyde Metz (College of Charleston, USA), Shawn Sendlinger (North Carolina Central University, U.S.A.)

Want to incorporate new material, approach a subject differently, or present a subject more effectively by introducing computational chemistry into your course? Working with limited or no funds? No problem—as long as you have access to a smart classroom or a computer laboratory. Examples and applications of molecular modeling, simulation, and mathematical software will be presented.

P231: Molecular modeling in the physical chemistry particle in a box experiment

Charles James (UNC at Asheville,)

The traditional Particle in a Box Visible Spectrum experiment has been extended using CAChe software. Incorporating a Computational Chemistry component into this experiment helps the students make the connections with a more realistic view of molecular structure and the physical properties of the compound. The original experiment did try to show the relationship between a simple picture of structure and experiment, but the changed experiment also allows the prediction of the physical properties based on theory. The presentation will address the changes in goals and student involvement in making the connections in the experiment.

P232: Visualization of the cutting edge: two examples

Mark Ellison (Ursinus College, USA)

Computer modeling programs can have tremendous impact on undergraduate education. This talk will present two examples to demonstrate this point. In the first example, a MathCad document can help students to understand the fundamentals of Ahmed Zewail's femtosecond-level studies of chemical reactions. In the second example, computer modeling in an undergraduate research project is described. This work used semi-empirical and density-functional calculations to help interpret experimental data on the interaction of water with carbon nanotubes. These examples demonstrate that computational chemistry can be used with undergraduates with success at the forefront of chemistry.

P233: Molecular modeling and kinetic simulations in physical chemistry

Gordon Purser (The University of Tulsa, USA)

There are two ideas in chemical kinetics that lend themselves well to modeling and computation. The first is the idea of a transition state species. The other is the change in concentration of reactants, products and intermediates in complex kinetic mechanisms. Recently two group assignments were used in a senior-level physical chemistry course to familiarize students with modeling and simulation techniques. Spartan '02 for Windows was used to model transition state structures for simple elementary systems. In another project, students used Mathematica to solve simultaneous differential equations and compared theoretical results with the observed experimental results. Following the projects, students were asked to comment on the effectiveness of the exercises in helping them visualize and understand the relevant kinetic concepts. This presentation will include details of the projects as well as a summary of student feedback.

P234: Pedagogy across the polymer chemistry–engineering interface via computation and visualization

Carl Aronson (Kettering University, USA)

Many engineering undergrads do not appear compelled to learn chemical reaction mechanisms

involving electron pushing, bond scission/formation thermodynamics or nanometer scale kinetics. Nevertheless, understanding reaction mechanisms plays an important role in stemming undesirable side reactions, chemical reactor optimization and control as well as developing tailored, novel materials. While the primary learning mechanism for organic chemical systems often involves mere memorization, most engineering students quickly assimilate multivariable manufacturing process design involving mechanical mechanisms and visualization of meter scale structures via computer aided design (CAD) graphical communication. To overcome these hurdles to learning organic chemistry, we have adapted computational and molecular visualization techniques to teach polymerization chemistry to engineering students. Molecular modeling of organic polymerization mechanisms is used to demonstrate monomer susceptibility, reaction geometry, thermodynamics and transition state structure. Polymerization kinetics are modeled as a function of temperature, solvent, chemical initiator identity and concentration of impurities using facile systems dynamics software. Students generated innovative CAD designs which superimposed abstract mechanistic organic molecular models onto recognizable mechanical mechanisms highlighting similarities in mechanistic repetition/iteration as well as differences in length scale and energy transport. Undergraduate research students and faculty collaborating across academic disciplines and institutions have contributed to this project. Preliminary results indicate that both structural and kinetic modeling exercises, and the CAD-molecular modeling superposition aid in developing the student's chemical reasoning skills. The reasoning skills help circumvent formulaic thinking via simple memorization as routinely observed for engineering students learning organic polymer chemistry.

9:15 AM - 12:00 PM STEW 214D

S29: Cooking with Chemistry - Session 1 of 1

Sally Mitchell (Syracuse University, USA)

Foods are complex mixtures of chemicals that interact and react during processing, storage, and cooking in ways that affect the nutritional value, flavor, texture, color, and safety of the final product. Food chemists rely on virtually all the branches of chemistry to understand the properties of foods and to apply this understanding toward improving the quality and nutritional value of our food supply. Thus, food examples offer relevant connections to basic chemical principles, common chemical reactions, as well as providing an appealing hook to capture the interest of most anyone who likes to cook, enjoys good food, or aspires to a career in food science or nutrition. This symposium will offer a multi-course menu of ideas, anecdotes, activities, and investigations that can be used to beef-up existing programs or add a bit of spice to most any chemistry course. Presenters will provide "food for thought" as they share their experiences and knowledge of food chemistry in order to help you add a bit of flavor to your classes.

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|-------|-------------------|--|
| 9:15 | | introduction |
| 9:20 | Sally Mitchell | P235: Teaching Chemistry Through Food Science |
| 9:40 | Rodney Green | P236: Alginates: A versatile teaching tool for many ages and chemical concepts |
| 10:00 | Susan Hershberger | P237: Flavors are More than Esters |
| 10:20 | | break |
| 10:30 | Michael Pelter | P238: Beer: Good for Cooking and Chemistry |

10:50 Jennifer Strahl P239: Montverde Academy Culinary Club: teaching high school food chemistry in an extracurricular club

11:10 discussion

11:30 Suzanne Nielsen P240: Food Enzymes: Friend or Foe? - - A Great Teaching Topic

P235: Teaching Chemistry Through Food Science

Sally Mitchell (Syracuse University, USA)

This paper will demonstrate different methods of introducing food science into the chemistry curriculum. Food science is interesting topic in chemistry and it attracts all different levels of students to the chemistry table. Students that are introduced to food science in an introductory chemistry course are more likely to gain a deeper interest and appreciation in the chemistry that they are studying. Sugar chemistry will be discussed in detail and laboratory activities will be shared. This is a great way to capture the interest of anyone who likes to cook or who enjoys good food prepared correctly.

P236: Alginates: A versatile teaching tool for many ages and chemical concepts

Rodney Green (Purdue University, USA)

Alginates are long chain polysaccharides produced naturally by brown seaweed (*Laminaria hyperborea*). Once extracted this unbranched polymer has potential not only as a food ingredient but as a teaching tool for multiple age groups. The primary function of alginates is as thermally stable cold-set gelling agents in the presence of calcium ions. As a food ingredient it is most commonly found mixed with the pimento in olive or added in frozen onion ring formulations to stabilize the ring shape. In the demonstration, food grade sodium alginate (TIC Gums) will aid in conveying the scientific material while doubling as an edible treat for participants. Discussion of substrates and their modifications can help teach various concepts, such as viscosity, ionic bonding, pH effects on proton donor/acceptor, and gelation. Each concept has its level of complexity that can be discussed and the demonstrations utilize common high school lab equipment with easily acquirable and inexpensive ingredients. When I've performed this before, young children have unofficially named this experiment "Instant Gummy Worms." This is because when a colored solution of alginate is quickly pipetted into a calcium solution, a gel sets instantaneously and the "worm" forms. The demo is visually appealing and exciting for children young and old to witness, all while teaching them concepts they will use later in learning.

P237: Flavors are More than Esters

Susan Hershberger (Miami University, USA), Mickey Sarquis (Miami University, USA)

Popular foods today include ingredients listed as natural flavors, artificial flavors or natural and artificial flavors. What are some of these flavors chemically? How can they be used to teach chemical principles and capture student's attention? Flavor chemistry activities appropriate for introductory chemistry classes, as well as organic classes will be described.

P238: Beer: Good for Cooking and Chemistry

Michael Pelter (Purdue University Calumet, USA)

Most people respond to the idea of a "Brewing Science" course with raised eyebrows and comments like "How can that be science?" In contrast, students who have taken the course can not believe how much science they have learned and begin to see science throughout their lives. In this presentation, I will highlight the units in the Brewing Science Course involve the chemistry and

biochemistry of Flavors and Fragrances. Beer is a complex mixture of over 950 known compounds. By analyzing the different beer styles, students learn how to distinguish the basic taste perceptions and trigeminal effects and couple them with a nasal and retronasal evaluation. The importance of this science in the Brewing Industry will be highlighted and the connection to other industries will be emphasized.

P239: Montverde Academy Culinary Club: teaching high school food chemistry in an extracurricular club

Jennifer Strahl (Montverde Academy, USA)

Montverde Academy, an independent school in central Florida, recently introduced a new academic club: The Montverde Academy Culinary Club. The upper-school student body is composed of both day and boarding students. Boarding students, in particular, eat nearly all of their meals in the school dining hall. Thus, many of them leave for college without much experience in the kitchen. The culinary club was founded as means of introducing students to the scientific foundations of cooking. Kitchen instruction is provided during the course of club activities that have strong scientific content. Club participants come from a range of grade levels, science backgrounds, and kitchen familiarity. Most club members are upperclassmen, and have previously taken or are concurrently enrolled in a first-year chemistry course. Given the varied student background, the club activities cover a wide range of chemistry topics - from elementary scientific method and properties of mixtures to acid-base reactions, colligative properties, and Maillard reactions. Some club activities are adapted from food-centered lab activities already used in their chemistry and physical science courses. These activities, which take place in the laboratory, include quantitative tests of foods and beverages for vitamin, mineral, and nutrient content, and the biochemistry of taste and food safety. Students often perform analyses of recipes. Students compare ratios in similar recipes to examine the effects of ingredient proportions. Students also treat a recipe ingredient as an independent variable to study how ingredient variation affects the finished products. For example, leavener effects are evaluated in pancakes; differences among butter, margarine, and vegetable spreads are sensed in a cookie recipe. Students also learn kitchen techniques such as the basics of wet and dry cooking methods, the creation of suspensions, colloids, and emulsions, and advanced topics such as browning reactions, the chemical and physical properties of sugar, and cheesemaking. Club time is also spent on connoisseurship; students learn to carefully taste and methodically evaluate flavors. Sensory evaluation is coupled with the chemistry of natural and artificial flavors. Faculty and student perspectives on the club's first year will be presented. Activities appropriate for laboratories, classrooms, and kitchen facilities will be shared.

P240: Food Enzymes: Friend or Foe? - - A Great Teaching Topic

Suzanne Nielsen (Purdue University, U.S.)

Enzymes are highly specialized proteins that catalyze specific biochemical reactions. In foods, enzymes can cause reactions that are either beneficial or detrimental. Their activity in foods can be controlled by factors such as temperature, oxygen, water content, pH, and certain chemicals that enhance or inhibit activity. Enzymes are important in the food industry because they may be: 1) added to cause particular reactions, 2) naturally present and you want to inactivate them, 3) naturally present and you want to enhance their activity, or 4) used as indicators of proper processing of a food product. All these principles about food enzymes can be easily demonstrated by the presentation of examples in the classroom and laboratory experiments for students. Student

interest in the subject can be peaked by asking introductory questions to which everyone can relate (e.g., Why do fruits like apples turn brown after biting into them? How do they get the liquid inside a chocolate covered cherry?). Students can conduct an experiment that shows the effect of oxygen, vitamin C, and acetic acid on activity of the enzyme that causes browning of apples. Students also can do an experiment that shows how the enzyme rennet coagulates milk proteins to make cheese, including the effect of temperature. These experiments can be used to cover the principles above at various levels, depending on the age of students. Glassware and supplies for these experiments are inexpensive and easily available. During the waiting time of experiments conducted by students, the instructor can show examples of natural and processed food products related to enzyme action in food, answering questions such as the following: What happens when you add fresh pineapple to gelatin, compared to using canned pineapple, and why is there a difference? How do they make some apple juice cloudy and others is clear? Why do onions make you “cry”? How do they use enzymes to make sure the milk you drink is safe?

9:15 AM - 12:05 PM STEW 202

S30: Information Obstacle Course: Successfully Incorporating Chemical Information Into Your Curriculum - Session 1 of 1

Leah Solla (Cornell University, USA)

Students need information to solve chemical problems and chemical information sources are rapidly increasing in number and variety. Students will be more successful in courses and in the research lab if they have good information navigation skills. The ACS CPT Guidelines stress the importance of teaching information searching as: "too complicated to leave to self-learning." These skills can be introduced and improved directly in the classes that demand their use. This session will cover a wide variety of case studies incorporating chemical information into the chemistry curriculum specifically at the undergraduate level.

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|-------|-------------------|--|
| 9:15 | | introduction |
| 9:20 | Patricia Kirkwood | P241: Teaching chemical information: tips and techniques |
| 10:35 | | break |
| 10:45 | Robert Landolt | P242: Integrating chemical information instruction into the undergraduate chemistry curriculum |
| 11:15 | Jung R. Oh | P243: Collaborative integration of information literacy: a progress report on the General Chemistry course |
| 11:35 | Steven Wathen | P244: Some free resources on the Internet for introducing chemical information |
| 11:55 | | discussion |

P241: Teaching chemical information: tips and techniques

Patricia Kirkwood (University of Arkansas, USA)

The American Chemical Society's Committee of Professional Training (CPT) guidelines stress that chemistry students need to become information literate. The skills needed by practicing chemists and chemical researchers are complex. Students need repetitive exposure to increasingly complicated information tools and skills to become information competent. To enable instructors to integrate chemical information into their course work, chemistry departments need to plan for

this type of instruction throughout the undergraduate curriculum. Graduate teaching assistants also need training in information skills to support the curriculum. Though this sounds like a daunting task, the Education Committee of the Division of Chemical Information has provided excellent resources, suggested curriculum guidelines, and sample exercises to help any chemistry department or faculty member develop an effective program.

P242: Integrating chemical information instruction into the undergraduate chemistry curriculum

Robert Landolt (Texas Wesleyan University, USA)

Through a cooperative learning strategy, students have been challenged to relate concepts learned in organic chemistry to published research, in order to attack a "real-world" environmental problem. A cost-effective process will be described, through which STN Easy has been demonstrated to have potential for use in the context of a laboratory course in undergraduate institutions. This and other tasks undertaken in Project UCAIR (Undergraduate Cooperative Access to Information Resources) will be subjects of discussion.

P243: Collaborative integration of information literacy: a progress report on the General Chemistry course

Jung R. Oh (Kansas State University - Salina, USA), *Judy Collins* (Kansas State University - Salina, USA), *Beverlee Kissick* (Kansas State University - Salina, USA), *Alysia Starkey* (Kansas State University - Salina, USA)

For "Information Literacy (IL)" instruction, faculty in Chemistry, Technical Writing, and the Library have collaborated with cross-curricular teaching and learning activities. This presentation describes the collaborative efforts and results of infusing curriculum with IL. It shares the process and experiences of developing discipline-specific assignments for defining and assessing context-sensitive IL. University General Education General Chemistry course assignment examples include: (1) pre-lab search summary integrated with library In-service lecture, prior to inquiry lab on "chromatography," and (2) search on "chemicals in consumer products" to evaluate benefits and precautions. Outcomes of this collaboration are rewarding, based on student perception survey responses, teacher observation of student work, and faculty lessons learned to bridge the interdisciplinary process.

P244: Some free resources on the Internet for introducing chemical information

Steven Wathen (Siena Heights University, USA)

Access to the chemical literature can be problematic for smaller schools. Library subscriptions to research journals are very expensive, smaller schools may not be able to subscribe to more than a couple of journals. Indexing and abstracting services like Chemical Abstracts and Web of Science are also quite costly. There are a variety of resources available over the Internet for free that can fill some of these gaps. Topics discussed in this session will include: Open Access journals, free databases, and journal searching without a subscription.

9:15 AM - 12:00 PM STEW 314

S31: Novel Ideas in Teaching Introductory Chemistry - Session 1 of 1

Don Carpenetti (Marietta College, USA), *Willy Hunter* (Illinois State University, USA)

This symposium of general interest to the Chemical Education community will focus primarily on novel ideas in the teaching of introductory chemistry.

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| 9:15 | | introduction |
| 9:20 | James R. Nye | P245: Visualizing the limiting reagent: An experiment for high school chemistry students |
| 9:40 | Jessica Orvis | P246: Active learning with paper wads |
| 10:00 | Arnaldo Carrasquillo, Jr. | P247: Improving conceptions in analytical chemistry: $c_i \times V_i = c_f \times V_f$ |
| 10:20 | | break |
| 10:35 | Robert Gregory | P248: Whoosh bottle safety: A new concern |
| 10:55 | Don Carpenetti | P249: Should the concept of hybridized orbitals be removed from general chemistry classes? |
| 11:15 | Todd Pagano | P250: Shedding light on spectroscopy: Rejuvenation and extensions of the flame test experiment |
| 11:35 | John Tanaka | P251: Solid State Chemistry via Glass and Ceramics |

P245: Visualizing the limiting reagent: An experiment for high school chemistry students

James R. Nye (Lock Haven University of Pennsylvania, United States), *Laura Lee* (Lock Haven University of PA, USA)

The limiting reagent concept is one that high school and first-year college chemistry students often have difficulty understanding. An experiment was created that visually illustrates this concept. Four sets of reactions are examined in the experiment; two gas evolution reactions and two precipitation reactions. Both one-to-one and two-to-one mole ratio reactions are included. Student observations are reinforced with theoretical calculations and quantitative demonstrations. Suggestions for related class discussion topics will also be presented.

P246: Active learning with paper wads

Jessica Orvis (Georgia Southern University, USA)

Active student learning demonstrations are fun for both students and teachers. A demonstration is described in which the entire classroom erupts in a controlled paper wad fight. In this active learning exercise, student misconceptions regarding the nature of equilibrium are addressed.

P247: Improving conceptions in analytical chemistry: $c_i \times V_i = c_f \times V_f$

Arnaldo Carrasquillo, Jr. (University of Puerto Rico, USA), *Margarita Rodriguez-Lopez* (Pontifical Catholic University of Puerto Rico, USA)

A common misconception related to analytical chemistry, which may be generalized as the failure to recognize and to account analytically for changes in substance density, is discussed. A cautionary example is made through the use of mass-based units of concentration during volumetric dilution. The correct application of the volumetric dilution equation $c_i \times V_i = c_f \times V_f$ is discussed. A quantitative description of the systematic error introduced by incorrect use of the volumetric dilution equation is also specified.

P248: Whoosh bottle safety: A new concern

Robert Gregory (Indiana University Purdue University Fort Wayne, USA)

Most literature references to the inherent safety of the classic whoosh bottle demonstration deal with the explosive nature of the vapor/container system. Several references, including some quite

recent ones, point to the use of lower-energy fuels and resilient containers to minimize the detonation potential and the concomitant risks to students and personnel. We have discovered a new risk associated with the demonstration. The use of lower chain alcohols in the combustion reaction can produce complex hydrocarbons, many of which are potential or recognized carcinogens. A review of our data, and a discussion of the safety hazard they may indicate is presented.

P249: Should the concept of hybridized orbitals be removed from general chemistry classes?

Don Carpenetti (Marietta College, USA)

The concept of orbital hybridization as it is generally portrayed in general chemistry texts will be compared with the results of actual experiments. Are we being disingenuous to the scientific method by continuing to teach orbital hybridization to freshmen?

P250: Shedding light on spectroscopy: Rejuvenation and extensions of the flame test experiment

Todd Pagano (Rochester Institute of Technology, USA)

The flame test is a fabulous experiment used by many high school and college programs. This student favorite is also often an activity of instructor preference. The experiment has been used to discover topics like introductions to light properties, descriptions of atomic structure, relevance of scientific/historical events, and basics concepts of quantum mechanics. Previous extensions of the experiment have been shown as a qualitative tool to assess various metallic components of consumer products. Our contributions to the legacy include modifying the experiment for early use in an instrumental analysis class as an introduction to not only spectroscopy, but also to the contemporary spectrophotometer. The basic instrumental components of modern spectroscopy instruments (light source, wavelength selector, detector, and computer) are depicted and understood in the flame test experiment with the corresponding (flame, prism or grating inside the spectroscope, the students' eyes, and chemical/physical information sources; respectfully). Emphasis is given to the fundamental process used to establish and apply calibration curves, as the curves are then used in the determination of unknowns. The benefits of this augmented experiment include improved student motivation and understanding of content.

P251: Solid State Chemistry via Glass and Ceramics

John Tanaka (Univ. Connecticut, USA)

Glass and ceramics are some of the oldest materials made by man. However, there is very little taught about the chemistry of these materials in the courses taken by undergraduate chemistry majors. In order to partially rectify this situation, an experiment has been devised to form a ceramic wherein the structures of kaolin, quartz, and feldspar are discussed. This is accompanied by a lecture demonstration wherein the properties of soft glass, Pyrex, and quartz are compared and related to structure. The combination of lecture, demonstration, and laboratory work help to introduce the rudiments of solid state chemistry.

9:15 AM - 12:00 PM STEW 218CD

S22: POGIL: Process-Oriented Guided Inquiry Learning - Session 2 of 4

Rick Moog (Franklin and Marshall College, USA)

POGIL is a student-centered instructional paradigm that combines a group learning approach with specially designed guided inquiry activities. The goal is to not only enhance student mastery of

course content, but also to develop important learning process skills such as communication, problem solving, and critical thinking. This symposium will include presentations dealing with the implementation and evaluation of this approach across a wide array of disciplines and institutional types and levels.

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|-------|------------------|--|
| 9:15 | Elizabeth Jensen | P252: Just Do It: Perspectives of First-Time POGIL Implementers |
| 9:35 | Suzanne Ruder | P253: POGIL in the Large Classroom: Managing Groups Amid the Chaos |
| 9:55 | Dan Libby | P254: Using Electron Energies to Emphasize Process in a POGIL Organic Course |
| 10:15 | Gary D. Anderson | P255: POGIL vs Traditional Lecture in Organic I |
| 10:35 | | break |
| 10:45 | George Trampe | P256: Assessment of content Learned in POGIL Sessions Using the ACS Standardized Test |
| 11:05 | Juliette Lantz | P257: The ANA-POGIL Project: Analytical Chemistry Meets Process Oriented Guided Inquiry Learning |
| 11:25 | Caryl Fish | P258: Using POGIL Activities in Instrumental Analysis |
| 11:45 | | discussion |

P252: Just Do It: Perspectives of First-Time POGIL Implementers

Elizabeth Jensen (Aquinas College, USA), Li-heng Chen (Aquinas College, US)

The authors' initial experiences implementing POGIL for general, organic, and physical chemistry courses at a small, liberal arts college (Aquinas College in Grand Rapids, Michigan) will be presented through anecdotal and student score data. Our reasons for introducing a POGIL approach, methodology, obstacles encountered, and lessons learned will be discussed.

P253: POGIL in the Large Classroom: Managing Groups Amid the Chaos

Suzanne Ruder (Virginia Commonwealth Univ., USA)

One of the major challenges of implementing POGIL in a large classroom is managing groups and effectively facilitating interactions with each group. With fixed seating and classrooms filled to capacity, managing groups is difficult from a logistical standpoint. A variety of techniques have been employed, including classroom polling devices and IF-AT answer sheets, to help maintain working groups. The author's experiences using the POGIL method in large organic chemistry classes at Virginia Commonwealth University will be discussed.

P254: Using Electron Energies to Emphasize Process in a POGIL Organic Course

Dan Libby (Moravian College, USA)

The unique aspect of the POGIL approach is to simultaneously teach academic content and key process skills that enhance student understanding of course material and provide them with tools for learning beyond the course. This presentation describes Electron Energy Analysis (EEA), which uses changes in the energies of electrons in reactions to provide students with a systematic analytical process. Focusing only on electron energies, EEA is a conceptually simple approach to identify the important, most reactive, sites even in complex reactions and use them to develop understanding and make predictions. Thus EEA emphasizes the process of analysis important for

understanding chemical reactions. Applications of EEA to teaching process in a POGIL introductory organic chemistry course will be discussed.

P255: POGIL vs Traditional Lecture in Organic I

Gary D. Anderson (Marshall University, USA)

This paper will compare the performance of two groups of students through the full year of Organic Chemistry. There were approximately 85 students in each group. One group of 85 was taught as a single section using the traditional lecture approach. The other group was taught as two sections using the POGIL approach. As far as possible, all other factors were the same for both groups. The same professor taught both groups and both groups had the same text, homework, quizzes, exams, and help sessions. Both groups were intermingled in two sections of Organic II with another professor who used a traditional lecture approach for both sections.

P256: Assessment of content Learned in POGIL Sessions Using the ACS Standardized Test

George Trampe (Shawnee State University, USA)

Organic chemistry students improved their performance on the ACS test in targeted areas that they were introduced to in POGIL sessions. Questions on the test were grouped by subject area. Selected subject areas were introduced using the POGIL approach and the percent correct responses in those areas was compared with previous years' results.

P257: The ANA-POGIL Project: Analytical Chemistry Meets Process Oriented Guided Inquiry Learning

Juliette Lantz (Drew University, USA)

Analytical chemistry has been a rather overlooked area of chemistry in many of the systemic curricular reform efforts that have occurred in the past decade. The POGIL methodology is an ideal fit for this data-driven sub-discipline. A project to generate and assess POGIL materials for analytical chemistry is underway, and the progress of this effort will be reported. A sampling of guided inquiry materials written for analytical chemistry will be presented.

P258: Using POGIL Activities in Instrumental Analysis

Caryl Fish (Saint Vincent College, USA)

Developing a student centered approach to teaching instrumental analysis has been challenging. Using the POGIL framework, I have developed and piloted several activities during 2005. These include activities on the analytical method, Beer-Lambert Law, UV-Vis spectroscopic instruments, and mass spectroscopy. This paper will discuss the use of those activities and preliminary feedback from students.

9:15 AM - 12:00 PM STEW 306

S4: Research in Chemical Education - Session 4 of 6

Christopher Bauer (Univ. of New Hampshire, USA)

This symposium, sponsored by the CHED Committee on Chemical Education Research, is a forum for research conducted on the teaching and learning of chemistry at any level. Presentations will address: 1) the motivation for the research and the theoretical bases in which it is grounded, 2) the methods used to gather and interpret data, and 3) the findings and their significance interpreted in light of theory and method. Authors are being strongly encouraged to bring copies of an extended abstract to share with the audience.

| | | |
|-------|------------------|---|
| 9:15 | Daniel Domin | P259: Utilizing advance organizers to facilitate change in general chemistry students' conceptions of the nature of science. |
| 9:35 | David Meyer | P260: Impact of vocabulary pre-reading activities on chemistry comprehension |
| 9:55 | Thomas Pentecost | P261: Analysis of first-year college chemistry students knowledge about and usage of text |
| 10:15 | | break |
| 10:25 | Michael Abraham | P262: Using molecular representations to aid student understanding of stereochemical concepts |
| 10:45 | Joe Shane | P263: General chemistry students' understanding of structure-function relationships |
| 11:05 | Sevil Akaygun | P264: How do 10th grade students interpret and evaluate different animations on H-bonding? |
| 11:25 | Eun Jung Park | P265: Understanding students' learning and conceptual development of atomic structure in the analysis of mental models using dual coding theory |

P259: Utilizing advance organizers to facilitate change in general chemistry students' conceptions of the nature of science.

Daniel Domin (Tennessee State University, USA)

Advance organizers regarding scientific theories and laws and the role of creativity and imagination were incorporated into lecture and laboratory respectively of the general chemistry curriculum at a historically black university. Three versions of each advance organizer was presented to different student groups: 1) explicit reference to the nature of science aspect, 2) implicit reference to the nature of science aspect, and 3) no reference to the nature of science aspect. Early-semester and late-semester administration of a modified View of Nature of Science-Form C (Lederman, et al., 2002, JRST, 39, 497-521) questionnaire was used along with semi-structured interviews to ascertain shifts in students' conceptions of these aspects of the nature of science. The survey was administered to 235 students prior to implementation of the advance organizers and to 135 students, later in the semester, after they completed the instructional activity that utilized the advance organizers. Semi-structured interviews allowed volunteers (5 – early semester and 6 – late semester) to elaborate on their responses to the written questionnaire. Results of this study show that with respect to scientific theories and laws, the utilization of advance organizers had virtually no effect on altering their conceptions. However, utilization of advance organizers for creativity and imagination as part of the laboratory activity led to significantly more students with more informed views. In this case, implicit reference to the nature of science aspect was more effective in altering students' conceptions than the explicit reference.

P260: Impact of vocabulary pre-reading activities on chemistry comprehension

David Meyer (Marshall Public Schools, US), *Renee Cole* (Central Missouri State University, USA), *Matt Thomas* (Central Missouri State University, USA)

One of the challenges facing chemistry teachers is the issue of students who do not seem able to learn material by reading the text. The educational field of Content Area Literacy has developed a number of teaching methods that facilitate the development of students' abilities to read to learn. One of these techniques is "pre-reading." Pre-reading involves trying to prepare students to read more actively and, consequently, successfully. Pre-reading is a literacy/learning concept that has

been around for some time, although its usefulness has not been studied extensively in science education, specifically chemistry. The hypothesis of this study was that vocabulary pre-reading instruction will result in better reading comprehension of high school chemistry textbooks. The hypothesis was investigated by administering a measure of comprehension to high school chemistry students after they had finished their required textbook readings. The results of these quizzes showed that when students received the pre-reading vocabulary instruction, their quiz scores were higher and the differences were statistically significant and showed nearly a large effect size. The results of this study indicate that vocabulary pre-reading instruction is effective in aiding students in the comprehension of high school chemistry textbooks.

P261: Analysis of first-year college chemistry students knowledge about and usage of text

Thomas Pentecost (Aims Community College, USA), Loretta Jones (University of Northern Colorado, USA)

This study analyzed the usage of textbooks by students in a first-year college chemistry course, the students' approaches to studying, and their knowledge about science reading. Students' knowledge about reading science text was measured by the Index of Science Reading Awareness (ISRA). Textbook usage was measured using the Science Reading Strategy Survey (SRSS). The students' approaches to studying were determined by using the Study Process Questionnaire (SPQ). Our data indicate that the majority of first-year chemistry students, 62 %, possess comprehensive knowledge about science reading strategies and science text. The majority of students, 71%, reported behaviors that indicated they were reading at a deep/making connections level. This is in contrast to the small minority of students, 7.1%, who indicated they had a deep approach to learning in the course. There was no correlation between students' metacognitive knowledge (ISRA) and either their reading strategies (SRSS) or achievement, as measured by the final exam score. Lastly, there was no correlation between students' strategy use (SRSS) and their approach to studying (SPQ). When an analysis of variance was run only the students' approach to studying and the instructor influenced the exam score.

P262: Using molecular representations to aid student understanding of stereochemical concepts

Michael Abraham (University of Oklahoma, USA)

Students experience difficulty in dealing with spatially related chemistry concepts requiring three-dimensional visualization. One of these concept areas in the chemistry curriculum is stereochemistry. A major problem with this subject is the necessity to visualize three-dimensional molecules mentally and in turn represent this on a two-dimensional surface. As an instructional aid, concrete manipulative like molecular models and other visuals are typically used. Computer animated visuals have been shown to help students form their own mental images and improve their achievement. The present study will investigate the relative effectiveness of three kinds of molecular representations on students understanding of stereochemistry concepts. The instructional activities include the use of (a) computer animated models (b) hand-held ball and stick models, and (c) perspective drawing representations of molecules.

P263: General chemistry students' understanding of structure-function relationships

Joe Shane (Shippensburg University, USA)

The goal of this study was to examine general chemistry students' understanding of the relationship between structure and chemical/physical properties . Case studies of three

undergraduate engineering students in the second semester of a year-long general chemistry course were conducted using Lewis electron dot structures. Each student was asked to use Lewis dot structures to analyze five problem sets on the following topics: Lewis acid-base reactions, the solubility of gases in aqueous solution, acid-dissociation equilibria, chemical kinetics, and thermodynamics. The interview data suggested that the students' perceptions or representations of Lewis dot structures could be classified primarily as verbal-linguistic or symbolic. The two students for whom these structures were most often verbal-linguistic representations exhibited a dependence on the external or visual features of dot structures. Their descriptions of the aforementioned chemical and physical phenomena tended to be static and inconsistent with scientific reality. The student for whom these structures were more likely to be symbolic representations exhibited more dynamic and interactive descriptions, which were more consistent with what one would expect from a practicing chemist. For this student, the dot structures were true symbols in that they had meaning beyond their external, visual features.

P264: How do 10th grade students interpret and evaluate different animations on H-bonding?

Sevil Akaygun (University of Northern Colorado, USA)

In chemistry, one of the important concepts that explains many behaviors of substances is hydrogen-bonding. Internet provides chemistry teachers with valuable resources that enable visualization of H-bonding at molecular level. The aim of this study is to examine students' evaluations and interpretations of five web-based animations, each of which displayed distinctive features on H-bonding. Fifteen randomly selected 10th grade students worked individually in the computer lab on their own pace by viewing the animations and answering the questions related to the animations. The results were analyzed with respect to students' evaluation of each animation in terms of effectiveness and comprehensibility, comparison of intended and observed interpretations, and changes in students' understanding of H-bonding.

P265: Understanding students' learning and conceptual development of atomic structure in the analysis of mental models using dual coding theory

Eun Jung Park (Ohio State University,)

Paivio's dual coding theory (1971) addresses the existence of two separate cognitive (coding) systems specialized for the verbal and imagery representation, respectively. To explore the cognitive processes understanding atomic structure, this study compares students' mental models as represented in the written and diagrammatic responses to questionnaires. Data for this study were collected from students of an introductory college chemistry course. In addition to the comparison of the written and diagrammatic responses, the analysis of the pre- and post-responses provides information about relationships between dual coding systems and conceptual development. Analyzing students' mental models helps understand the relationship of cognitive processes and the two different representations. This study supports the influence and importance of imagery representations in learning atomic structure.

9:15 AM - 12:00 PM STEW 214A

S24: Science Education: Vital Connection of Science to the Public Sphere - Session 2 of 3

Rainer Glaser (University of Missouri-Columbia, USA)

Pervasive connections exist among science and the political, economic and sociological

foundations of society and the interactions between societies. Every modern society must constantly review and negotiate the moral, ethical, and philosophical aspects of these connections. All societies face the central challenge of achieving successful progress in light of “inform & consent”-based interdisciplinary collaboration. In an environment of disciplinary specialization and increasing discipline-based competition, systematic change can only be achieved with interdisciplinary approaches that are designed with respect for society’s true complexity. The symposium brings together speakers with expertise in various science disciplines, the theory and practice of education, sociology, political science, journalism, and art. The speakers represent all ranks and various types of institutions and share a common interest in interdisciplinary science education. The speakers will share their insights and experiences, present and argue their ideas, and provide guidance to improving “science communication.”

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|-------|-----------------|--|
| 9:15 | | introduction |
| 9:20 | Jan Weaver | P266: By the Rules: how rules of nature, society & individuals interact to cause and solve environmental problems |
| 10:00 | Daniel Kleinman | P267: Citizen Participation in Technological Decisionmaking: The Case of the Nanotechnology Consensus Conference in Madison, Wisconsin |
| 10:40 | | break |
| 10:50 | Rainer Glaser | P268: Chemistry Is in the News: Preparation for Science Communication |
| 11:10 | Kerry Karukstis | P269: Promoting the Interrelationship of Chemistry and Society with a Case Study Approach |
| 11:30 | Nora Demers | P270: Using Contemporary Issues to Teach Skeptical Inquiry: An Approach to Improve Science and Information Literacy among Undergraduates |
| 11:50 | Joanne Stewart | P271: Integrative Learning in the Sciences: Decision Making at the Intersection of Science Knowledge and Student Beliefs and Values |

P266: By the Rules: how rules of nature, society & individuals interact to cause and solve environmental problems

Jan Weaver (University of Missouri, USA)

Environmental problems are due to complex interactions of nature, society and individuals. In order to solve environmental problems it is useful to understand some of the rules that govern nature, society and individuals. These include, for nature: heat disperses, matter cycles, populations grow, life evolves; for society: society stratifies, tragedy of the commons, the devil is in the details; for individuals: perception is reality, follow the money, money is a proxy for meaning. The failure of scientists to understand the rules that govern society and individuals, or of policy makers, business owners (and even scientists) to understand the rules that govern nature, complicates efforts to identify, analyze and solve environmental problems. It is important that people not only know these rules, but also understand how they interact to foster the spread of persistent organic pollutants, the establishment of an international treaty on chlorofluorocarbons, and to fuel the appearance of a scientific debate on climate change.

P267: Citizen Participation in Technological Decisionmaking: The Case of the Nanotechnology Consensus Conference in Madison, Wisconsin

Daniel Kleinman (,)

Consensus conferences were pioneered in Denmark in the 1980s, as a means to involve lay citizens in decision-making on technologies of broad public importance. These fora bring a diverse group of twelve to fifteen citizens together over three days to discuss a high profile technical issue and to issue a report on the questions under discussion. In the spring of 2005, a group of undergraduate students at the University of Wisconsin, a postdoctoral fellow, and I organized one of the first consensus conferences held in the United States. The topic was nanotechnology. In this presentation, I will describe how our consensus conference was organized and will consider the educational and civic engagement benefits that came out of our citizen forum

P268: Chemistry Is in the News: Preparation for Science Communication

Rainer Glaser (University of Missouri-Columbia, USA)

The “Chemistry Is in the News” (CIITN, <http://ciitn.missouri.edu>) project teaches chemistry in the context of real-world social, economic, and political issues. The CIITN curriculum provides meaningful content for collaborative group learning and offers modern and authentic learning opportunities, preparing students for science communication in a global world. The implementation relies on the Internet and on information science and technology for the study of CIITN portfolios, portfolio creation, peer review of portfolios, and the assessment of the curriculum. We will describe the CIITN curriculum, including recent and continuing developments. Recognizing that science literacy is incomplete without media literacy, we collaborate with journalists to strengthen CIITN’s base in popular media. Building on successful inter-state collaborations, we are pursuing international learning activities, including international peer review and transnational project creation. We believe that direct person-to-person contact, both between faculty and students, is essential for building meaningful relations and, aside from asynchronous communication, we are expanding our communication tools to include video-conferencing. The CIITN Residence 2005 brought a group of German students to MU to collaborate with their American peers and this event marks an important first step in science communication in a binational context.

P269: Promoting the Interrelationship of Chemistry and Society with a Case Study Approach

Kerry Karukstis (Harvey Mudd College, U.S.A.)

Most opportunities to explore the relationship of science and technology with contemporary society occur as students prepare to graduate. Such capstone experiences enable students to draw upon their broad exposure to a range of fields throughout a four-year academic program. Nevertheless, both the significance and complexity of the interrelationships between science and society warrant consideration by students earlier in the curriculum. A collection of case studies that enables General Chemistry students to examine the environmental and economic implications of modern chemical applications will be described. Each exercise guides students through the key chemical, environmental, and economic aspects of the case study and assists them in exploring the array of benefits and costs of each technical application. Instructors at several institutions in a variety of general chemistry courses have tested the case studies to broaden the project’s impact. Aspects of case study design, implementation, and assessment will be presented.

P270: Using Contemporary Issues to Teach Skeptical Inquiry: An Approach to Improve Science and Information Literacy among Undergraduates

Nora Demers (Florida Gulf Coast University, USA)

The ability to construct individual meaningful knowledge from our information-rich society is a skill critical to empower effective civic engagement. Issues in Science and Technology is an upper division interdisciplinary course that provides an opportunity to help students move from taking a stance on an issue in science and technology to using critical inquiry skills to consider the issue and make informed decisions about its effects on our society. I provide a scaffold of assignments to help students refine the skills needed to function effectively and respond to the issues. A diversity of issues in Science and Technology that are shaping our world are examined. Students gain a better understanding of historical and societal events that have helped define the issues. The role media, politics, economics and culture play in shaping the issues in our society is explored and considered. An important outcome of the class is a better awareness of the way our actions (and inactions) have led us to this current list of Issues in Science and Technology. Problem-solving, critical thinking and information literacy are all critical outcomes that are assessed improved to help provide a scientifically literate and informed citizenry.

P271: Integrative Learning in the Sciences: Decision Making at the Intersection of Science Knowledge and Student Beliefs and Values

Joanne Stewart (Hope College, US)

What does student learning look like when students are immersed in a complex science problem using a data-rich, inquiry-based approach? How does this learning approach affect student beliefs about science knowledge? What does it look like when students are asked to make decisions about complex problems that require the integration of science knowledge with their own beliefs and values? These questions were explored in an undergraduate science course that 1) immersed students in the complexity of our developing understanding of abrupt climate change, and 2) asked students to address the problem of human vulnerability to climate change at different sites around the world. The course is part of a Carnegie Scholar project on integrative learning. The integration of student understanding across disciplines, between courses, and across academic and personal experiences will be described. Course design and examples of student work will be presented.

9:15 AM - 12:00 PM STEW 206

S32: The George R. Hague Jr. Memorial AP/IB Chemistry Symposium - Session 1 of 1

Harvey Gendreau (Framingham High School, United States)

This symposium will help you in your AP classroom and give you ideas and avenues to pursue. The contacts with other AP teachers will give you a resource and ability to meet and network with others with similar problems and challenges. Topics covered will include input from the Chief Reader of the AP exam and from members of the Test Development Committee how to start an AP course and first year experiences. Presenters will also share ideas, demos, tasks, labs, concepts, etc. with other AP teachers. The symposium honors the many outstanding contributions by George Hague to chemical education.

9:15 introduction

9:20 Thomas Adams P272: What I learned at the 2006 AP Chemistry read

9:50 Andrew Cherkas P273: Design a buffer

10:20 break

10:30 Adele Mouakad P274: Using environmental topics in AP Chemistry to concretize chemical concepts
11:00 Dennis Kliza P275: The lost art of estimation
11:30 discussion

P272: What I learned at the 2006 AP Chemistry read

Thomas Adams (Indiana Academy, USA)

Grading rubrics, score distributions, and common student errors will be shared.

P273: Design a buffer

Andrew Cherkas (Stouffville DSS, Canada)

Students have a better understanding of phenomena if they can experience it first hand. This paper will illustrate how students can design a buffer solution of a specific pH, make the solution and then test the solution's ability to hold its pH on dilution or treatment with strong acid or base solutions.

P274: Using environmental topics in AP Chemistry to concretize chemical concepts

Adele Mouakad (St. John's School, USA), Chuck Mills (Gibson Southern High School, USA)

Many students have difficulty with bonding concepts, particularly bond polarity and molecular polarity. The greenhouse effect is a perfect medium to study molecular polarity and have the students see its relevance. The students develop a good understanding of molecular polarity and dipole moment as a result of the study of the properties of greenhouse gases. Usually this is a topic that is with little applications in the AP Chemistry course. Another problem area is predicting chemical reactions. Acid deposition is an excellent method for students to develop an understanding of the acid nature of nonmetallic oxides. Using a series of demonstrations the presenter will illustrate this. The participants will have a series of mini labs they can take back with them. Ozone chemistry is another excellent source to illustrate many chemical concepts such as kinetics, catalysis, solubility, and gas phase chemistry. We will show how ozone chemistry be used to develop a deeper understanding in the students.

P275: The lost art of estimation

Dennis Kliza (The Hotchkiss School, USA)

Several standardized chemistry examinations are now non-calculator based tests. Chemistry students are increasingly unprepared for the types of questions requiring non-calculator based mathematical estimation. This presentation (with handout) will help prepare teachers and students for the types of problems students will be required to solve on these examinations.

9:15 AM - 12:00 PM STEW 214B

S33: Using JCE Resources Effectively - Session 1 of 2

John Moore (Univ of Wisconsin-Madison, USA)

Have you used a JCE Tested Demonstration in your teaching? Have you used a JCE laboratory experiment and the Project Chemlab index of laboratory experiments to enhance your laboratory program? Have you used a JCE Classroom Activity with your students or in an outreach program? Have you used JCE software in your classes? Have you used Chemistry Comes Alive! videos to show your students chemistry that would otherwise not be available to them? Have you used the JCE Digital Library offerings (JCE WebWare, JCE SymMath, and others)? Have you used JCE in

some other way? High school and college teachers will offer short papers describing how resources from the Journal of Chemical Education have been incorporated into classes and curricula. Presenters will share their ideas and successes, large and small, with others who may be interested in doing likewise.

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| 9:15 | | introduction |
| 9:20 | Erica K. Jacobsen | P276: JCE Classroom Activities: How to use them and how to publish one |
| 9:40 | Erica K. Jacobsen | P277: JCE CLIC and CTC: A teacher time- (and money-) saver |
| 10:00 | John Woolcock | P278: Using project chemlab effectively |
| 10:20 | Dell Jensen | P279: Organic chemistry laboratory from the Journal of Chemical Education |
| 10:40 | | break |
| 10:50 | Jon Holmes | P280: JCE Software: from CD to WWW |
| 11:10 | Jonathan Mitschele | P281: Static electricity on a rainy day: using CCA! Vol. 8 to teach about electric charge and the photoelectric effect |
| 11:30 | John Moore | P282: Incorporating Chemistry Comes Alive! videos into chemistry classes |
| 11:50 | John Moore | P283: Using JCE resources in inorganic and general chemistry courses |

P276: JCE Classroom Activities: How to use them and how to publish one

Erica K. Jacobsen (Univ. of Wisconsin-Madison, U.S.)

The Journal of Chemical Education (JCE) offers a wealth of resources for high school teachers. This includes the Classroom Activity series. JCE Classroom Activities are thought-provoking, hands-on, ready-to-photocopy-and-use chemistry Activities targeted to high school students. These user-friendly Activities can be used in a variety of settings including take-home assignments. Most of the supplies used to carry out the Activities are low-cost items found in the home or grocery store. Classroom Activities also provide an excellent opportunity for high school teachers to submit their curriculum ideas for publication in a professional journal. This presentation will share information about the Activity series, allow participants to see an Activity demonstrated or try an Activity (if resources permit), and learn how to take an idea for an Activity and turn it into a submission.

P277: JCE CLIC and CTC: A teacher time- (and money-) saver

Erica K. Jacobsen (Univ. of Wisconsin-Madison, U.S.)

Chemistry Teacher Connection (CTC) is an exciting new initiative to enhance high school teachers' interactions with the American Chemical Society (ACS). ACS has joined forces with the ACS Division of Chemical Education (CHED), and the Journal of Chemical Education (JCE), to enable high school teachers to associate with the ACS as an affiliate member of CHED and to obtain online access to the High School CLIC section of JCE Online. CLIC tailors JCE Online specifically for the high school teacher and allows educators to quickly find resources they can use. This presentation will demonstrate CLIC and share information about the benefits of CTC.

P278: Using project chemlab effectively

John Woolcock (Indiana University of PA, USA), **Carolyn Allen** (University of North Carolina at Charlotte, USA)

Project Chemlab, a Committee of the Division of Chemical Education since 1980, is now closely associated with the Journal of Chemical Education (JCE). Project Chemlab is charged with maintaining a searchable list of key-worded "annotations" of laboratory experiments published in JCE. The Project Chemlab database is available on CD (updated yearly) or can be searched from the JCE website (updated monthly). It supplements the JCE Index since the online Index has had keywords and abstracts of published papers for only the last 7-8 years. Project Chemlab's special set of keywords devised specifically for lab experiments, also allows for faster searching based on the general area of chemistry and the level of the students. Reviewers with teaching or research experience in the general area of the lab experiment create the keywords and annotations. In this presentation, we will describe and illustrate the unique features of Project Chemlab in more detail and demonstrate how to use it effectively to search for laboratory experiments.

P279: Organic chemistry laboratory from the Journal of Chemical Education

Dell Jensen (Augustana College, USA), **Richard M. Narske** (Augustana College, USA)

Organic chemistry experiments have commonly become a series of cookbook procedures taken from textbooks or journal articles compiled in a laboratory manual written by instructor. This situation along with the fact that many students do not engage with the experiment but just follow directions, encouraged us consider other options for the laboratory experience. The "In the Laboratory" section of this Journal has become our inspiration and resource for a change. Selected articles are provided to students with the expectation that student will chose an experiment, read and engage with the chemical literature, develop their own experimental procedures, reproduce the experiment and explain their results. This avenue gives the students a wide range of experiments to select from covering various organic topics within laboratory guidelines. Student use formal reports based on the ACS Style Guide for scientific paper to communicate their results. (141 words)

P280: JCE Software: from CD to WWW

Jon Holmes (University of Wisconsin Madison, United States)

JCE Software has published software for student use since 1988. Recently, several of these programs have been transformed and updated for delivery over the WWW. Such programs no longer require installation and are presented within the ubiquitous Internet browser window where even the newest chemistry students are comfortable and know their way around. An overview of the JCE Software materials that are available via the WWW will be presented. Specific programs will be demonstrated.

P281: Static electricity on a rainy day: using CCA! Vol. 8 to teach about electric charge and the photoelectric effect

Jonathan Mutschele (Saint Joseph's College, USA)

I use static electricity to teach my classes about electric charge and about the photoelectric effect, so a nice, dry day is on my equipment list for both demonstrations. Both topics are a part of what I cover in the first semester, so all too often the day I try to do one or the other demonstration is a typical fall day in Maine: rainy. With Chemistry Comes Alive! Volume 8 (CCA8), this is no longer a problem, because CCA8 includes QuickTime movies of electrostatics and photoelectric effect demonstrations—and much more! I will show you my approach to teaching about electric charge

and the photoelectric effect using CCA8, and introduce you to an extensive video collection of demonstrations of wave and particle phenomena that the Journal of Chemical Education distributes as one in the Chemistry Comes Alive! series.

P282: Incorporating Chemistry Comes Alive! videos into chemistry classes

John Moore (Univ of Wisconsin-Madison, USA)

The Chemistry Comes Alive! series of CD-ROMs from JCE Software contains thousands of video clips showing chemistry in action. These can be used by a teacher in a variety of different ways: to show a chemical reaction to a group of students; incorporated into tutorial or other software or Web pages; as part of a quiz or examination; as a supplement to the laboratory curriculum; and as enrichment material for students to study and enjoy on their own. There are several ways to find individual video clips: by browsing a visual interface; from a table of contents that lists all video clips on a CD-ROM; by keyword using a search function; and by correlation with the tables of contents of standard textbooks. I will illustrate several cases in which I have used the Chemistry Comes Alive! collection in my teaching of general and inorganic chemistry.

P283: Using JCE resources in inorganic and general chemistry courses

John Moore (Univ of Wisconsin-Madison, USA)

The Journal of Chemical Education has for many years contributed to how I teach chemistry and how my courses are organized. Here are some of the resources I have used in general chemistry and inorganic chemistry courses: articles from JCE itself; software programs from the General Chemistry Collection and the Advanced Chemistry Collection; videos from Chemistry Comes Alive!; pre-lab preparation materials in ChemPages Laboratory; problems presented by General Chemistry Multimedia Problems; the interactive periodic table in Periodic Table Live!; the videotape HIV-1 Protease: An Enzyme at Work; quiz and homework questions from JCE QBank; and interactive Web-Ed articles from JCE Online. I will present an overview of use of these materials in large classes and report on their efficacy.

9:15 AM - 12:00 PM STEW 318

S26: Web-Based Applications for Chemical Education - Session 2 of 3

John H. Penn (West Virginia University, USA), **Robert E Belford** (University of Arkansas at Little Rock, USA)

In this symposium, developers of web-based applications will come together with chemical educators to share experiences and innovations from the perspectives of development and implementation. Presenters will cover specific web-based applications, creative solutions to web-based issues in the context of chemical education, reports of the impact of web-based applications on pedagogy and learning, or visions of the future.

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|-------|---------------------|---|
| 9:15 | | introduction |
| 9:20 | Susan Wiediger | P284: Chemistry Learning in Progress: Teaching the Development of the Periodic Table with a Computer Based Activity |
| 9:40 | Romualdo Desouza | P285: CALM-Editor : A Web-Based GUI Tool for Developing a Multi-Institutional Teaching Community |
| 10:00 | Tom Greenbowe | P286: Six Years of Web-Based Computer Simulations |

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|-------|--------------------|---|
| 10:20 | Robert M Hanson | P287: AJAX /JSON Click-JavaScript -- A New Vision for Web-Based Chemistry Applications |
| 10:40 | | break |
| 10:50 | Norah MacCuish | P288: A Virtual Classroom in Cheminformatics |
| 11:10 | Julie Haack | P289: GEMs: A Database of Greener Education Materials for Chemists |
| 11:30 | George Long | P290: Interactive Multimedia to Support Problem Based Learning for Non-Majors Chemistry Courses |
| 11:50 | | discussion |

P284: Chemistry Learning in Progress: Teaching the Development of the Periodic Table with a Computer Based Activity

Susan Wiediger (Southern Illinois University Edwardsville, USA), Neil Alfredson (Southern Illinois University Edwardsville, U.S.A.), Rich Carney (Southern Illinois University Edwardsville, U.S.A.), Nathan Mikeska (Southern Illinois University Edwardsville, U.S.A.), Brian Navarro (Southern Illinois University Edwardsville, U.S.A.)

Several manipulative activities exist for guiding students in the pattern recognition fundamental to the development of the periodic table. One such paper-based activity is now also a computer-based activity. Converting the periodic table arranger for computer use provides multiple benefits including simplifying use, increasing use of color, assisting in modification of activity difficulty, and prompting students to provide their reasoning. In addition, the new software allows the on-screen arrangement process to be captured for later playback. This has the potential to provide insights into the thought process the user is engaged in during the activity. This talk will present the software and pilot test results from use of the software in General Chemistry.

P285: CALM-Editor : A Web-Based GUI Tool for Developing a Multi-Institutional Teaching Community

Romualdo Desouza (Indiana University, USA)

Computer Assisted Learning Method is a learning environment that presents students with algorithmically generated, individualized questions selected by a faculty member from a database. Students are provided with instantaneous feedback on the correctness of their responses. CALM is presently used by over 3000 students at IU-Bloomington annually and 3000 HS students at 50 HS across Indiana. Recently, we have focused on development of a Web-based GUI authoring tool that facilitates the development of content. Details of this new CALM authoring interface will be described.

P286: Six Years of Web-Based Computer Simulations

Tom Greenbowe (Iowa State University, USA), Han-Chin Liu (University of Tawain, Tawian), Rohini Vanchiswaran (University of Arizona, USA)

Our Flash computer simulations for general chemistry have been available on our web site for six years. We have received e-mail messages from over 300 chemistry instructors, world-wide, who are using these simulations in a variety of ways. Examples of the simulations and how they are being used will be presented. Also, a brief discussion of several research projects that have been conducted to test the effectiveness of the computer simulations will be presented.

P287: AJAX /JSON Click-JavaScript -- A New Vision for Web-Based Chemistry Applications

Robert M Hanson (St. Olaf College, US)

Asynchronous JavaScript And XML, or AJAX, and JavaScript Object Notation (JSON) are new Web development techniques for creating highly dynamic interactive web applications. In this presentation I will briefly introduce these techniques and then show some examples that use them to embed "tools" such as periodic tables, calculators, chemical equation balancers, graphs, molecular visualizers, and other useful components in web pages. The best part of the story is that the web page designer need not have any expertise whatsoever in the inner workings of the tools, and need not even store the tools on their own site. Efforts toward the development of an open-source depository of such tools for chemists will be discussed.

P288: A Virtual Classroom in Cheminformatics

Norah MacCuish (Mesa Analytics & Computing, LLC, USA), John MacCuish (Mesa Analytics & Computing, LLC, USA)

Mesa Analytics & Computing, LLC is currently in year two of a Phase II Small Business Innovative Research Grant, "Cheminformatics Teaching Tools for the Cheminformatics Virtual Classroom," from the National Science Foundation. This presentation will describe research and product development in the area of cheminformatics and concept learning through virtual classrooms. Vendor and academic participation will be described as well as student and faculty feedback in the development process.

P289: GEMs: A Database of Greener Education Materials for Chemists

Julie Haack (University of Oregon, USA)

Green Chemistry is the design of chemical products and processes that reduce or eliminate the use and generation of hazardous substances. The incorporation of green chemistry principles into the chemistry curriculum provides new opportunities to enhance the curriculum and engage a broader spectrum of students in the study of chemistry. In order to facilitate the development green chemistry educational materials and their incorporation into the chemistry curriculum, we have designed an interactive, web-based database of Greener Education Materials for chemists called GEMs. The database provides a tool for the organization and dissemination of core green chemistry educational materials that can be utilized to support chemical education across chemical disciplines (e.g., general, organic, physical, analytical, materials, etc.) and among diverse educational audiences (e.g., K-12, colleges and universities). Since the database includes both published and original submissions, it provides the infrastructure for collaborative development of this resource among the chemical education community.

P290: Interactive Multimedia to Support Problem Based Learning for Non-Majors Chemistry Courses

George Long (Indiana Univ. of PA, USA)

Creation of specific problem based learning (PBL) scenarios for the non-science major chemistry course is a difficult task. The major stumbling blocks to creating problem based learning (PBL) exercises for these courses are the diversity of students' backgrounds and the difficult logistics of carrying out the PBL process in classes that typically have a high student/faculty ratio. This presentation will discuss the use of interactive multimedia exercises that rely on a database of background information to tutor novice students during the exercise. Students learn fundamental

concepts in the context of the problem based scenarios.

9:15 AM - 12:00 PM STEW 322

S27: Women in Chemistry Education - Session 2 of 2

Janet Clark (St. Mary-of-the-Woods College, USA)

The purpose of this broad symposium is to share the experiences of women currently involved in chemistry education, either as researchers, instructors, or mentors. Presenters will explore barriers faced by women in the field, models for overcoming such barriers, and the overall situation and outlook for women in chemistry education. Research and insights into how women learn science will also be shared.

| | | |
|-------|-----------------------|---|
| 9:15 | | introduction |
| 9:20 | Bassam Z. Shakhashiri | P291: Women in science |
| 9:40 | Seyhan Ege | P292: Women in chemistry at the University of Michigan: A personal perspective |
| 10:20 | | break |
| 10:30 | Ted Clark | P293: Women's attitudes toward learning in undergraduate chemistry laboratories |
| 10:50 | Barbara A. Sawrey | P294: Student ways of understanding and ways of thinking about aromaticity |
| 11:10 | Valerie Kuck | P295: Analysis of the doctoral training of faculty members at research universities |
| 11:30 | | discussion |

P291: Women in science

Bassam Z. Shakhashiri (UW-Madison,)

One of the programs of the Initiative for Science Literacy is "Women in Science." This program encourages the participation of girls and women in science by making them aware of role models and examining efforts of these models in the advancement of science. It emphasizes mentoring, decreasing isolation and stereotyping, and creating supportive environments. Special efforts are made to promote pathways to success in academic and professional settings for women at the college level and beyond. One example is the exemplary symposium WOMEN OF SCIENCE held in the spring of 2005 at UW-Madison along with the traveling exhibit from the Chemical Heritage Foundation.

P292: Women in chemistry at the University of Michigan: A personal perspective

Seyhan Ege (University of Michigan, USA)

Major changes have taken place both in chemical education and in the role of women at the Department of Chemistry at the University of Michigan over a span of more than fifty years. This paper will explore some of the factors that led to these changes from the personal perspective of a woman who has been associated with the department for most of that time.

P293: Women's attitudes toward learning in undergraduate chemistry laboratories

Ted Clark (the Ohio State University, USA), **Caroline Clark** (Ohio State University, USA)
A multi-year correlation study involving undergraduate chemistry students assessing their attitudes toward learning in a laboratory setting has been undertaken using a quantitative methodology. Data were gathered for students enrolled in different Analytical chemistry classes at a large public university. The significant number of female students enrolled in these courses affords us an excellent opportunity for examining the importance of gender as a determinant for student attitudes and learning preferences. The role of gender, and the possibility that female and male students may express different views when given the opportunity to complete open-ended, non-dualistic laboratory assignments inform our overarching views of student attitudes toward laboratory instruction. Indeed, calls to develop a more gender inclusive science curriculum have noted the importance of including problems that are holistic and global in scope, rather than hierarchical and reductionistic. The implicit rationale for this suggestion, i.e. that male students are more comfortable with dualism and problems with single concrete answers, while female students are better able to deal with complex problems and ambiguity, is relevant for our investigation. This research has implications for curricular changes that aim to transform undergraduate or high school science instruction by providing authentic scientific research opportunities. Also, the complex relationships between attitudes toward learning, academic achievement, and gender, while an area of interest for researchers from a variety of disciplines, is perhaps, most importantly, a topic that chemical educators should become aware of to better instruct all of their students.

P294: Student ways of understanding and ways of thinking about aromaticity

Barbara A. Sawrey (UCSD, USA), **Anne Duffy** (UCSD, USA)

We will outline the three foundational principles of DNR-based instruction (a conceptual framework developed by Harel for mathematics education) and discuss, in detail, one of the three principles, the duality principle, by which the student interviews were analyzed. The analysis of students' ways of understanding and ways of thinking about the concept of aromaticity under typical instructional practices in organic chemistry will be presented, with instructional implications for consideration.

P295: Analysis of the doctoral training of faculty members at research universities

Valerie Kuck (,)

Determination of the doctoral schools of faculty members in 2003 at Research Universities categorized as having very high research activity by the Carnegie Foundation for the Advancement of Teaching in 2006 shows that the hiring of tenure-track professors has focused on the doctoral graduates from a select group of departments. Analysis on recent hires indicates that male graduates are being preferentially hired over females. At only ~20% of the 35 top ranked National Research Council chemistry department did the female doctoral graduates do better than the male graduates in obtaining faculty positions at a Research institution. At ~50% of the departments, the female graduates did significantly poorer than the males in attaining a faculty position. Ways for increasing the number of women on Research I faculties will be discussed.

Workshops

Tuesday, August 1 morning

W20: Chemistry's Dirty Little Secret: Soil Analysis for Inquiry-Based Chemical Education

9:15 AM - 12:15 PM BRWN 2124

Donald Storer (Southern State Community College, USA)

This workshop will introduce educators to some of the ways in which the chemical analysis of soil can provide inexpensive and highly effective teaching tools for inquiry-based learning in general chemistry. Soil, as both a geological and cultural product, is uniquely suited to chemical education, because its analysis transcends the narrow confines of many natural and social science curricula. In this workshop, the presenters will show how soil chemistry is used in archaeology. A variety of human activities impact soils through the deposition of chemical residues and with simple-to-prepare extractants and basic analytical instrumentation, such as a spectrophotometer, these activity residues can be detected and studied. The presenters in this workshop will describe a number of experiments that can be performed in the classroom. In particular, participants will analyze 2,000-year-old soil from Central America to learn what the ancient Maya did in their ceremonial plazas. In addition, each participant will receive a copy of *The Chemistry of Soil Analysis*, which explains the basics of soil chemistry and includes laboratory activities for general chemistry courses.

Capacity: 24 Fee: \$20**W21: Introducing the New Vernier Spectrometer**

9:15 AM - 12:15 PM BRWN 2125

Dan Holmquist (Vernier Software & Technology, USA)

This hands-on workshop will allow you to try the new Vernier Spectrometer powered by Ocean Optics. Logger Pro 3.4.5 now supports several Ocean Optics Spectrometers including their UV-VIS, Red Tide, and this less expensive model sold exclusively by Vernier. Obtain a spectrum in a fraction of a second, study Beer's law, and perform kinetics experiments. Emission spectrum studies are also possible with these spectrometers. Come try them out!

Capacity: 40 Fee: \$0**W22: Nuts and Bolts of Chemical Education Research: Developing Student Achievement Measures**

9:15 AM - 12:15 PM STEW 320

Diane Bunce (Catholic University of America, USA)

The purpose of this workshop is to help participants learn how to develop and analyze student achievement instruments. Emphasis will be on group work to write valid achievement questions in a variety of formats including multiple choice, traditional problem solving and essays. Statistical and qualitative methods of analysis will be presented and participants will have an opportunity to practice implementing them on sample data. Discussion of possible uses of the ACS Exam Institute's Paired Question General Chemistry Exam will be included. The cost of the workshop includes the price of a book that will prove helpful to the workshop participants both during and after the workshop.

Capacity: 35 Fee: \$55**W23: Research-based Lab Experiments – the CASPiE Model**

9:15 AM - 12:15 PM WTHR 217

Gabriela Weaver (Purdue University, USA)

This workshop will introduce participants to experiments, supporting materials and methods that have been developed as part of the CASPiE project. The experiments are designed to allow students to participate in authentic research by learning techniques and collecting data that can contribute to a research project. Students are involved in the development of experimental procedures and in decisions about data collection and analysis. (Designed to fit in standard 3-hour once-per-week lab schedule.) Supporting materials include materials for PLTL (peer-led team learning) workshops that help students learn basics of research notebook skills, data analysis and inference, experimental design, and reading/writing journal articles. Participants will have the opportunity to carry out at least one of the research experiments and receive training on the content and use of the PLTL materials. Other aspects of the CASPiE collaborative, such as developing future research modules or using the remote instrumentation network will also be discussed

Capacity: 18 Fee: \$30

W24: Smallscale Gas Reactions

9:15 AM - 12:15 PM BRWN 2134

Viktor Obendrauf (University of Graz, Austria)

Since 1992 simple small scale gas generators developed by the workshop leader have been proven to be very practical in many countries in Europe. A special small scale technique with low-cost material allows an instructor to perform portable demonstrations even involving toxic and/or flammable gases without a fumehood. Using the same low cost material for student's activities and for demonstrations, many properties of gases and violent reactions of stoichiometric mixtures can be shown safely. During the workshop, the participants will prepare their own kit of microscale apparatuses for use with student activities and demonstrations. After spending a short time getting accustomed to the equipment, the new technique offers many time- and cost saving possibilities in performing small scale reactions without polluting the environment. Workshop activities include: water electrolysis, explosion limits, and gas generation (experiments with hydrogen, oxygen, ammonia, carbon monoxide).

Capacity: 25 Fee: \$ 25

Tuesday, August 1 afternoon

Plenary Speakers

Tuesday, August 1 evening

7:00 PM - 8:00 PM

L6: The Secret Life of Food

Shirley Corriher (,)

Solve food mysteries and debunk cooking myths with this award-winning culinary food sleuth. Shirley Corriher will share secrets of her success in the kitchen and provide chemistry-based tips on improving good recipes and just saying no to bad recipes. Learn why red cabbage turns blue during cooking but red peppers don't and explore everything from browning to curdling. The focus of the presentation is on the science behind food and recipes and how you can use this knowledge

to grab students' attention. Unite your love of chemistry with a new-found confidence in the classroom and in your kitchen skills.

Poster sessions

Tuesday, August 1 afternoon

12:30 PM - 1:30 PM E Lounge 1st floor Union

Session 3 of 5: 1st Floor Union

Ann Cutler (University of Indianapolis, USA)

Poster presentations provide a unique venue for sharing ideas, learning about creative endeavors from colleagues, and highly personal one-on-one interactions. As such, the 19th BCCE will continue the long standing tradition of holding several poster sessions during the meeting.

| | |
|-----------------------------|--|
| Larry Kolopajlo | T39: Attitudes of future elementary teachers toward chemistry |
| Lindell Ward | T40: Bomb calorimetry of common candy bars: An undergraduate physical chemistry laboratory |
| Douglas D. Danforth | T42: Can video games contribute meaningfully to the chemistry curriculum? |
| Kevin Dunn | T43: Caveman chemistry: Hands-on projects in chemical technology |
| Maria Esther Del Rey Leñero | T45: Chemistry and art |
| Daqing Gao | T48: Computational chemistry at a community college level |
| Miriam Falero-Gil | T51: Enhancement in the teaching of general chemistry by the incorporation of technology |
| MaryKay Orgill | T54: General chemistry students' perceptions of buffers and buffer problems |
| James Goll | T55: Green chemistry a human issues project |
| Mark Fritz | T56: Helping patients reduce heartburn: A service learning project in the general chemistry lab |
| Arnaldo Carrasquillo, Jr. | T58: Improving conceptions in analytical chemistry through IBL activities: The central limit theorem |
| Midge Hall | T59: Intensive introductory chemistry: Is the experience level of the students responsible for greater performance |
| Katherine Bichler | T60: Interdisciplinary linking seminar between general chemistry and college algebra: UW-Manitowoc's answer to co-requisites |
| Laura Sonnichsen | T67: Peer review of laboratory notebooks |
| Robin Tanke | T73: Student designed research projects |
| Grace Zoorob | T78: Using a personal response system in the teaching of analytical chemistry |

T39: Attitudes of future elementary teachers toward chemistry

Larry Kolopajlo (Eastern Michigan University, USA)

The attitudes, logical thinking skills, and conceptual chemical knowledge of future elementary teachers were measured at Eastern Michigan University in Chem 101, "Chemistry for Elementary Teachers." Writing and crossword puzzles were used as a tool to help students adapt to Chemistry.

T40: Bomb calorimetry of common candy bars: An undergraduate physical chemistry laboratory

Lindell Ward (Franklin College, USA), Stephen McCoy (Franklin College, USA)

Bomb calorimetry is arguably one of the most common physical chemistry laboratories performed in the undergraduate curriculum. These studies introduce the analysis of common candy bars, specifically Kit Kat, using bomb calorimetry. Two analysis pathways are investigated, with differing levels of precision. The results show excellent correlation to the Caloric content of the candy, thus giving a "real-world" application to a technique that is often viewed by students as purely academic.

T42: Can video games contribute meaningfully to the chemistry curriculum?

Douglas D. Danforth (Purdue University, USA), Kermin J. Martinez-Hernandez (Purdue University, USA), Carlos R Morales (Purdue University, USA), Naveen Nattam (Purdue University, USA), Patrick Robertson (Purdue University, USA), Gabriela Weaver (Purdue University, USA)

It has been argued in the literature that computer games can engage a learner and provide learning benefits if they promote interaction with the gaming environment. Video games encourage the player to attempt a variety of strategies and present constantly shifting scenarios and progressive tiers of difficulty to keep players of differing skill levels challenged. Video games also motivate through the achievement of mastering difficult challenges and through the fun of game play. Based on a review of the literature and criteria derived from previous phases of our on-going research project, we have developed a video game which embeds a series of chemistry challenges within normal game play. The process of game design and production via a cross-disciplinary team will be presented. The preliminary results from data collected through student interaction with the game will also be described in this poster.

T43: Caveman chemistry: Hands-on projects in chemical technology

Kevin Dunn (Hampden-Sydney College,)

Non-science students often approach chemistry with reluctance and trepidation. This poster will outline a strategy for engaging students through a series of 28 hands-on chemical projects. We begin in the Stone Age, making fire by friction, arrowheads, and honey wine. We make a ceramic crucible from clay, spin yarn from wool, and extract potash from wood ashes. We smelt bronze in our crucible and dye our yarn with indigo. In later projects we make paper from hay, soap from fat, mauve dye from aniline, and photographs from egg whites and salt. Along the way we learn a history of chemical technology from the Paleolithic campfire, to the crafts of antiquity, to the alchemy of the Middle Ages, to the chamber acid and soda factories of the Industrial Revolution, to the multi-national chemical giants of the twentieth century.

T45: Chemistry and art

Maria Esther Del Rey Leñero (Escuela Nacional Preparatoria, UNAM, Mexico), Yolanda Castells de García (UNAM, Mexico), Federico García Jiménez (Instituto de Química, UNAM, Mexico)

Chemistry and art share many things in common. The properties of the chemicals used allow artists

to create colorful and interesting works. We have found that blending the content of these two fields is a useful teaching tool particularly as this provides avenues for capturing the interest and creativity of students. In this poster, we will share methods we have used with pre-university students at our school. We engage our students in learning the chemistry and the process of manufacturing various types of arts and crafts (such as boscage, engraving and etching). As the students carry out the various procedures they are challenged to solve problems that arise and employ chemistry concepts (such as electronegativity and stoichiometry) in the solution. Once completed the students display their works in different shows and science exhibitions.

T48: Computational chemistry at a community college level

Daqing Gao (Queensborough CC/CUNY, USA)

We have been doing computational chemistry research with about ten students at Queensborough Community College, The City University of New York over the past two years. In this poster, we will share our experience with interested colleagues.

T51: Enhancement in the teaching of general chemistry by the incorporation of technology

Miriam Falero-Gil (Universidad Metropolitana, USA), *Lymari Fuentes* (Universidad Metropolitana, USA)

The implementation of technological features in the general chemistry course has been explored in the past years looking to enhance the interaction of the students with the concepts they are introduced to. In our institution, we are using the Blackboard Learning System™ to help the students in the understanding of the material discussed in the general chemistry lectures. This method gives the students the opportunity to access the information of the course via the web sources as complement of the discussion in the classroom. This strategy produced a more effective interaction between the students and the faculty in the development of the course. Various aspects of the results of the incorporation of this strategy will be discussed.

T54: General chemistry students' perceptions of buffers and buffer problems

MaryKay Orgill (UNLV, USA), *Katrina Kaczmarek* (UNLV, USA)

Chemistry students at all levels find “buffers” to be a difficult concept and struggle with solving corresponding buffer problems, even though this topic is taught in nearly every chemistry class in an undergraduate program. The goal of this project is to determine how general chemistry students perceive buffer problems and to use that information to improve classroom instruction. Specifically we will present (1) the different approaches general chemistry students use to solve buffer problems, (2) the misconceptions that keep students from solving buffer problems correctly, and (3) the types of support general chemistry students need to understand and solve buffer problems. We will also compare students' conceptions of buffers with those of their instructors in order to determine how instruction can be modified to benefit students in a general chemistry class.

T55: Green chemistry a human issues project

James Goll (Edgewood College, USA)

The capstone experience at Edgewood College is the Human Issues Program. This capstone may include an independent project under the supervision of a faculty member. The project requires multidisciplinary inquiry, engaged learning, and a presentation of the results of the project. The students that I have been supervising in the Human Issues Program have been investigating how Green Chemistry may be incorporated into the Edgewood College chemistry curriculum.

T56: Helping patients reduce heartburn: A service learning project in the general chemistry lab

Mark Fritz (University of Cincinnati, USA), Rupa Rao (Digestive Care, Inc., USA)

In general chemistry lab courses, students frequently learn to measure pH. In the community, people frequently suffer from heartburn. A simple project helps students learn about measuring pH while they serve people in the local community. Students measured the pH of common beverages and placed the results in a patient-friendly graph. The graph lists the beverages from least acidic to most acidic. A local physician specializing in gastroenterology now hands this graph to patients in treatment for severe heartburn. The detailed yet easy-to-follow graph aids patient counseling, making it easier for patients to identify and cut back on highly-acidic beverages which can contribute to heartburn.

T58: Improving conceptions in analytical chemistry through IBL activities: The central limit theorem

Arnaldo Carrasquillo, Jr. (University of Puerto Rico, USA), Margarita Rodriguez-Lopez (Pontifical Catholic University of Puerto Rico, USA)

Variability is an intrinsic property of nature. The study of physical phenomena, through analytical measurements, requires a quantitative understanding of variability. Sampling Statistics (SS) is therefore a vital subject for most fields of scientific endeavor - chemical analysis and industrial quality control are no exception. In fact, experienced analytical chemists make frequent use of SS and related concepts to solve a variety of problems. This poster will discuss the Central Limit Theorem (CLT) and the relation it has with analytical chemistry. An in-classroom, inquiry-based learning (IBL) experiment will be described. The experiment was designed for learners from the field of Chemistry and Chemical Engineering. The principal objectives of the IBL activity are to introduce the CLT in-classroom and to confront students with an experience that allows them to identify their misconceptions and to expand their level of understanding about the fundamental concepts of SS. During the experiment, students create population and sample histograms for several numerical populations. Bell-shaped histograms, predicted by the Central Limit Theorem, are observed for samples (averages) obtained through random sampling of each population. Students are then asked (i) to relate their observations with theoretical SS concepts discussed in class, and (ii) to formulate questions which are used later (iii) to guide a group study session. The IBL experiment, its implementation, typical student results (histograms, sample averages, grand averages, standard deviations, etc.) and exemplary study guide questions will be presented and discussed.

T59: Intensive introductory chemistry: Is the experience level of the students responsible for greater performance

Midge Hall (Clark State Community College, U.S.), Linda Wilson (Middle Tennessee State University, USA)

Students taking the intensive, 3-week, course in Introductory Chemistry at MTSU tend to earn higher grades on the final exam and for the course than do students in the traditional 15-week version of this course. Data were collected from four offerings of both course formats taught by the same instructor using the same text and exams. Students taking the intensive version of the course generally have completed more credit hours: average 86 credit hours for students in the intensive course versus 46 credit hour average for students in the traditional version of the course. The

intensive course students also graduated from high school longer ago: average 5.3 years ago for students in the intensive course versus an average 3.5 years ago for the students in the traditional version. These greater levels of academic and life experience could account for the better performance of the students in the intensive course. However, when subgroups of students with similar numbers of completed credit hours or years since high school graduation were compared, students in the intensive course consistently outperformed students in the 15-week course.

T60: Interdisciplinary linking seminar between general chemistry and college algebra: UW-Manitowoc's answer to co-requisites

Katherine Bichler (UW-Manitowoc, US)

As a result of students taking College Algebra as a co-requisite to general chemistry instead of as the traditional prerequisite, many students were struggling with the chemistry material because of a lack of mathematical skills. A one-credit linking seminar was offered for the first time at UW-Manitowoc in the Fall 2004 semester and again in Fall 2005 to students concurrently enrolled in CHE 145 and MAT 110 or 124 (College Algebra or Pre-Calculus). The main goal of this seminar was to improve the ability of students to apply mathematical concepts to problems specific to the chemistry course. The poster will focus on (1) the content of the course, (2) student feedback, (3) instructor impressions, and (4) preliminary results indicating increased student success.

T67: Peer review of laboratory notebooks

Laura Sonnichsen (Parkland College, USA)

For many students, organic chemistry laboratory is the first time their record keeping ability is assessed. In my experience of working with organic chemistry students, I have found that many times they do not understand the importance of keeping a well-written, legible, and complete lab notebook. Therefore, a peer review method for assessing student lab notebooks was developed. The peer review illustrates to the students the importance of their lab notebook and provides examples the results of both good and bad record keeping, in addition to being an assessment tool. The peer review method and some student examples will be presented in this poster.

T73: Student designed research projects

Robin Tanke (University of Wisconsin- Stevens Point, USA)

A current trend in science education is to offer not only inquiry based learning but also a research experience. The goal is to not only provide one-on-one research experiences to our chemistry students but also classroom based research projects. I recently revised our advanced synthesis course to have students pose research questions, interact with the primary literature, and design safe experiments in addition to the normally covered skills. In order to do this models and grading rubrics were designed during the summer of 2005 and the course was given the fall of 2005. Examples of course materials and student work will be presented in the poster.

T78: Using a personal response system in the teaching of analytical chemistry

Grace Zoorob (Vanderbilt University, USA)

A personal response system (PRS) is a form of technology that offers the instructor the opportunity to ask in-class questions during lecture, receive responses from every student and obtain immediate feedback. It is generally used in freshman and organic chemistry lectures. This year, it was used in a junior level analytical chemistry lecture to maximize the classroom learning environment. Advantages and disadvantages of the technology will be presented and compared to learning in a

traditional lecture.

12:30 PM - 1:30 PM E Lounge 2nd floor Union

Session 4 of 5: 2nd Floor Union

Ann Cutler (University of Indianapolis, USA)

Poster presentations provide a unique venue for sharing ideas, learning about creative endeavors from colleagues, and highly personal one-on-one interactions. As such, the 19th BCCE will continue the long standing tradition of holding several poster sessions during the meeting.

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| Al Hazari | T37: Are YOU practicing safe chemistry? |
| James M. Chapman | T38: Arson investigation: A gas chromatography laboratory experience for general chemistry |
| Michael Pelter | T41: Brewing science |
| James R. Nye | T44: Chemical fortune: A competitive board game providing practice in balancing chemical equations using industrial reactions |
| Louise Liable-Sands | T46: Chemistry outreach at Widener University |
| Kristin Cline | T47: Comparison of dilution procedures: An experiment for the quantitative analysis lab |
| Beth Marie Motter | T49: Connecting science and literacy: Hands-on inquiry in the elementary classroom |
| Chana Hawkins | T50: Details and dynamics of the Afrocentric idea: Repositioning the approach to science education research |
| Paul Szalay | T52: Experiment in mixture separation and infrared spectroscopy for introductory chemistry |
| Trilisa Perrine | T53: General chemistry and the visually impaired student |
| Craig Davis | T57: I dream of mendeleev |
| Sunita Dhingra | T61: Isolation of pigment from red rose petals for multifarious applications: A green and a low cost project for undergraduate students |
| Lynne Divis | T62: Measuring the effects of nitrogen, carbon dioxide, carbon monoxide, and temperature on the percent oxygen saturation of bovine hemoglobin using visible spectrophotometry: an undergraduate research project |
| Libbie Pelter | T63: Microwave heating in the undergraduate organic laboratory |
| Janice Hall | T64: Nanoscience for teachers: An online course at UW-Madison |
| Andoni Garritz | T65: Nature of science and inquiry as main characteristics of general chemistry textbooks |
| Eric Malina | T66: NCATE accreditation assessment #7; Safety, legal, and ethical issues: How to assess student performance via a web-based module |
| Al Hazari | T68: Periodic fun |

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| John H. Penn | T69: Picture is worth a thousand words: Web-based prelabs |
| Allen Hunter | T70: Pre-college teacher/researchers at Youngstown State University |
| Pasquale Di Raddo | T71: Reaction mechanisms involved in the synthesis of benz[a]pyrene diol epoxide |
| Allen Hunter | T72: Review of the crystallographic/diffraction education literature |
| Loyd Bastin | T74: Synthesis, analysis, and application of azo-dyes: An organic chemistry or joint organic/physical chemistry experiment |
| Nak Han Jang | T75: Thermodynamic interpretations of temperature depression in slush |
| Laura Ruebush | T76: Three-step sequence for the teaching of consecutive first-order reaction kinetics |
| David Smith | T77: Ultrasonic initiation of Grignard reactions: Comparison of conventional results , and student results |
| Allen Hunter | T79: Using discovery learning experiences to facilitate student integration of diverse concepts: Structure-property relationships in (arene)Cr(CO) ₃ chemistry |
| Nak Han Jang | T80: Women's superiority on understanding of chemical bonding concepts for korean high school students |

T37: Are YOU practicing safe chemistry?

Al Hazari (University of Tennessee, USA)

K-16 students begin to learn science and chemistry by instruction. As they mature, their instruction is presented less passively, and they take a more active role in learning. This presentation will highlight some of the efforts by the American Chemical Society (membership.acs.org/c/ccs ; membership.acs.org/c/chas) and the National Science Teachers Association (nsta.org) to help create an environment that stimulates education in safe practices in science and chemistry activities.

T38: Arson investigation: A gas chromatography laboratory experience for general chemistry

James M. Chapman (Rockhurst University, USA), Angela Orf (Rockhurst University, USA)

We have developed an arson investigation experiment for the introduction of gas chromatography analysis and forensic sample preparation into the General Chemistry Laboratory. Working with information provided to us from the Kansas City Crime Lab, we modified their procedures to yield a less expensive method and more suitable time frame to complement our laboratory schedule. The experiment is carried out over a three-week period with a total time commitment of 2-3 hours. The laboratory is designed to be an add-on to our schedule without taking the place of any existing experiments. The students are introduced to the concepts of gas chromatography (single and multi-vial sampling procedures), sample preparation, data acquisition, and data analysis.

T41: Brewing science

Michael Pelter (Purdue University Calumet, USA)

A novel way to introduce non-science majors to the chemistry laboratory using hands-on experiments can be done with a favorite beverage of college students – beer. Following the brewing process from “grain-to-glass,” this course uses the biological and chemical principles of brewing to teach science to the non-science major. Students learn about the fermentation process, the malting and mashing process to liberate and break down starch to simple sugars, and the importance and chemistry of water, yeast, and hops. The students gain, by hands-on experience, an understanding of each step in the brewing process. Sensory evaluation exercises are included to develop student’s ability to critically evaluate a product and convey that analysis using accurate descriptors. A major goal of the course is to provide the students with scientific knowledge they can use for the rest of their lives.

T44: Chemical fortune: A competitive board game providing practice in balancing chemical equations using industrial reactions

James R. Nye (Lock Haven University of Pennsylvania, United States), *Laura Lee* (Lock Haven University of PA, USA)

Chemical Fortune is a board game that serves as an alternative to the current methods available for practicing balancing equations. The board game is shaped like the periodic table and is set up so students purchase various chemical companies that each produce a common industrial chemical or element. In order to purchase the company, the student must correctly balance the chemical equation for the formation of that product. Unexpected “opportunity” and “loss” scenarios taken from business and industry add interest as well as an element of chance to this game. Chemical Fortune has been game tested and is designed for use in the high school classroom.

T46: Chemistry outreach at Widener University

Louise Liable-Sands (Widener University Science Division, USA), *Mark Bradley* (Widener University Science Division, USA)

Over the past several years, chemistry faculty at Widener University have performed chemical demonstrations and provided chemistry activities for classes at local and regional schools. These activities have been field tested for a variety of different age groups ranging from early elementary to middle school students. The activities use safe, readily available and inexpensive materials. Chemistry students from the American Chemical Society Student Affiliates Chemistry Club have volunteered to take chemistry activities to a variety of events including an after school program at a local middle school, a science day for fifth graders on campus and the opening of new science classrooms at a local Montessori school. The elementary and middle school students have been very receptive to the activities and interactions with Widener students. Both groups benefited from the experience. The Chemistry Club students are working on expanding the number and scope of suitable activities and continue to provide activities to other local middle schools.

T47: Comparison of dilution procedures: An experiment for the quantitative analysis lab

Kristin Cline (Wittenberg University, US)

Students in the quantitative analysis course at Wittenberg University conduct a short experiment in which they prepare five “identical” dilute solutions of a red food dye (Allura Red AC) and then assess their solution-making precision by measuring the absorbance of their five solutions at 505 nm. Students are assigned one of three procedures for making their solutions. A common spreadsheet of the class data is generated, and then students conduct statistical tests to compare data between students and between procedures. The experiment serves to introduce students to

careful solution preparation techniques and to the notion of serial dilution, and it gives them experience with statistical data analysis.

T49: Connecting science and literacy: Hands-on inquiry in the elementary classroom

Beth Marie Motter (Miami University, U.S.A.), Stacey Lowery Bretz (Miami University, U.S.A.), Kathryn Nafziger (Miami University, U.S.A.), Nazan Uludag (Miami University, U.S.A.), Jeff Winslow (Talawanda School District, U.S.A.)

Elementary teachers face the daily challenge of developing literacy skills in their students.

Emphasis on reading and writing literacy often comes at the expense of science literacy; many teachers report there just isn't enough time to teach science. This research describe a partnership between the chemistry department and K-2 teachers in a local school. Award winning children's literature (both fiction and non-fiction) was mapped to both Ohio's Academic Content Standards for K-2 Science strands and to hands-on inquiry activities directly related to the literature.

Preliminary findings will be reported.

T50: Details and dynamics of the Afrocentric idea: Repositioning the approach to science education research

Chana Hawkins (Purdue University, United States)

Since the 1970s, the participation of African Americans/Blacks in science has been a topic of concern and debate among groups such as researchers, scientists and science educators; and for greater than 20 years the discussion and representation of African Americans/Blacks has remained virtually unchanged. Past approaches to research are heavily quantitative, with focus on undergraduate and graduate student degree attainment statistics as a gauge for the success or failure of efforts to increase the participation of African Americans in the science pipeline and research science careers. The findings currently available lack dialogue with the inclusion of the voices of the students themselves. In 2000 and 2001, 15 African American/Black graduate students in the Department of Chemistry and the Department of Curriculum & Instruction at Purdue University gathered at the table to engage in a dialogue on how we came to be part of a critical mass of racially underrepresented people pursuing science careers. In this poster, I re/presents portions of my masters thesis study focusing on the lens through which we sought to understand the problem of underrepresentation from our individual and collective perspective and experiences.

T52: Experiment in mixture separation and infrared spectroscopy for introductory chemistry

Paul Szalay (Muskingum College, United States)

Infrared spectroscopy (IR) can be a valuable instrumental laboratory tool for introductory chemistry. This technique can compliment lecture discussions of topics such as bond strength, resonance, hydrogen bonding, and molecular structure. High quality instruments easily operated by students are much less expensive than most spectroscopic instrumentation. In addition, exposing students early in their education to instrumental methods of analysis gives them a more complete picture of laboratory work in the chemical sciences. These considerations coupled with the capability for high student through-put make it feasible and worthwhile to include hands-on experiments using IR in introductory chemistry classes. The experiment presented involves two primary parts with IR analysis being incorporated in the second of these. A two component solid mixture of caffeine and ibuprofen is separated through a series of solution extractions. The solid components once recovered, dried, and massed are analyzed using IR. The goal of the IR analysis

is to determine how effectively the two components were separated by comparing their spectra with the known spectra of the pure components. Typical student experimental and laboratory report results will be presented.

T53: General chemistry and the visually impaired student

Trilisa Perrine (University of Michigan, USA), Barry Dunitz (, USA)

Technological and scientific fields are often avoided by individuals with visual impairments. Scientific knowledge, as usually presented, is difficult to access without the use of visual means. Modern chemistry is often taught using a rather visual approach; orbital diagrams, two dimensional molecular models, color changes, and molecular orbital pictures are a few examples of the ways chemistry at the introductory level becomes a visual experience for the average student. Various methods and techniques can be used to help translate these images and other chemical concepts, which fully sighted instructors often take for granted, to a more meaningful and accessible experience for the visually impaired student. These techniques include the use of tactile models, more precise lecturing skills, as well as others. This follows the concept of “universal design,” where fully-sighted students will benefit from the adjustments made to accommodate the vision impaired students. General chemistry is the gateway to more advanced topics in chemistry, and therefore should be made accessible to visually impaired students in order to encourage more involvement in this exciting scientific field.

T57: I dream of mendeleyev

Craig Davis (Xavier University, United States)

Xavier University offers an Honors section of our non-science-majors course, “Chemistry in Society”. Recent strategies to distinguish this section have included using a General-Organic-Biochemistry textbook or using a mainstream non-science-majors textbook but adding a series of essays. The former allowed a more rigorous discussion of chemical principles, but at the expense of the “society” issues; the latter required more work by the students, but the lecture material was then too similar to the other sections. This past year a non-science-majors textbook was selected, but an ancillary text was added: “Mendeleyev’s Dream: The Quest for the Elements” (by Paul Strathern; Berkley Books, 2000). This book begins with the ancient Greek philosophers and the first “scientific” thinking, progresses through the era of the alchemists, enters the modern scientific era, highlights key discoveries and new concepts that heralded the modern field of chemistry, and concludes, as the title suggests, with the development of the Periodic Table by Mendeleyev in 1869. The treatment of the beginnings of modern chemistry was the most beneficial to the students. The book would introduce the experiment performed or natural phenomenon observed, explain how the scientist interpreted the data, and then reveal how this new insight was greeted by fellow scientists and/or the religious establishment. This allowed the students to learn how science is done, rather than simply present them with the results of science. Details of the topics discussed and how the text was integrated into the course will be presented.

T61: Isolation of pigment from red rose petals for multifarious applications: A green and a low cost project for undergraduate students

Sunita Dhingra (Miranda House, India), Shahana Sheikh (Sardar Patel Vidyalaya, India)

The pigment isolated from red rose petals contains mainly anthocyanins (cyanin). It was earlier obtained by extraction with methanol in presence of conc. hydrochloric acid. In the present work, it has been extracted without use of any organic solvent. The crude extract was used for detection of

phenolic group and reducing monosaccharide. The pigment has different colour in acidic and alkalyine medium and hence before using it as an indicator for acid based titration, the pH range in which it changes colour was found out. This has been done by pH-metric titration. A comparison with already used indicators i.e. phenolphthalin and methyl orange was also studied. Once the pH range of the indicator (extract) was known, it was used 1. as an indicator in the volumetric titration between a strong acid and a strong base. 2. for making the pH paper strips. The results of the above project were very encouraging. We are in the process of developing projects for undergraduate students. The emphasis is on use of natural compounds for multifarious applications. A student learns various techniques and skills with practically no costs and no pollution.

T62: Measuring the effects of nitrogen, carbon dioxide, carbon monoxide, and temperature on the percent oxygen saturation of bovine hemoglobin using visible spectrophotometry: an undergraduate research project

Lynne Divis (Franciscan University, USA)

Deoxygenation of oxyhemoglobin is a biochemically important process. The effects of nitrogen, carbon dioxide, carbon monoxide, and temperature on the deoxygenation of bovine oxyhemoglobin were studied using visible spectrophotometry. Wavelengths were chosen for multicomponent analysis. Spectra were collected before and after treatment, and percent oxygen saturation levels were calculated. For both nitrogen and carbon dioxide, percent saturation values decreased with increasing time of bubbling gas through oxyhemoglobin solutions. For carbon monoxide obtained from a cigarette-smoking apparatus, results were inconclusive due to discoloration of the hemoglobin solution by other products of the burning cigarette. Percent saturation values decreased with increasing temperature. Method details, resulting spectra, and percent saturation results will be presented.

T63: Microwave heating in the undergraduate organic laboratory

Libbie Pelter (Purdue University Calumet, USA), **Michael Pelter** (Purdue University Calumet, USA)

Developing new and interesting inquiry-based experiments can be difficult due to the limited number of reactions that can be performed in a three-hour time slot. Many of the reactions presently used require reaction times of over one hour, leaving little time for the students to obtain key spectral data and physical property information. This “hurry up and wait!” mentality leads to the following questions: How can we do less waiting? How can we shorten reactions times? How can we develop cleaner and more energy efficient processes? We have enlarged the number of interesting inquiry-based experiments available through the utilization of microwave heating. A reaction requiring heating at 80°C for 8 hours can be completed in 8 minutes at 140°C under microwave irradiation. We will be presenting our adaptations of lengthy reactions that, with the utilization of microwave heating techniques, can be easily completed in a standard laboratory time slot. Students are now provided with the tools, knowledge, and time to identify the product through careful evaluation and critical reasoning. All of our NMR analyses have been carried out on a 60 MHz permanent-magnet FT instrument.

T64: Nanoscience for teachers: An online course at UW-Madison

Janice Hall (UW-Madison, USA)

Recently, the field of nanotechnology has bloomed into one of the most promising and well-funded areas of research. Such an influential and currently relevant topic should be addressed in our

schools' curricula. The Nanoscale Science and Engineering Center (NSEC) at the UW-Madison is sponsoring the development of an online course for high school teachers about nanoscience. This course offers educators the opportunity to learn about nanoscience, and to discover how the subject can be used to illustrate scientific concepts. Ultimately, the course provides educators with materials and information to teach nanoscience within their current curricula. Offering it online allows teachers to better fit it in their busy schedules, and potentially teachers from all over the globe can enroll and share their experiences. Online interactions between teachers and the instructor are enabled through the course management system, Moodle. Educators are asked to put together a nanoscience module based on their understanding of the subject and their current curricula, using the materials provided in each topic.

T65: Nature of science and inquiry as main characteristics of general chemistry textbooks
Andoni Garritz (UNAM, MEXICO)

The objectives of this poster are to present: 1) A survey on the desirable components reported in the literature for Science and General Chemistry textbooks; 2) A new University General Chemistry textbook with 'Nature-of- Science', 'Inquiry' and 'Skepticism promotion' as main characteristics, recently appeared in Spanish for Latin American readers: Garritz, A., Gasque, L. and Martínez, A. Química Universitaria, Pearson Education, Mexico, 2005. 3) The decision-making process to arrive to the final set of contents of this book.

T66: NCATE accreditation assessment #7; Safety, legal, and ethical issues: How to assess student performance via a web-based module

Eric Malina (Southern Illinois Univ. Edwardsville, USA), Tom Foster (Southern Illinois Univ. Edwardsville, USA)

The NCATE accreditation process has undergone a complete revision during the past two years. Institutions seeking NCATE accreditation are allowed only eight assessments to address all national standards. One of the eight assessments should be specific to safety, legal, and ethical issues associated with the science classroom. While all students pursuing science teachers certification at Southern Illinois University Edwardsville are taught safety, legal, and ethical issues throughout their program, no assessment specific to all these standards existed. This poster presents our solution to this problems; the design of a Blackboard based module to assess student understanding of safety, legal, and ethical issues.

T68: Periodic fun

Al Hazari (University of Tennessee, USA)

A fun and educational display of at least 40 periodic tables of the elements will be presented. It begins with the old (pre-Mendeleev) tables, continues through the modern ones, and then covers the most unusual ones.

T69: Picture is worth a thousand words: Web-based prelabs

John H. Penn (West Virginia University, USA)

The ease of generating digitized pictures and their subsequent manipulation has allowed for easy generation of pre-laboratory materials for student usage. Not surprisingly, students prefer these pre-laboratory materials, compared to the traditional textbooks, by a wide margin. This talk will be illustrated with examples and how easy it is to generate such materials via Powerpoint or equivalent software. Application to student performance and to student learning will be made.

T70: Pre-college teacher/researchers at Youngstown State University

Allen Hunter (Youngstown State University, USA)

For decades, the compositions of research teams at both predominantly undergraduate and PhD granting institutions has remained essentially the same: a mixture of BS, MS, & PhD students, postdoctoral fellows, and other research associates/technicians. One category of research team member that has been conspicuously absent is the large pool of pre-service and in-service high school science teachers that are “out there”. This presentation will focus on their improved integration into the national research enterprise, including: teacher preparation for research, integration of teacher/researchers into research & graduate programs, funding opportunities, and conceptual & institutional barriers to their research integration. We will discuss genesis and current state of the program at Youngstown State University to integrate pre-college teachers into our Predominantly Undergraduate Institution research teams. Examples will include specific chemical education, instrumentation, and synthetic chemistry research projects (and their hybrids) and general program design features.

T71: Reaction mechanisms involved in the synthesis of benz[a]pyrene diol epoxide

Pasquale Di Raddo (Ferris State University, USA)

Polycyclic aromatic hydrocarbons are well-known environmental pollutants known to cause cancer, the prototype example of which is benz[a]pyrene. The multistep synthesis of the metabolite benz[a]pyrene diol epoxide (BPDE) starting from pyrene is achieved using a series of chemical reactions familiar in type to those reactions that are covered in a two-semester sophomore level organic chemistry sequence, such as the one offered at our school. In order to demonstrate the application of the many organic reactions that students learn in these classes then, we look closely at the individual reaction mechanisms and use the common curved arrow symbolism to demonstrate this synthesis. We find that using such a biologically relevant compound increases students' interest in the material taught.

T72: Review of the crystallographic/diffraction education literature

Allen Hunter (Youngstown State University, USA)

Recent advances in crystallographic theory and software and data collection and computational hardware have facilitated the introduction of crystallographic/diffraction topics into an increasingly broad array of instructional settings. These settings range from dedicated graduate level courses through modules suitable for preschool children. The Youngstown State University and Muskingum College hubs of the STaRBURSTT CyberDiffraction Consortium has been very active in developing, testing, and disseminating such educational materials. In excess of 500 papers have been published on the teaching of crystallography and diffraction methods. In spite of this, no comprehensive annotated review of this crystallographic/diffraction education literature is available. In this presentation, we report the results of such a review. Suggestions for areas where crystallography/diffraction methods topics are underutilized in the curriculum and for which new education research and materials development are needed will be presented.

T74: Synthesis, analysis, and application of azo-dyes: An organic chemistry or joint organic/physical chemistry experiment

Loyd Bastin (Widener University, United States), *Ismail Kul* (Widener University, United States), *Jim Patterson* (North Seattle Community College, United States), *Mark Schneider* (Widener

University, United States)

Here we describe an undergraduate laboratory experiment designed to foster collaboration between organic laboratory students and/or organic and physical chemistry laboratory students. The experiment involves the synthesis of an azo-dye from a 13 compound library of aromatic amines and activated aromatic compounds by the organic laboratory students. Once the dye has been synthesized, it is characterized in neutral, acidic, and basic conditions by UV-Vis spectroscopy. The experimental UV-Vis spectroscopic data is compared to theoretical values obtained by the physical chemistry students using Spartan '04. The azo-dye is then used to dye a xx piece fabric that is chemically analyzed by the students. The azo-dye is then used to attempt the dyeing of KH₂PO₄ (KDP) Crystals. Here we present a summary of the student results obtained from a variety of students in different courses (Allied Health Organic/Biochemistry, Organic Chemistry, and Honors Organic Chemistry) at various institutions (the University of Washington, Antioch College, Claremont McKenna College, Pitzer College, Scripps College, North Seattle Community College, and Widener University).

T75: Thermodynamic interpretations of temperature depression in slush

Nak Han Jang (Kongju National University of Education, KOREA)

About 10 millions ago, Korean ancestors kept ice in stone warehouses until the summer. In summer, they made ice cream using slush; ice to which salt was added. We have investigated thermodynamic interpretations of temperature depression in slush made with sodium chloride (NaCl). In slush, the lowest temperature was -21.1 C, at 23.3 wt% NaCl (eutectic mixture). This phenomenon could be explained with heat of solution in slush. Heat of this solution (the lattice energy plus solvation (hydration) energy for NaCl may explain this phenomenon. Exothermic solvation energies combine with exothermic lattice energy to produce an overall endothermic process. The driving force for this endothermic process is the entropy increase due to the ice lattice bond breaking. Thus, at concentrations up to 23.3 wt% NaCl, some ice will melt due to the temperature depression and leave a more highly concentrated salt solution at temperatures near and above -21.1 C. In ocean water (about 3.5 wt% salts), slush begins to form at -1.91 C.

T76: Three-step sequence for the teaching of consecutive first-order reaction kinetics

Laura Ruebush (Texas A&M University, USA), Simon North (Texas A&M, USA)

The teaching of consecutive first-order kinetics often involves the derivation of integrated rate law expressions and subsequent discussion based on these expressions. Many students have a difficult time developing an intuitive understanding and often lose sight of many of the qualitative, sometimes counter-intuitive, results based on these equations. In an effort to facilitate insight into consecutive reaction kinetics the following sequence of activities has been developed. First, students are shown a water flow analogy, where the holes between different sections of tubing are analogous to the rates of reaction. Secondly, the students participated in a hands-on exercise in stochastic kinetics modeling through the use of a dice rolling exercise. The last activity in the sequence uses a deterministic kinetics simulator program. The full sequence was conducted with ten participants in The Information Technology in Science Center for Teaching and Learning during July 2005. The response to the demonstrations was overwhelmingly positive. The participants reported an increased understanding of kinetics and were eager to use the technique in their own classroom teaching. Detailed findings will be reported from this pilot study.

T77: Ultrasonic initiation of Grignard reactions: Comparison of conventional results , and

student results

David Smith (Doane College, United States)

Traditional Grignard reactions are very difficult to initiate because they must take place in extremely dry conditions. The ultrasonic method of making Grignard reagents allows reaction initiation under average, even "wet" laboratory conditions, greatly speeding up the typical undergraduate laboratory experiment. This study compares the product mixtures resulting from ultrasonic and conventional methods and focuses on the mixtures obtained in an undergraduate class, including some common student mistakes.

T79: Using discovery learning experiences to facilitate student integration of diverse concepts: Structure-property relationships in (arene)Cr(CO)₃ chemistry

Allen Hunter (Youngstown State University, USA)

One of the most difficult challenges facing students is the integration of knowledge gained across different parts of a course or courses. Student research experiences have been shown to strongly facilitate such integration while laboratory "experiments" following the verification/skills model are much less successful. An alternative/supplementary approach for the inorganic laboratory is to replace some or all of its conventional "experiments" with open ended projects that more closely resemble, and in at least some ways are superior to, research. These discovery oriented/group learning projects are carried out as structure/property relationship studies on series of closely related compounds. An optimized project of this type using (Arene)Cr(CO)₃ complexes will be discussed in detail with information on how this project both develops skills in, and helps the students integrate knowledge about, synthetic techniques, bonding models and calculations, structural methods including X-ray crystallography, spectroscopy (IR, NMR, MS, etc.), and electrochemistry in inorganic chemistry.

T80: Women's superiority on understanding of chemical bonding concepts for Korean high school students

Nak Han Jang (Kongju National University of Education, KOREA)

Understanding of chemical bonding concepts was investigated using the Chemical Bonding Diagnostic Test (CBDT) for Korean high school students. The mean score for all female students was higher than that of all male students. Results of examinations of misconceptions will be presented as well. Overall, grade 12 female students had a better understanding of the concepts of chemical bonding than other Korean high school students. It can be inferred that the superior female students usually join the science declared classes and they are the core; however, the number of them is small. In contrast, the distribution of male students is more diverse with a number of male students is two or three times larger than the female in the science declared classes. In addition, this can be inferred that all students do not focus as much if they don't select chemistry as a subject on the college scholastic ability test. The science-preferred grade 12 female students have the best understanding of the concept of the chemical bonding. This can be inferred that the science-preferred grade 12 female students studied to prepare for the college scholastic ability test or had more exposure to the concept of chemical bonding.

Demonstration sessions

Tuesday, August 1 afternoon

1:15 PM - 4:50 PM WTHR 200

Session 1 of 2

James Maynard (UW Madison, U.S.), **Kenneth Lyle** (Duke University, USA)

In the hands of a skilled educator, chemical demonstrations can be an effective instructional strategy that helps students learn and understand the chemical concepts. The emphasis of this symposium is on the pedagogical use of chemical demonstrations to foster student learning. Presenters will share demonstrations that have proven to be an effective instructional tool and how these demonstrations are used in their classrooms to promote learning of the concepts. Presenters will also provide a teacher's guide for each demonstration that includes 1) the chemical concepts addressed; 2) a brief description of how the demonstration addresses these concepts; 3) a guide to preparing and performing the demonstration, including safety and disposal issues; and 4) a description of how the demonstration is used in the classroom to foster learning and understanding of the concepts. Once completed, the teacher's guide will be posted on the BCCE Web site.

| | |
|-----------------------------|--|
| 1:15 | introduction |
| 1:20 Kathryn Wagner | D1: Voice-activated reaction and how it works |
| 1:35 Andrew Cherkas | D2: Stuck on you |
| 1:50 Robert Richman | D3: Electrolytic titration |
| 2:05 David (Randy) Sullivan | D4: Migrating colors |
| 2:20 Robert Gregory | D5: Fun with transparency films: The Rutherford gold foil experiments and beyond |
| 2:35 Jeffrey Fieberg | D6: Visualizing the transition state and reaction coordinate |
| 2:50 Joanne Wittbrodt | D7: Will olive oil float? |
| 3:05 Dean Campbell | D8: Flash ignition of carbon nanotubes |
| 3:20 | break |
| 3:30 Brian Rohrig | D9: Do flares work underwater? |
| 3:45 Adele Mouakad | D10: Kinetics and catalysis |
| 4:00 Ed Vitz | D11: Magic sand/magic water |
| 4:15 Malka Yayon | D12: As a matter of heat |
| 4:30 Kenneth Lyle | D13: Teaching kinetics with the Landolt clock reaction |
| 4:45 Mark Ellison | D14: Entropy bomb |

D1: Voice-activated reaction and how it works

Kathryn Wagner (Princeton University, USA)

When students talk to a flask of red solution, it turns yellow. We use this "voice-activated" reaction to introduce the scientific method and experimental design. Since it requires audience participation, it makes a great ice-breaker. (Of course, it can also be used as part of a unit on acid/base indicators or carbon dioxide.)

D2: Stuck on you

Andrew Cherkas (Stouffville DSS, Canada)

Members of the class[audience] will be asked to become an atom of a particular atom by having cards denoting a specific number of electrons and protons. The students portraying the elements will transfer the correct number of electrons to other elements thereby becoming ionized and charged. The resulting valence will be simulated with velcro tape. The correct formulas for the resulting compounds will thus be obtained.

D3: Electrolytic titration

Robert Richman (Mount St. Mary's University, USA)

The titration of aqueous barium hydroxide by aqueous sulfuric acid in the presence of a conductivity-indicating light bulb is described in the Chemical Demonstrations sourcebook by Summerlin, Borgford, and Ealy. While not as entertaining as explosions or liquid nitrogen, it does keep students' interest. Moreover, it is the most pedagogically useful demonstration I have found in 30 years of teaching. In a highly interactive format, it tests student understanding of acid-base neutralization, precipitation reactions, limiting and excess reagents, and electrolytes.

D4: Migrating colors

David (Randy) Sullivan (U. of Oregon, USA), Deborah Exton (University of Oregon, USA)

Ethyl acetate has a very low dielectric constant (6.02 [1]). Water, on the other hand, has a relatively high dielectric constant (78.54 [1]). Since ethyl acetate is incapable of effectively separating the Coulombic forces of attraction between the water molecules, these two liquids are immiscible. However when ethanol, which has a dielectric constant of intermediate value (28.0 [1]), is introduced to the system a single phase is observed. This simple demonstration illustrates the connection between dielectric constant, the polarity of molecules, intermolecular attractions, and solubility. Unlike classic "like dissolves like" demonstrations that utilize hazardous chemicals with concomitant waste disposal issues, this demonstration is performed using common household chemicals. Based upon their knowledge of intermolecular attractions, students are asked to make predictions, followed by observation of the demonstration (in a large class) or a hands-on activity in a smaller class. An interesting twist at the end challenges students to think beyond simple predictions. In a glass cylinder, water is added to fingernail polish remover (ethyl acetate). Since these two liquids are immiscible, they form two layers. A few drops of blue food coloring are then added to the cylinder. They fall through the ethyl acetate and dissolve in the water layer, dyeing it blue. But when some ethanol is then added and the mixture is stirred, it goes into a single phase of uniform color. [1] Robert C. Weast, ed. (1986-87) CRC Handbook of Chemistry and Physics, 67th ed, (pp. E-50 - E-51). Boca Raton, Florida: CRC Press, Inc.

D5: Fun with transparency films: The Rutherford gold foil experiments and beyond

Robert Gregory (Indiana University Purdue University Fort Wayne, USA)

In the search for a simple yet effective approach to demonstrate the unexpected nature of the Gold Foil experiments, two picture frames and a laser pointer was found to be all that was needed. Along the way, some very interesting interactions of light and transparency films were found. Among them, Airy rings, Newton's rings, linear diffraction, and stress-strain demonstrations in polymers are all easily shown. This presentation will demonstrate each of these, including the seminal model of the Rutherford demonstration.

D6: Visualizing the transition state and reaction coordinate

Jeffrey Fieberg (Centre College, USA)

Transition state theory, also called activated complex theory, is often introduced in general chemistry courses when discussing kinetics. A reaction energy diagram is used to follow the progress of the reaction from reactants through a transition state to products. The reaction energy diagram plots the system's potential energy versus reaction coordinate and shows that reactant molecules must overcome an activation energy to pass through the transition state (activated complex) to form products. This demonstration takes the very abstract concepts of transition state, activation energy, and reaction coordinate and makes them more concrete and accessible. The demonstration uses a child's toy (Hoberman Switch Pitch) to model a chemical reaction that follows reactants through a transition state before making products. The reaction coordinate, activation energy, and specific geometry of the transition state are discussed as part of a question and answer dialogue. The complex, multi-dimensionality of a reaction coordinate and the inherent instability of a transition state become evident. The demonstration also shows that certain reactions may "go" more readily if the energy of a reactant is in a particular type of internal mode (vibrations or rotations). Often, the preferential partition of a given total energy into internal modes of motion (vibrational, rotational) versus translational collision energy allows the system to access the transition state more easily.

D7: Will olive oil float?

Joanne Wittbrodt (Wayne County Community College District,)

This demonstration illustrates the concepts of density and of miscibility. The only supplies required are rubbing alcohol (labeled as 75% or greater isopropyl alcohol), olive oil, water and a clear, colorless container with a leakproof lid. Isopropyl alcohol is volatile and flammable, so use with caution and avoid ignition sources. Before the demonstration, ask the students if olive oil will float or sink. Pour rubbing alcohol into the container, then add some olive oil. The oil will sink. Add water to the mixture. The water will mix with the alcohol layer and will increase its density, causing the two layers to invert so that the oil will float. Compare the densities of the three substances. Categorize each pair of the substances as miscible or immiscible.

D8: Flash ignition of carbon nanotubes

Dean Campbell (Bradley University, USA)

Flash-initiated combustion of single-walled carbon nanotubes can be demonstrated in a large setting. These demonstrations can also be used to illustrate the importance of surface area in chemical reactions. In one type of demonstration, the nanotubes melt and/or ignite a suspended, stretched piece of plastic film. Another type of demonstration utilizes the combustion of carbon nanotubes to ignite a strip of flash paper.

D9: Do flares work underwater?

Brian Rohrig (Jonathan Alder High School, USA)

An easy but spectacular classroom demonstration can be performed with an ordinary road flare. The flare is activated, and then submerged in an aquarium full of water. The flare continues to burn brightly for several minutes! This is due to the fact that the flare contains an internal oxidizer, and does not rely on the presence of outside oxygen to burn. The chemistry of the flare will be discussed, as well as related explosives that are so violent in their reactions because they already contain an oxidizer.

D10: Kinetics and catalysis

Adele Mouakad (St. John's School, USA)

In kinetics there are two basic types of catalysts, homogeneous catalysis, which is the use of a catalyst in the same phase as the reacting species. The other is heterogeneous catalysis, which involves the use of a catalyst that exists in a different phase as the reacting species. In these demonstrations we will see the two different types of catalysis. In the catalytic reaction of potassium sodium tartrate with hydrogen peroxide, the cobalt chloride catalyst is in the same phase as the two reactants. The student can see the progress of the reaction via the formation of the green activated complex. In the catalytic oxidation of methanol, the platinum is a heterogeneous catalyst, where the platinum is in a solid state and catalyzes the oxidation of the methanol vapors. This reaction repeats itself as long as the methanol is not consumed and the platinum is left in the flask.

D11: Magic sand/magic water

Ed Vitz (Kutztown University, USA)

Demonstrations involving Magic Sand[®] can be used to help explore concepts as diverse as hydrogen bonding in water, entropy, HPLC, and biogenesis¹. It has been used as a JCE Classroom Activity² and as an overhead projector demonstration³. As we will see, the real magic is in water, and as Tom Robbins says, "Human Beings were invented by water as a device for transporting itself from one place to another."

1. Vitz, E., "Magic sand: Modeling the hydrophobic effect and reversed-phase liquid chromatography", *J. Chem. Educ.* 1990, 67, 512.
2. *J. Chem. Educ.* 2000, 77, 40A.
3. Goldsmith, Robert H. *J. Chem. Educ.* 2000 77 41.
4. Robbins, T. *Even Cowgirls Get the Blues*, Houghton Mifflin, Boston, 1976, p. 2.

D12: As a matter of heat

Malka Yayon (Katzir Highschool, Israel)

Matter behaves very differently when heated, depending on the molecular structure of the substance or material. Frying an egg, with melted cheese and bread, demonstrate some of these transitions.

D13: Teaching kinetics with the Landolt clock reaction

Kenneth Lyle (Duke University, USA)

The Landolt Iodine Clock reaction can be used to help students understand several chemical concepts associated with kinetics--measurement of reaction rates, determination of the influence changing the concentration has on the overall rate, making qualitative and quantitative predictions, and first-order kinetics. Students are actively engaged in several ways: counting out loud at a steady pace from when the reactants are first combined until the mixture turns blue-black; making qualitative predictions about the time to react when the iodate concentration is halved and defending their reasoning; and making quantitative predictions about the time to react when the iodate concentration is now one-fourth the original and defending their reasoning. A molecular explanation is included in the discussion after the first reaction has been performed.

D14: Entropy bomb

Mark Ellison (Ursinus College, USA)

The evaporation of liquid nitrogen in a closed system (plastic soda bottle) underwater provides a

powerful demonstration for numerous concepts. These include: work, heat, enthalpy, entropy, spontaneous processes. It clearly shows that endothermic processes can be spontaneous. The demonstration may be used as a starting point for discussion of energy transfer, entropy, work, or other topics. Additionally, students can calculate many of the quantities involved in this demonstration.

Symposia sessions

Tuesday, August 1 afternoon

1:15 PM - 5:10 PM STEW 310

S18: Best Practices in e-learning Design and Delivery. - Session 2 of 2

Moustapha Diack (Southern University, USA), **Nancy Konigsberg Kerner** (University of Michigan, USA)

Faculty and students are realizing the benefits of technology in the learning experience and improvement of learning. What lessons have we learned relative to effective implementation of technology? This session will offer practical tips for teaching with technology to enhance student learning based on your experiences. Sources of high quality materials with documented learning outcomes will also be shared.

| | | |
|------|-------------------|---|
| 1:15 | | introduction |
| 1:20 | Roberto Gregorius | P296: An eBook for general chemistry: What may be achieved by switching from print to multimedia textbooks |
| 1:40 | Roberto Gregorius | P297: Focusing on inductive learning as a solution for implementing inquiry in the large general chemistry lecture hall |
| 2:00 | Gabriela Weaver | P298: Development and testing of a chemistry-based video game |
| 2:20 | Erik Epp | P299: Implementation and study of e-learning in a laboratory course: Issues, solutions and findings |
| 2:40 | Joann Pfeiffer | P300: Improving students' conceptual knowledge in general chemistry using Desire2Learn, an e-learning system |
| 3:00 | | break |
| 3:10 | Gretchen Wolf | P301: Using new technology to teach beginning chemistry |
| 3:30 | Nancy Grim Hunter | P302: Teacher quality enhancement: Best practices in developing web-enhanced learning environments |
| 3:50 | Martin Ondrus | P303: Teaching chemistry at a laptop campus |
| 4:10 | Alexandra Yeung | P304: Personalised or non-personalised text: Does it matter for e-learning? |
| 4:30 | John Gelder | P305: Integrating before and after class web activities with a large lecture classroom |
| 4:50 | | discussion |

P296: An eBook for general chemistry: What may be achieved by switching from print to multimedia textbooks

Roberto Gregorius (University of Texas-Pan American, USA)

An eBook (textbook built entirely using Macromedia's Flash authoring software) for the first semester of general chemistry was prepared and implemented. This presentation will focus on the design and structure of the key features of the eBook that allowed the students to be directed toward inductively constructing the concepts for themselves (as opposed to deductively applying explicitly described knowledge). Examples of how a multimedia content can be developed and used to present concepts so that Johnstone's interdependent components of chemistry learning: macroscopic phenomena, symbolic representation, and particulate conception are strongly connected in the student's understanding will be shown. The perceived limits and appropriate use of such a material based on the instructor's and students' experience with the eBook will be described and compared to that of traditional lectures and textbook presentations, as well as to the traditional lecture augmented with PowerPoint and WebCT. Preliminary data on student performance and attitudes will be presented. A process that will allow future instructors/users to modify the eBook to suit their individual/research needs will be presented.

P297: Focusing on inductive learning as a solution for implementing inquiry in the large general chemistry lecture hall

Roberto Gregorius (University of Texas-Pan American, USA)

A report will be made on the attempt to achieve the goals of inquiry learning by developing and implementing an eBook replacement for the standard printed textbook and having a cooperative learning format in the lecture hall. An eBook (textbook built entirely using Macromedia's Flash authoring software) for general chemistry was prepared and implemented. The eBook was designed to be inductive in its approach, focusing on providing students the opportunity to construct the general chemistry concepts for themselves as opposed to being provided the fundamental ideas and having to apply them deductively. The lecture sessions were designed around cooperative learning principles and used to provide students the opportunity to present their own understanding and constructed concepts, as well as to correct for any misconceptions. Preliminary data on student performance and attitudes, as well as the author's first-time experience, will be provided.

P298: Development and testing of a chemistry-based video game

Gabriela Weaver (Purdue University, USA), Douglas D. Danforth (Purdue University, USA), Kermin J. Martinez-Hernandez (Purdue University, USA), Carlos R Morales (Purdue University, USA), Naveen Nattam (Purdue University, USA), Patrick Robertson (Purdue University, USA)
We have begun development of a video game that is modeled after commercial games but includes chemistry-based "challenges" throughout the storyline. The game is a collaborative effort between researchers in chemical education and in computer graphics technology. The first level of the game includes eight interconnecting rooms with three different chemistry puzzles. At this time we have tested a fully functional version of the Haber-Bosch room, which includes concepts on stoichiometry, catalysis and kinetics. This room was tested with freshmen and sophomore college students, and data was collected using surveys, interviews and observations. In this talk, we will demonstrate the Haber-Bosch room of the video game. We will also discuss the results of the testing. Finally, we will discuss our results with respect to gender issues around the idea of using

video games as educational supplements.

P299: Implementation and study of e-learning in a laboratory course: Issues, solutions and findings

Erik Epp (Purdue University, USA), Katherine Jennings (Purdue University, USA), Gabriela Weaver (Purdue University, USA)

The Physical Chemistry in Practice DVD is a non-linear, multimedia tool for teaching about physical chemistry through examples of current research. The DVD gives students exposure to the uses of physical chemistry in an applied setting to which they would not normally have access, and allows them to view the material at their own pace in an order of their choosing. In the fall of 2005, the DVD was used as a laboratory activity in an undergraduate, physical-chemistry laboratory course. To better understand how the DVD was used, students' interactions with the DVD were recorded through a duplicate video output. This method of unobtrusively collecting video data allowed us to view the on-screen activities of students with minimal disruption to the learning environment. Implementation issues related to technology limits, accessibility, and cross-platform compatibility will be described, along with how these were overcome. Findings from analysis of our video data regarding student use of the interface will also be presented.

P300: Improving students' conceptual knowledge in general chemistry using Desire2Learn, an e-learning system

Joann Pfeiffer (Century College, USA)

Desire2Learn (D2L) is a web-based classroom management system similar to Blackboard and WebCT. This presentation describes an innovative use of the quiz tool in D2L to enhance learning in a general chemistry course. The goal of the technique is to help students focus on obtaining a deep understanding of chemistry concepts rather than on memorizing algorithms to solve problems. This presentation will include time-saving tips on how to implement this technique easily into your courses, provided your school has access to an e-learning system. Assessment results will also be presented.

P301: Using new technology to teach beginning chemistry

Gretchen Wolf (Purdue University Calumet, USA)

Learning/teaching remedial chemistry can be taxing for both the student and the instructor. Students who approach the course with anxiety either from a previous class or a self perceived lack of ability can quickly lose interest and motivation if they do not have early engagement and assessment opportunities that support their learning. By utilizing new technologies both in the classroom and out, student success can be improved by the immediacy of feedback. This presentation will describe the use of technologies such as the eInstruction Classroom Performance System and WebCT Vista to provide such feedback. Examples will be presented including the use of eInstruction questions used in conjunction with power point lecture presentations to actively assess student conceptual understanding in the classroom. WebCT Vista generated problem sets are used outside the classroom between major tests, to help students assess their own level of learning. Portions of major tests have been administered using eInstruction. The grading of these activities is immediate, providing timely feedback to both the student and instructor. The student develops self monitoring skills needed to determine how best to spend their valuable study time. The instructor has a more timely pulse for the class with the benefit of reduced grading time. This allows the instructor to more effectively facilitate student learning. This talk will describe student

performance data measured for a group of students from the spring 2006 semester and will compare student learning outcomes from this course over previous semesters in which these methods were not used.

P302: Teacher quality enhancement: Best practices in developing web-enhanced learning environments

Nancy Grim Hunter (Chicago State University, USA)

The Teacher Quality Enhancement Project was founded to develop and sustain professional development opportunities for higher education faculty at the community college and university level in order to promote systemic reform in teacher preparation. This paper will explore the lessons learned about best practices in developing web-enhanced learning environments and show models of our best online modules developed by our faculty partners in science and mathematics.

P303: Teaching chemistry at a laptop campus

Martin Ondrus (University of Wisconsin-Stout, United States)

The 2005-06 academic year was the University of Wisconsin-Stout's fourth year as a laptop campus. During those years, the entire campus was converted to wireless network connectivity. All faculty were provided with new notebook computers that are being replaced on a three-year rotation, and virtually every student now leases an Apple or Hewlett Packard laptop with site-licensed and key-served software. Members of the department of chemistry have strongly supported the laptop initiative both in the classroom and in the laboratory. Chemistry faculty now expect students to access lecture notes, laboratory procedures, assignments, on-line movies, on-line quizzes, and related web links. Many general-chemistry experiments have been revised to use student laptops with key-served Vernier software to collect and analyze data. Every laboratory is equipped with a wireless networked printer. In advanced courses students use site-licensed software for instrument operation and for data analysis. Students also use digital technology to photograph laboratory apparatus and record laboratory procedures for lab reports and lab notebooks. Having participated in a two-year pilot project prior to initiation of the campus-wide program, chemistry has now completed its sixth laptop year.

P304: Personalised or non-personalised text: Does it matter for e-learning?

Alexandra Yeung (University of Sydney, Australia), *Adrian George* (University of Sydney, AUSTRALIA), *Michael King* (The University of Sydney, Australia), *Siegbert Schmid* (The University of Sydney, Australia)

Information and communications technologies are increasingly being incorporated into teaching activities in higher education. As a consequence, there has been substantial research interest into the design of multimedia materials that best promote student learning. Mayer and co-workers have examined the use of personalised messages (text presented in an informal/conversational/first person style) in e-learning activities in biology. They found that personalised text forms led to higher student performance on both retention and transfer tests, when compared with a control group using non-personalised messages (text presented in a formal/third person style).

Our study extended the investigation of the personalisation hypothesis to the domain of chemistry, and also examined the influence of prior knowledge. Our study was carried out in a large first year chemistry unit of study (approximately 600 students) and includes students with varying levels of

prior knowledge in the domain. The effect of personalisation on the academic performance of students with different gender, learning styles and language background has also been investigated. This presentation will describe the results in detail and the implications they may have for teaching and learning.

P305: Integrating before and after class web activities with a large lecture classroom

John Gelder (Oklahoma State University, United States), Michael Abraham (University of Oklahoma, USA)

Guided by instructional theory and research on instructional strategies, and aided by recent advances in instructional technology, we have been developing and implementing instructional materials based on the learning cycle approach that can be conveniently used in large lecture settings. This approach is based on linked activities that students would do before, during, and after a class meeting. The Before Class Exploration (BCE) is a web-based exercise that students do before they attend a lecture. It will usually consist of 5 to 7 questions that require only 10 to 15 minutes of a student's time to complete. Upon submission of the BCE, students receive a copy of their responses and, when appropriate, an expert's response to the same questions for comparison. The instructor can access all student responses to the BCE at anytime, and use them to customize his/her lecture activities. The During Class Invention (DCI) poses questions/problems that focus on a course learning objective and is designed to be done by small cooperative groups. Students can report their consensus response for the instructor's consideration using a student response system (H-IIT, Educue, eLearning) and/or by turning in a written response. The After Class Application (ACA) is a web-based set of questions that will allow students to apply their knowledge of the concept introduced by the BCE and 'invented' by the DCI. Both the BCE and ACA are web-based and all responses are stored in a relational database. The technology to deliver the web activities and mine the student responses, along with examples of BCE/DCI/ACA materials will be presented.

1:15 PM - 5:10 PM STEW 214C

S34: Different Methods of Using Learning Theory in Teaching Organic Chemistry - Session 1 of 2: New Methods that Replace or Enhance Lectures

Barbara Murray (University of Redlands, USA)

This symposium will cover new teaching methods in organic chemistry, such as POGIL, PBL, and PLTL. The audience will be able to compare all methods presented and will be better able to judge which one might work in his/her own classroom.

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|------------------------|---|
| 1:15 | introduction |
| 1:20 Alan Kiste | P306: Integrating enhanced podcasts with organic chemistry lectures |
| 1:40 Deborah Louda | P307: Group activities in organic chemistry |
| 2:00 Jack Kampmeier | P308: Peer-Led Team Learning in organic chemistry |
| 2:20 Jane Myong | P309: Use of molecular modeling programs to create an active learning organic chemistry classroom |
| 2:40 | break |
| 2:50 Andrei Straumanis | P310: Does POGIL work for organic chemistry? |

| | | |
|------|---------------------|--|
| 3:10 | Kelly Butler | P311: Benefits and challenges of POGIL in an organic chemistry course |
| 3:30 | Christina Mewhinney | P312: Strategies for managing student group interactions in active learning environments |
| 3:50 | Predrag-Peter Ilich | P313: Sophomore organic chemistry: Moving to the 21st century |

P306: Integrating enhanced podcasts with organic chemistry lectures

Alan Kiste (University of Michigan, USA)

In the Fall of 2005, we integrated visually-enhanced Podcasts into the first and second semester lecture courses, and we collected 4 waves of survey data on student use of all direct and supplemental instruction opportunities we offer in an effort to examine how students navigate their way through the options available to them. Details about the podcasts and data on student use of the podcasts as well as other supplemental instruction will be presented.

P307: Group activities in organic chemistry

Deborah Louda (Florida Atlantic University, USA), Jerome Haky (Florida Atlantic University, USA)

To improve student understanding in organic chemistry, the organic chemistry curriculum at Florida Atlantic University has been revised. Specifically, Organic Chemistry 1 Lab is being phased out and replaced with a two-credit, experiment-intensive organic chemistry laboratory that will accompany Organic Chemistry 2. In place of Organic Chemistry 1 Lab, students participate in group activities that complement the Organic Chemistry 1 lecture. These activities reinforce key concepts that students traditionally find difficult and use molecular models and other tools to incorporate various approaches to learning. Examples of these activities and their effect on organic chemistry students will be discussed.

P308: Peer-Led Team Learning in organic chemistry

Jack Kampmeier (Univ of Rochester, US), **Pratibha Varma-Nelson** (Northeastern Illinois University, US)

The traditional sophomore organic course is a challenge to students and instructors alike. In spite of the power of the structure-reactivity paradigm and the rationalization of the subject provided by our mechanistic understanding, many students continue to try to learn organic chemistry by brute force memorization, as if it were a collection of unrelated facts. This approach is a recipe for disappointment and disaffection. This paper will discuss how Peer- Led Team Learning (PLTL) can help students build enthusiasm for the subject and find success in the course. The PLTL Workshop is a proven pedagogy that is designed to help students learn science, including organic chemistry. The PLTL Workshop has been adopted by more than 100 different colleges and universities to help more than 20,000 students/year learn chemistry. Approximately one quarter of these implementations are in organic chemistry; statistically significant data show improvement in both the performance and the satisfaction of the Workshop students.

P309: Use of molecular modeling programs to create an active learning organic chemistry classroom

Jane Myong (SINCLAIR COMMUNITY COLLEGE, USA)

It is well documented that when students are actively engaged in the learning process, they understand the material better and retain it longer. To provide an active learning environment and

to help the students understand the reactivity of organic molecules better, I have adapted molecular modeling activities using CAChe and Spartan View. I will demonstrate the molecular modeling software and present the activities that we have been using in our organic chemistry courses.

P310: Does POGIL work for organic chemistry?

Andrei Straumanis (College of Charleston, USA)

POGIL is a lecture-less teaching method that seeks to increase student engagement in the classroom by having students work in self-managed teams to analyze data and draw conclusions, modeling the way a team of scientists function in the research laboratory. This talk will describe student performance data, including ACS Organic Exam scores, collected at a range of institutions in both POGIL and traditional sections of organic chemistry. Information regarding the POGIL materials and methods used in these courses is available at www.pogil.org. Faculty adoption of POGIL is supported by NSF via the POGIL Project in the form of faculty development workshops, consultancies, and local networks of POGIL users.

P311: Benefits and challenges of POGIL in an organic chemistry course

Kelly Butler (Chestnut Hill College, USA)

This presentation will discuss the implementation and use of Process Oriented Guided Inquiry Learning (POGIL) for two years in a small organic chemistry course. Students in this POGIL course learn basic organic chemistry skills, such as using curved arrows and drawing resonance structures, much better than previous students taught via the traditional lecture format. While managing the peer led groups can be demanding at times for the instructor, the process oriented classroom forces the students to reflect on how to solve problems, developing mechanisms rather than memorizing them, and makes students much more responsible for their own learning. Students stay focused and engaged for the entire class period. Both the benefits and challenges of POGIL in this setting will be examined, and the discussion will include specific examples from and strategies used within this course.

P312: Strategies for managing student group interactions in active learning environments

Christina Mewhinney (Eastfield College, USA)

Many “active learning” pedagogies are based on peer led group interactions. In theory these pedagogies are promising, but sometimes in practice the results are disappointing or the classroom too challenging to manage. Perhaps this is a result of difficulties in managing the group interactions rather than the pedagogy. This presentation suggests solutions to common group interaction problems and discusses a variety of strategies for managing groups in and out of the classroom.

P313: Sophomore organic chemistry: Moving to the 21st century

Predrag-Peter Ilich (Loras College, USA)

Introductory organic chemistry, by its large size, rigid structure, complexity of concepts and multitude of presentation modes, constitutes an important section of the backbone of the natural science education. At the same time the subject, as it is often presented, is plagued with anachronisms, inaccuracies, and incorrect and irrelevant information, making the transfer of knowledge more difficult and less efficient. Examples of dubious concepts, incongruous reaction mechanisms, erroneous graphical representations, and organic chemistry textbook disneyfications will be examined. Possible improvements using physically-based concepts, culling inessential

material, and making the whole subject simpler and more rigorous are suggested. Concepts and ideas related to the second language acquisition, the grammatical structure of the symbolic organic chemistry and possible ways of a more efficient transfer and acquisition of the subject material will be presented.

1:15 PM - 4:50 PM STEW 302

S35: First Year College Chemistry - Session 1 of 3

Matthew Fisher (Saint Vincent College , USA)

Entry level college chemistry courses, whether for science majors or nonmajors, present unique challenges for instructors. This symposium will focus on several aspects of these challenges posed by first-year chemistry courses. Topics to be considered will include teaching strategies, curriculum questions especially as they relate to issues of globalization and harmonizing disparate needs and interests, and assessment of student learning.

| | | |
|------|---------------------|---|
| 1:15 | | introduction |
| 1:20 | Margaret Asirvatham | P314: International Center for First-year Undergraduate Chemistry Education (ICUC): Enriching chemistry teaching and learning through global interactions |
| 1:40 | Sonia Peter | P315: First -year chemistry at the Barbados Community College . Structure and philosophy |
| 2:00 | Amina El-Ashmawy | P316: Results of a national comparative study between community college and university general chemistry course content |
| 2:20 | Jimmy Reeves | P317: Impact of evolving technologies on general chemistry |
| 2:40 | Caryl Fish | P318: Teaching general chemistry as a freshman seminar |
| 3:00 | | break |
| 3:10 | Kristen Leckrone | P319: Assessing student's preparation for second semester general chemistry through use of a placement exam |
| 3:30 | Deborah A. McCarthy | P320: From one section of 95 students to four sections of 24 : Matters of retention |
| 3:50 | Pamela Marks | P321: Implementation of a teaching teams program at Arizona State University |
| 4:10 | Charity Flener | P322: Student assessment of first year college chemistry class size and teaching style |
| 4:30 | Laura Eisen | P323: Implementing the ACS General Chemistry Curriculum.Chapter 8: Entropy and molecular organization |

P314: International Center for First-year Undergraduate Chemistry Education (ICUC): Enriching chemistry teaching and learning through global interactions

Margaret Asirvatham (University of Colorado-Boulder, U.S.A)

Teaching first-year chemistry is both challenging and exciting, especially as we prepare 21st century students to succeed in the global community. ICUC, formed in late 2003, focuses on the impact of entry-level chemistry courses and provides opportunities for professional growth and international collaborations. The inaugural conference, "First-Year Chemistry: The Richness of Difference," held in May 2005, was attended by 170 chemical educators from 29 states and 5

foreign countries. The mission, goals, and benefits of membership will be discussed. Highlights of the inaugural conference and plans for the next conference in Mexico City in 2007 will be presented.

P315: First -year chemistry at the Barbados Community College . Structure and philosophy
Sonia Peter (Barbados Community College, Barbados)

The Division of Natural Sciences at the Barbados Community College offers Associate Degrees with majors in Chemistry, Environmental Science, Biology, Agriculture, Physics and Mathematics. In the two year programme, students pursue courses in two or three majors, core subjects and electives. The Chemistry major was developed to provide students with exposure to the fundamental principles in the first year and applied concepts in the second year. The modules were structured to ensure that the graduates possessed a strong theoretical and practical foundation, and the associated skills, for advanced study or entry level positions in the chemical industry. The underlying contribution of this academic programme to national development was an important consideration in the curriculum design.

P316: Results of a national comparative study between community college and university general chemistry course content

Amina El-Ashmawy (Collin County Community College, USA)

A national study was conducted to compare general chemistry content between community colleges and universities. The study was done through a survey of community college and university chemistry department chairs or contact persons. This paper will address the similarities and differences of course content in general chemistry as revealed by the survey of over 200 colleges/universities from 46 states.

P317: Impact of evolving technologies on general chemistry

Jimmy Reeves (University of North Carolina Wilmington, USA), Charles Ward (UNCW, USA)

Enormous technological changes that have revolutionized many aspects of our lives have had only minimal impact on general chemistry instruction. While PowerPoints dominate the lecture landscape, most students do homework and take notes, quizzes, and exams using paper and pencil, and the majority of their interactions with their instructor and classmates outside of class occur face to face. Recent advances in communication technologies and computers coupled with the widespread availability of broadband Internet access provide new possibilities for technology-based student learning. This paper will describe our efforts to create a distance learning community that exploits these advances and assesses their impact on students enthusiasm and the quality of their learning in general chemistry.

P318: Teaching general chemistry as a freshman seminar

Caryl Fish (Saint Vincent College, USA)

In 2002 Saint Vincent College began offering Freshman Seminars to all incoming first year students. The freshman seminars are designed to meet core curriculum requirements in a specific discipline as well as meet goals that have been established by the faculty in the following areas: academic responsibility, critical thinking, and presentation of ideas. The natural science faculty have also developed goals for the natural science core curriculum courses to ensure that all students have a basic understanding of the natural sciences. One section of General Chemistry I has been offered each fall as a freshman seminar course. Through a variety of interactive, student

centered activities this course has been able to meet all of these goals.

P319: Assessing student's preparation for second semester general chemistry through use of a placement exam

Kristen Leckrone (Roosevelt University,)

This paper reports on Roosevelt University's adoption of the California Chemistry Diagnostic Exam for use in assessing student preparedness for general chemistry II. At Roosevelt, as at most other universities, prerequisites for general chemistry II consist of college algebra and general chemistry I with grades of C or higher. However, Roosevelt receives a high percentage of transfer students from community colleges, returning adult degree completion students, and other non-traditional students who do not complete the general chemistry course in an immediate, linear two-course sequence. Perhaps as a consequence of the time elapsed since the student completed the prerequisites, a high percentage of students enrolling in general chemistry II do not succeed in the course, despite successful completion of the prerequisites. This paper will report on: (1)The reliability of the California Chemistry Diagnostic Test as a predictor of student success in second semester general chemistry. (2)What correlations, if any, exist between a student's prior course grade in algebra, chemistry I, their placement exam score, and their chemistry II course outcome. (3)Use of the placement exam to assist in counseling students regarding course enrollment and to direct marginally-prepared students to academic support services to increase their chances for success. (4)Use of the placement exam to assist the instructor in tailoring course content in response to class results on specific placement content items.

P320: From one section of 95 students to four sections of 24 : Matters of retention

Deborah A. McCarthy (Saint Mary's College, USA)

In 1992 Saint Mary's College had a new teacher in the classroom and one section of 95 students in the first year course for "science" majors, Principles of Chemistry. The disasters of large sections of first semester, first year college students trying to learn difficult material in this setting were noticed immediately. The first iteration was to send the "less" prepared students to another course that covered the same material but did not have the same math and depth of coverage. The second iteration was to split the class into two sections of about 45 which were taught by two professors using different modes. Currently we are teaching four sections of all inquiry group work in the classroom. This talk will discuss the issues of retention and success of the students in this class over the 13 years. The data presented will show the relationship between the small group work and retention compared to the earlier larger sections.

P321: Implementation of a teaching teams program at Arizona State University

Pamela Marks (Arizona State University, US), Richard Bauer (Arizona State University, US), James Birk (Arizona State University, USA), Sonya Curry (Arizona State University, US)

Incoming students at ASU differ widely in how prepared they are for general chemistry courses. We have many learning-improvement resources that help students learn chemistry. However, most do not result in students forming study groups outside of class, and they do not motivate those "top-end" students who often procrastinate and do minimal work. During the 2005-06 academic year we piloted a Teaching Teams Program, which is modeled after the programs developed and used at three other universities. In this program, student team leaders are responsible for understanding the course material to a greater extent and ahead of time so that they can lead regular help sessions for their peers. The details of this program will be described, and class data

will be presented along with changes made for the spring semester.

P322: Student assessment of first year college chemistry class size and teaching style

Charity Flener (University of Illinois, United States), Paul Kelter (U of Illinois, US of A)

Much research has suggested that smaller class sizes tend to improve student performance at the K-12 level but few studies have discussed a relationship between class size and performance in higher education. We present the results of a year-long study that compared student's opinions and subsequent performance of two formats of first-year chemistry courses offered at the University of Illinois at Urbana-Champaign: a large 350 person lecture paired with a separate 30 person discussion sections versus a small 30 person lecture with discussion sessions integrated into the lecture. Student opinions were gathered from an online survey and student performance was assessed using exam scores. If given the choice again, most students would take the larger lecture rather than the smaller lecture. Reasons for this preference will be discussed. Comparisons will be made between lecture styles, student performance, and student satisfaction according to gender, class size, and background in chemistry.

P323: Implementing the ACS General Chemistry Curriculum. Chapter 8: Entropy and molecular organization

Laura Eisen (The George Washington University, USA)

In 2004, Chemistry, a new general chemistry textbook from the American Chemical Society, was published. The text focuses on conceptual understanding and reasoning, supported by the extensive use of different kinds of models, and uses pedagogy built on active learning and group interactions. One of the most innovative chapters in the new text is Chapter 8: Entropy and Molecular Organization. Starting with the assumption that each distinguishable molecular arrangement of a system is equally probable, students consider models of macroscopic systems in order to understand what drives spontaneous change in mixing, osmosis and heat transfer. They discover that the spontaneous direction of change can be understood in terms of changes in the total number of distinguishable arrangements of the system. The criteria for change that are developed are then used to examine the ice-water phase change, freezing point depression and other colligative properties, and the behavior of a rubber band. This paper will present an overview of the activities used in the chapter, along with suggestions for implementing the material in the classroom.

1:15 PM - 5:10 PM STEW 218CD

S36: Forensic Science: Challenges and Changes - Session 1 of 1

Cheryl Frech (University of Central Oklahoma, United States)

Faculty and students are excited about forensic science. From grade school curriculum units to specialized graduate school programs, forensic science is everywhere. In this symposium we will discuss best practices in forensic science education at the college level. Topics will include student preparation, new accreditation guidelines, and employment prospects.

1:15 introduction

1:20 Wendy Elcesser P324: CSI@IUP: challenges in developing forensic chromatography labs

1:40 Lon Porter P325: Forensic chemistry and the educated citizen: a liberal arts approach

2:00 Huggins Msimanga P326: Multivariate analysis in forensic instrumental analysis

2:20 Matthew Johll P327: Turning to crime: using cases to teach chemistry

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| 2:40 | break |
| 2:55 Robert Bost | P328: Accreditation of forensic science degree programs |
| 3:15 David von Minden | P329: Forensic science at UCO: the undergraduate perspective |
| 3:35 Dana Rundle | P330: Development of a MS in FS: a five-year retrospective |
| 3:55 Cheryl Frech | P331: Growing pains: forensic science and chemistry |

P324: CSI@IUP: challenges in developing forensic chromatography labs

Wendy Elcesser (Indiana University of PA, USA), Anne Kondo (Indiana U. of PA, USA), Philip Palko (Indiana Senior High School, USA), John Woolcock (Indiana University of PA, USA)

Two introductory forensic science experiments were developed as part of our General Chemistry laboratory program, which is structured around the “Working With Chemistry” Laboratory manual. The first experiment utilizes the ToxiLab TLC system to identify the drugs present in a suspect sample and illustrates general chromatography techniques. In the second, students use paper chromatography on the ink contained in a note related to the crime and explore the effectiveness of various solvents at separating the components of a mixture. To stimulate interest in chromatography and the principles of intermolecular forces, we capitalized on the popularity of the CSI television programs to develop a campus crime scene scenario. The scenario ties the experiments together, and completion of the pair allows the students to solve the crime. One challenge was to create a believable, relatively innocuous crime scenario that allows us to change the identity of the prime suspect from semester to semester without major revisions. Another challenge was to decide which of the two labs to do first. In this presentation we will examine these challenges and others we encountered.

P325: Forensic chemistry and the educated citizen: a liberal arts approach

Lon Porter (Wabash College, USA)

Forensic chemistry is the application of chemistry to criminal investigation. While television programs portray a variety of exciting stereotypical roles, forensic scientists analyze evidence that is brought in from crime scenes and reach conclusions based on qualitative and quantitative tests. They apply knowledge from diverse disciplines such as chemistry, biology, physics, materials science, and mathematics to the analysis of evidence found at crime scenes or on/in the body of a crime suspect. In response to the growing popularity of criminalistics, we have designed a new forensic chemistry course open to undergraduate students that have completed at least one semester of chemistry. This half-semester course was developed primarily for non-science majors to cut through the television and movie hype to expose students to the interdisciplinary world of forensic science and criminalistics. Students will draw upon and reinforce their introductory knowledge in chemistry and other disciplines to gain insight into the collection, handling, and analysis of evidence. The course served to spotlight modern techniques, case studies, analytical experiments, and the proper recording and presentation of data.

P326: Multivariate analysis in forensic instrumental analysis

Huggins Msimanga (Kennesaw State University, USA)

After three years of offering an introductory forensic chemistry course at KSU, we have sensed a need to introduce an upper-level forensic chemistry class that will provide students with the use of modern instruments and data-processing techniques. Crime labs must discern whether various batches of illicit drugs have similar or different compositions. Such information helps forensic

scientists to link the batches to their origin. We have adapted and developed lab experiments that use multivariate analysis (principal component analysis, partial least-squares) to analyze different brands of over-the-counter medicinal drugs for similarities/dissimilarities. We obtained spectral (UV/VIS) and HPLC/PDA (chromatograms) data on various brands of analgesics that contain the same active ingredients but different binding substances. We have also applied these techniques to ink analysis. This paper discusses and reports the results from multivariate analysis and HPLC/PDA chromatograms of the same samples. These projects provide the skills that forensic chemists use intensively in crime labs.

P327: Turning to crime: using cases to teach chemistry

Matthew Johll (Illinois Valley Community College, USA)

Teaching the liberal-arts chemistry course presents significant challenges. Non-science majors are typically a reluctant audience: afraid of math and often burdened by past experiences with science that have not gone well. A second challenge is the large range of math abilities that these students bring with them to the course. Engaging students is the key to both conveying basic chemical principles and helping students grasp the quantitative aspects of chemistry. Students are genuinely interested in what happens on shows like CSI; instructors can use this curiosity to motivate them to learn, understand, and retain the basic principles. This presentation will focus on using forensic science as a theme for the non-science majors course.

P328: Accreditation of forensic science degree programs

Robert Bost (University of Central Oklahoma, USA), Dana Rundle (UCO, USA), David von Minden (University of Central Oklahoma, USA)

The public's fascination with forensic science has been fueled by both fictional (CSI, Law and Order) programs and actual events (O.J. Simpson trial) which has driven the increasing demand for educational programs to train students in forensic science. Many colleges and universities have created programs to meet this demand. Forensic science practitioners and other interested parties, especially attorneys who need properly trained experts, have raised concerns about the adequacy of training being given to students by these various programs. In 2001, the American Academy of Forensic Sciences (AAFS) formed an ad hoc committee to formulate guidelines for colleges and universities regarding the components of a suitable education curriculum, and a process for evaluating these degree programs, leading to accreditation. Out of this deliberation, the Forensic Sciences Education Program Accreditation Commission (FEPAC) has evolved. This presentation will provide an overview of the curriculum recommendations and of the application and evaluation process which lead to accreditation of academic forensic science degree programs.

P329: Forensic science at UCO: the undergraduate perspective

David von Minden (University of Central Oklahoma, USA), Dana Rundle (UCO, USA)

The undergraduate degree program in forensic science at the University of Central Oklahoma has been in existence for over 30 years. It has grown from a small start of a few students to become the largest major in the Department of Chemistry. In this presentation, changes in the undergraduate curriculum will be described. One driver of curriculum change is the American Academy of Forensic Sciences' Forensic Science Education Programs Accreditation Commission (FEPAC). A second factor involves one of our stakeholders, the Oklahoma State Bureau of Investigation construction of a state-of-the-art forensic laboratory adjacent to the university campus. The success of the program can be measured in part by the success of our graduates in obtaining employment in

the forensic science community in Oklahoma and the United States. Activities of our successful student organization, the Student Academy of Forensic Sciences, will also be described.

P330: Development of a MS in FS: a five-year retrospective

Dana Rundle (UCO, USA)

The graduate degree program in forensic science at the University of Central Oklahoma was developed within the Department of Chemistry to provide advanced training in three areas: forensic nursing, technical investigations, and criminalistics. The first class of students started in January 2000 and since that time the program has continued to flourish. The diverse nature of the program, the varied educational backgrounds of the students, and the requirement that the students do an internship prior to graduation have placed unusual demands on a traditional chemistry faculty. The evolving process of improving the graduate student experience will be discussed in terms of faculty needs, budget, and course development to attain accreditation by the American Academy of Forensic Sciences' recently formed Forensic Science Education Programs Accreditation Commission (FEPAC).

P331: Growing pains: forensic science and chemistry

Cheryl Frech (University of Central Oklahoma, United States)

The University of Central Oklahoma created a bachelor's degree in forensic science in the 1970s. For many years, this degree program languished with only a few students and was in danger of being discontinued. The mid-1990s brought forensic science to the public's attention with high-profile criminal cases and glitzy television shows. Suddenly, students were clamoring for forensic science in the university. This presentation summarizes the challenges of a department that has both chemistry and forensic science students and faculty.

1:15 PM - 5:10 PM STEW 214D

S37: General Chemistry: Integrating the 'Lecture' and Lab Experience - Session 1 of 1

Kimberly Woznack (California University of Pennsylvania, USA)

Recently a number of educators have developed college chemistry courses that break out of the traditionally separate "lecture" and lab mold. "Traditional" courses can have different faculty and/or teaching assistants teaching students lab and lecturing on different days and in different facilities. This can make it difficult for students to recognize the link between the topics covered in lecture and the hands-on experiences they have in the laboratory. Several new approaches specifically aim to integrate the students' classroom and lab experiences. Some institutions have called this approach "StudioChemistry", to parallel the model popular in physics education, while others may call their course "activities-based" or "technology-based". Non-traditional course variations may include longer blocks of class time, facilities which accommodate both classroom and lab activities, and technology-intensive class sessions.

1:15 introduction

1:20 Phil McBride P332: Introductory college chemistry: an integrated lecture/lab approach

1:40 Jeffrey Paradis P333: Integrated lecture and laboratory: An approach to teaching science to pre-service teachers

2:00 Grace Neff P334: Integrated general chemistry for engineers at California Polytechnic

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|------|-------------------|---|
| | | State University |
| 2:20 | Elizabeth Sprague | P335: General chemistry for engineering and science majors: a hybrid approach. |
| 2:40 | Amy Gottfried | P336: Influence of teaching space and teaching methods on the integrated 'lecture' and lab experience at the University of Michigan |
| 3:00 | | break |
| 3:10 | Anne-Marie Nickel | P337: Applied science majors and activity-based teaching: a perfect match?! |
| 3:30 | Jennifer Retsek | P338: Students' perceptions of integrated lecture-lab courses compared to 'traditional' chemistry courses |
| 3:50 | Christina Bailey | P339: From a room to a building - evolution of the integrated format |
| 4:10 | Kimberly Woznack | P340: Designing a StudioChemistry course and facility |
| 4:30 | Maria Oliver-Hoyo | P341: Integrating lecture and lab throughout the chemistry curriculum |
| 4:50 | | discussion |

P332: Introductory college chemistry: an integrated lecture/lab approach

Phil McBride (Eastern Arizona College, USA), Mickey Sarquis (Miami University, USA)
Introductory Chemistry courses at Eastern Arizona College are taught using a 2-hour block on MWF to allow non-traditional students and those with work and family conflicts the opportunity to take chemistry. This course is taught using an integrated lecture/lab format that enables students to conduct laboratory investigations on concepts they are currently studying. The structure of this course allows for flexibility in the mode of presentation. Lecture, cooperative group learning activities, guided inquiry laboratory activities, and computer tutorials are all part of this course. Results of a study comparing the lecture/lab mode of instruction with the traditional mode will be presented.

P333: Integrated lecture and laboratory: An approach to teaching science to pre-service teachers

Jeffrey Paradis (CA State U-Sacramento, USA)
As part of changes in the teacher preparation program at California State University Sacramento (CSUS) the liberal studies degree that students typically take was "blended" with the post-baccalaureate credentialing program. Faculty in the sciences were therefore asked to reevaluate not only their course content (primarily to incorporate the CA State Education Standards), but also their method of instruction. During his 4 years at CSUS the author has revamped the chemistry course taken by students planning to be K-8 teachers. Significant changes in the course include a seamless blending of the lecture and laboratory components, the development and implementation of guided-inquiry activities, and the use of authentic assessment strategies. The course format, sample activities and preliminary assessment will all be discussed.

P334: Integrated general chemistry for engineers at California Polytechnic State University
Grace Neff (Cal Poly State University, United States), Christina Bailey (California Polytechnic

State University, U.S.A.)

General Chemistry for Engineering Majors is one of the largest support courses taught by the Department of Chemistry & Biochemistry at Cal Poly State University in San Luis Obispo, serving over 1000 students per academic year. Since Spring 1997 this two-quarter series has been taught in an integrated “studio” format. As compared to the more traditional mode of teaching chemistry – three hours of lecture a week plus 3 hours of lab, often taught by different instructors in very different locations – this integrated approach gives students a learning experience in which both the laboratory and lecture components occupy the same physical environment for six hours per week, taught by the same instructor. This approach involves an active learning environment focusing on cooperative groups and student responsibility for learning. The content is designed to be more relevant to engineers and the pace is different from the other general chemistry courses in the department. While still a wet chemistry lab environment, technology, including the use of web resources, is integrated into the teaching-learning pedagogy.

P335: General chemistry for engineering and science majors: a hybrid approach.

Elizabeth Sprague (Rensselaer Polytechnic Institute, USA)

Development of an interactive classroom environment that can challenge and engage students from varying backgrounds is under constant review. The Chemistry Principles for Engineers course at Rensselaer Polytechnic Institute is a one semester, core course requirement offered to freshman engineering majors. Recently, we have combined the Chemistry Principles for Engineers course with Chemistry I for the science majors. A second semester Chemistry II course completes the one year core requirement for our science majors. This new combined Chemistry I/ Chemistry Principles for Engineers course was revised to include a “traditional” yet interactive classroom experience linked closely to the discussion/laboratory session. The classroom format includes interactive demonstrations and in-lecture, RF response from the students along with discussion/laboratory sessions with a maximum of 60 students. The course also uses online homework and WebCT internet support. The discussion/laboratory sessions are devoted to applications of the course material, problem solving approaches (not homework review), and laboratory experience. The Chemistry I/Chemistry Principles for Engineers course is designed to provide a base foundation of chemistry topics for engineering students who will not go on to other chemistry courses while preparing other students for subsequent chemistry, chemical engineering, and materials engineering courses. Success of the student response system, on-line homework, class demonstrations, and laboratory experiments, as well as student feedback, will be presented. Future course development will be discussed.

P336: Influence of teaching space and teaching methods on the integrated ‘lecture’ and lab experience at the University of Michigan

Amy Gottfried (University of Michigan, USA), Mark Banaszak Holl (University of Michigan, USA), Brian Coppola (University of Michigan, USA), Jessica Hessler (University of Michigan, USA), Ryan Sweeder (Michigan State University,)

The integrated ‘lecture’ and lab experience at the University of Michigan is one-semester “studio” general chemistry course. As the studio course has evolved through its four iterations, we have found teaching space and teaching methods to be two highly influential factors in the course of that evolution. A traditional laboratory space, lecture room, and later a discussion room have housed the course. We ideally wanted the course to transcend these physical boundaries but found that they had a great impact on course content and design. The authors also sought to incorporate best

educational practices supported by chemical education research. The success of multiple teaching methods are supported by the chemical education research, so which is/are best for a studio course? Our experiences with both space and teaching methods will be presented.

P337: Applied science majors and activity-based teaching: a perfect match?!

Anne-Marie Nickel (Milwaukee School of Engineering, USA)

Using activity-based teaching allowed students to experience chemical phenomena and then learn the chemical concepts governing their experience through guided-inquiry questions. It was expected that the hands-on approach of this teaching style would increase conceptual understanding and be more appealing to applied science majors. The course was run in this format for four terms with both the Chemistry I and Chemistry II courses. Survey data will describe the reactions of these nursing and engineering students to the activity-based teaching style as compared to the standard lecture/laboratory format.

P338: Students' perceptions of integrated lecture-lab courses compared to 'traditional' chemistry courses

Jennifer Retsek (California Polytechnic State University, San Luis Obispo, US), *Christina Bailey* (California Polytechnic State University, U.S.A.), *Lara Baxley* (Cal Poly, SLO, USA)

At California Polytechnic State University, San Luis Obispo, the first quarter of the "General Chemistry for the Engineering Disciplines" course is taught in an integrated lecture-lab format in the studio classroom. Due to space constraints, the follow-up course is often offered in a "traditional" format with separate lecture and labs. Results of a survey given at the end of the second quarter suggest that most of the students tend to favor one format over the other. The classroom environment, lab experience, schedule, and level of personal contact are some of the various reasons students cited for preferring one of the two formats. This talk will discuss the students' preferences as determined from end-of-quarter survey results in further detail.

P339: From a room to a building - evolution of the integrated format

Christina Bailey (California Polytechnic State University, U.S.A.)

The concept of an integrated lecture-laboratory experience has evolved from single room environments to the construction of additions and entire buildings. This presentation will highlight some variations in room configuration that promote the vision of chemistry as a human, collaborative endeavor.

P340: Designing a StudioChemistry course and facility

Kimberly Woznick (California University of Pennsylvania, USA)

The "Studio" approach to teaching undergraduate science classes first emerged in the discipline of Physics. Once this model proved successful in Physics, others began to adapt this model to the discipline of Chemistry. As a new faculty member I gladly accepted my Dean's special assignment to develop a StudioChemistry program at California University of Pennsylvania. I will review my observations and findings from talking with others who have implemented this approach. Some of my considerations for both facility design as well as curricular plans will also be presented along with an update on the project status.

P341: Integrating lecture and lab throughout the chemistry curriculum

Maria Oliver-Hoyo (North Carolina State University, United States)

The concept Advancement through chemistry Lab-Lecture format, cAcL2, started at North Carolina State University in the general chemistry program and its success have prompted the adoption of this format for the chemistry majors curriculum. This presentation will include highlights of characteristic features of the format, results of the studies in student performance and attitudes, and future plans for its implementation in upper-level chemistry courses. Two different approaches at integration are been considered which permits flexibility and consequently promotes its adoption by different instructors in different chemistry courses.

1:15 PM - 4:50 PM STEW 314

S38: Management and Innovation in Introductory Chemistry Courses - Session 1 of 1

Daniel Tofan (Eastern Kentucky University, US), **Willy Hunter** (Illinois State University, USA)

This symposium of general interest to the Chemical Education community will focus primarily on management and innovation in introductory chemistry courses.

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|-------------------------|---|
| 1:15 | introduction |
| 1:20 Daniel Tofan | P342: Automating the management of an introductory chemistry open lab |
| 1:40 Charles James | P343: Use of 'bad science' movies to teach non-majors chemistry |
| 2:00 Shawn Kellie | P344: Using retail name-brand toys to teach chemistry |
| 2:20 Dharshi Bopegedera | P345: Matter and minerals: A thematic approach to teaching chemistry to a broader audience |
| 2:40 | break |
| 2:55 Nithya Rajan | P346: Effects of a student-centered active learning approach in an introductory chemistry course for non-science majors |
| 3:15 David Pierce | P347: Effective strategies for using demonstration assessment in large classes |
| 3:35 Susan K. Swope | P348: DNA's extraordinary world': Development of a nonmajors science course with a chemistry focus |
| 3:55 Keith Walters | P349: Teaching the history of chemistry as a study abroad course in Great Britain |

P342: Automating the management of an introductory chemistry open lab

Daniel Tofan (Eastern Kentucky University, US)

Eastern Kentucky University uses an open lab format for the introductory chemistry courses offered for non science and nursing majors to allow a large number of students (450-500) to complete a two hour weekly lab in a room that has only 22 workstations. We have a pre-lab testing system that gives students short quizzes to test their preparedness for the experiments. Software is used to check students in and out of the lab, recording the day and time, events that took place in the lab, and other information. The computer automatically assigns unknowns and a station number to each student, after checking their pre-lab quiz score. Instructors are able to send an instant message to the coordinator in case assistance is needed. The lab coordinator is able to remotely connect to the database and at any moment see who is working in the lab, where and since when. Upon check-out, students will enter their data into the computer and will receive a grade instantly. This system will allow the collection of a large amount of data and will free instructors from

managing the student traffic in and out of the laboratory and from grading lab reports, leaving them with just the task of supervising lab activity.

P343: Use of 'bad science' movies to teach non-majors chemistry

Charles James (UNC at Asheville,)

The principles of Chemistry, Physics and Biology are illustrated using examples of their violation in the Science fiction and monster movies of the 30's through the 90's. Examples come mostly from the Japanese and American popular cinema. Principles covered include Newton's Three laws, Molecular structure, Chemical Change, Conservation of matter, Potential Energy: Mechanical, Chemical and Nuclear, Thermodynamics and rates of chemical change. Some time is spent placing the movies in their historical context so that we can ask what would the public have known at the time.

P344: Using retail name-brand toys to teach chemistry

Shawn Kellie (Elizabethtown Community & Technical College, USA)

At some point in a child's life, parents will try to encourage a child's interest in learning by giving them an educational toy. These toys usually are purchased at great expense and effort from specialty stores. Unfortunately, due to either poor marketing or a lack of actual fun, the vast majority of these toys wind up being discarded by the child in favor of cheaper readily available toys that they have been seduced into buying by advertisements on the Cartoon Network. What is often underappreciated is the potential educational value of these commercially available toys. Hot Wheel cars can be used to teach children about electrolytes, gas laws and water pressure. Stink Guns can be used to teach diffusion and gas laws. Nerf Guns are the perfect example of gas laws and Newton's third law of physics. Marvel Hero Zizzlingers can be used to teach chemical kinetics and conservation of mass. These toys are just a few examples of toys that kids want that can be used to teach chemistry. Additionally, they are cheaper than using the specially toys.

P345: Matter and minerals: A thematic approach to teaching chemistry to a broader audience

Dharshi Bopegedera (The Evergreen State College, USA)

In this presentation I will discuss my experience of teaching a year-long, full time academic program titled "Matter and Minerals" with a geologist and a mathematician. This academic program was developed to teach a full year of general chemistry, college calculus, physical geology and mineralogy using the study of minerals as a theme. I will discuss the effectiveness of this method in teaching general chemistry to a broader group of students and how we made connections among the three disciplines using the theme of minerals.

P346: Effects of a student-centered active learning approach in an introductory chemistry course for non-science majors

Nithya Rajan (DePaul University, USA)

This paper describes preliminary results from a study that investigates how non-science majors best learn the subject of chemistry. Chemistry is almost always perceived as being too abstract and difficult to comprehend or seen as unrelated to their future endeavors by non majors. This study compares a student-centered active learning approach with a traditional approach implemented in an introductory chemistry course designed for non-science majors at DePaul University. The new method of instruction takes a lecture-only course, integrates laboratory experience into the

classroom, and incorporates instructional methods supported by research in chemical education. In this method, concepts are learned with relevant hands-on activities, organized around a smaller group of peers followed by guided inquiry assignments. The activities are created from traditional labs and demonstrations with modifications to comply with classroom management, students' safety and guidelines for chemical handling. The learning outcomes in chemical concepts, and attitudes towards chemistry and the learning environment, are compared between the two teaching formats. Pre and post-content tests and attitudinal survey questionnaires are used as measurement tools to compute statistical differences.

P347: Effective strategies for using demonstration assessment in large classes

David Pierce (University of North Dakota, USA)

Demonstration Assessment is an effective pedagogical tool for improving the learning of concepts in introductory chemistry classes. However, we have found that quantifiable improvements are not as evident when concepts introduced in Demonstration Assessments are later reinforced in an accompanying laboratory. Because Demonstration Assessment requires a heavy time commitment, both in terms of preparation and execution, we have also found that pre-recorded demonstrations are often more effective than live-demonstrations. Our findings should help instructors to more effectively target this beneficial but rather demanding form of classroom assessment.

P348: DNA's extraordinary world': Development of a nonmajors science course with a chemistry focus

Susan K. Swope (Plymouth State University, USA)

Recent advances in biochemistry and biotechnology include topics that lend themselves well to incorporation into a general education course. Chemists have played a vital role in our present understanding of biology at the molecular level, and the presentation of these contributions in an historical context adds an interesting dimension to the course. Development of a general education course with such a focus has additional benefits: content can readily be chosen to focus on chemical concepts; excellent supporting material is available on the Web; and there are a variety of appropriate laboratory applications that may readily be integrated into the course.

P349: Teaching the history of chemistry as a study abroad course in Great Britain

Keith Walters (Northern Kentucky University, USA)

In the fall of 2005 a history of chemistry course was added to the department curriculum at Northern Kentucky University. As an offshoot of this new course, it was also advertised as a two-week intersession course to be taught in London as part of the Cooperative Center for Study Abroad (CCSA). This presentation documents the course content and field trips for the initial offering of this course in the 2005-6 winter intersession term. Ten students joined the instructor on a "tour de force" of the big naves of chemistry that passed through Great Britain and how their contributions shaped how we study and understand chemistry today.

1:15 PM - 4:50 PM STEW 202

S39: New Directions in Problem Solving - Session 1 of 1

Stuart Bennett (Open University, United Kingdom)

Problem solving based on a holistic application of knowledge and skills has been increasingly a feature of degree level programs in recent years. The trend is a move from 'algorithmic style' exercises to problems of a less structured and more open-ended character which involve creative

solutions. This symposium will bring together the latest thinking in terms of problem design methodology of student approach and modes of assessment.

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|---------------------------|---|
| 1:15 | introduction |
| 1:20 George Bodner | P350: Research on problem solving at Purdue University |
| 1:45 Tina Overton | P351: Open ended problem solving and the influence of cognitive factors on student success |
| 2:05 Jason Justice | P352: Extending quantitative problem solving methods to qualitative problems |
| 2:05 Mithra Beikmohamadi | P353: Bridging the math chemistry divide |
| 2:25 Santiago Sandi-Urena | P354: Measurement and impact of metacognitive activity use |
| 2:45 | break |
| 2:55 Stuart Bennett | P355: Fuzzy problems: student performance, educational background, approaches to solutions |
| 3:15 Jackie Stewart | P356: Discovering how students solve organic chemistry problems |
| 3:35 William Kilner | P357: Increasing students' success in college chemistry by remediation of basic math skills |
| 3:55 Nathan Barrows | P358: Beyond numbers: algorithmic problem solving in organic chemistry |
| 4:15 | discussion |

P350: Research on problem solving at Purdue University

George Bodner (Purdue University, US)

For almost 20 years, we have been studying the differences between successful and unsuccessful problem solvers. It doesn't seem to matter whether the study examines beginning students' ability to solve multiple-choice stoichiometry questions during a general chemistry course or graduate students' ability to solve complex synthesis questions in a graduate-level course on organic synthesis, or any course between these extremes. It doesn't matter whether the data are collected outside of class, through think-aloud interviews while students are working problems or by a combination of analysis of students' answers to exam questions followed by interviews in which they explain their answers. In each case, students who use symbolic representations are more likely to be successful than those who don't, and students who construct more than one representation during their search for the solution to the problem are more likely to be successful than those who don't. This paper will examine a simple model to explain what successful problem solvers do in a variety of different environments.

P351: Open ended problem solving and the influence of cognitive factors on student success

Tina Overton (University of Hull, UK), Nicholas Potter (University of Hull, UK)

Most problem solving activities in chemistry focus on the development of quantitative skills and the solving of algorithmic problems. Problems which are more open ended in nature are less often encountered and are more difficult to develop and to assess in terms of student performance. However, such problems present advantages in terms of motivating students and to providing a

more realistic experience of problem solving as a skill. We have developed a set of context-based open ended problems which are being used with chemistry undergraduates at several levels. The problems have been evaluated for intellectual demand and compared to traditional chemistry based problems of similar demand level. Students success in tackling these problems is being investigated. The influence of cognitive variables such as working memory and field dependence is being investigated and attitude testing and interviews used to probe the effect of this style of problem on undergraduates engagement and motivation.

P352: Extending quantitative problem solving methods to qualitative problems

Jason Justice (North Carolina State University, USA), *Maria Oliver-Hoyo* (North Carolina State University, United States)

The majority of problem solving methods at all levels of chemistry are designed to help students solve quantitative problems but provide limited help in solving qualitative problems due, in part, to the algorithmic nature of the existing methods. The Gather, Organize, Analyze, and Learn (GOAL) problem solving method, while originally designed to help solve algorithmic physics problems, can be used as a universal problem solving method for chemistry problems. The core principles underlying the GOAL method are taken from the work of Polya and it is the nature of the Learn step that differentiates this method from others by promoting the student to think critically about how the answer relates to the question. This presentation will address our study with students in a first semester general chemistry course. Students were assigned specific problems throughout the semester to be completed using the GOAL method and the Learn responses were classified in terms of how and what the student reflected on. A chi-square test was used to evaluate whether or not the types of responses were significantly different between questions. Results suggest that chronological trends can be drawn and differences in responses can be compared to the six levels of the Cognitive Domain of Bloom's Taxonomy.

P353: Bridging the math chemistry divide

Mithra Beikmohamadi (UW - Madison, USA), **Andrew Greenberg** (University of Wisconsin-Madison, US)

One of the greatest issues general chemistry students face is problem solving. Many students who have strong math backgrounds have a difficult time adapting and integrating the skills they have acquired in their math education into problem solving in the general chemistry classroom. This presentation will describe a study that is designed to understand where and why students are having problems with integration of math in chemistry problem solving. Through a series of individual biweekly tutoring sessions, the researchers gained a better understanding of where students encounter issues with math integration and problem solving. Case studies of the eight subjects, enrolled in four different general chemistry courses at the University of Wisconsin-Madison, will be described.

P354: Measurement and impact of metacognitive activity use

Santiago Sandi-Urena (Clemson University, USA), *Melanie Cooper* (Clemson University, United States)

Findings suggest that metacognition may be more important for problem solving success than aptitude. This work describes the development and validation of an off-line self-report instrument to assess metacognitive activities in chemistry problem solving. This method was used and compared with a concurrent on-line record using IMMEX technology. IMMEX is a web-based

platform that allows collection of student problem solving strategy and performance information. Convergence between the on and off-line instruments is discussed. An intervention to promote use of metacognition was designed and its effect on strategy, performance and ability measured by the two methods. This work will report on the relationships amongst metacognition promotion, performance and solving strategy.

P355: Fuzzy problems: student performance, educational background, approaches to solutions

Stuart Bennett (Open University, United Kingdom)

Most first year university chemistry-based ‘problems’, whether posed in examinations, in tests or in open book assessments, are of a closed nature. The input data are given (or easily obtained), the method of solution is familiar and the output defined. Contextual problems are not like this as rarely are the input data complete or the routes to a solution apparent. Non-algorithmic problems have been devised and tackled by a range of students (~500) with widely different educational backgrounds and age profiles. Student performance and formal educational background show no statistically valid connection. However, educational background is shown to be an advantage in the solution of ‘closed’ problems (or exercises as they are more appropriately termed). Student performance on non-algorithmic problems was little affected by gender difference. However, in depth interviews with students revealed differences by gender and age in the approach to these problems. There was a tendency for younger, male students of good formal educational background to attack the problems in a head-on manner, trying different, but in each case, well-defined approaches. Older students, female students and those with a less formal education adopted an approach that involved assembling all the known information about the problem, looking for links and identifying pieces of information that were needed. These may have to be researched or estimated but the inclusion of ‘missing information’ in a scheme did not seem to be a worry for this group. Many of interviewees in this latter group developed branched flow charts as an aid to the solution: this behaviour was less common in first group. The paper will analyse exemplars of fuzzy problems, present data supporting the above conclusions, suggest ways of introducing these problems in the first year and attempt to justify why this should be done.

P356: Discovering how students solve organic chemistry problems

Jackie Stewart (The University of British Columbia, Canada), *France Gagnon* (The University of British Columbia,)

Undergraduate science programs strive to help students learn science content, think about and use science as scientists do, and improve methods for self-directing their learning. Despite considerable theoretical and empirical research on these topics, there is an important gap—we know little about how students bring prior knowledge to bear in preparing to solve a problem, and there is scant data that directly reflects methods they use to solve problems. In this context, a significant challenge facing chemistry education is determining how students are learning and solving problems as they strive to master content. While common assessment tools such as homework sets and examinations provide summative measures of student learning, these provide little to no insights into the dynamics of how students apply and improve strategies for solving problems and for transferring those skills to new problems they encounter. We have implemented a newly developed, leading-edge software—gStudy, a system created by Winne and his team in the Learning Kit Project (<http://www.learningkit.sfu.ca/>), which provides unique methods for gathering data that reveal how students study and how they approach problem solving.

P357: Increasing students' success in college chemistry by remediation of basic math skills
William Kilner (University of New Hampshire, USA)

Increasing students' success in college-preparatory chemistry and in college general chemistry by remediation of requisite basic math skills. Cary Kilner & Christopher Bauer University of New Hampshire Much valuable research has been done to determine why students have trouble solving chemistry and physics problems, why they resort to algorithmic techniques without understanding the concepts involved, and why they cannot transfer acquired problem-solving skills to novel situations. Such research has shown that many students come to high school and college chemistry with serious gaps in their mathematical understanding. This jeopardizes all attempts to teach them problem solving. A manifestation of this is the unorganized way in which many students set up and execute chemistry problems, despite repeated instruction in good practices. Sloppy work may also indicate sloppy thinking and weak conceptual understanding. Even high-achieving math students can have serious missing pieces of mathematical understanding, which we assume without verification that they have previously acquired. Knowledge and skill in abstract mathematics will not transfer to chemistry (and physics) problem solving unless students are assisted in learning explicit procedures that clearly connect to the science involved. And consistently emphasizing these procedures can shore up a fragmented understanding of basic mathematics. In my current work with college freshman, and in my previous work in high school, I have identified 17 consecutive mathematical skill areas that must be addressed in order to provide this support for student learning in chemistry. I have also developed concomitant techniques for instruction, including practice problems that provide the necessary drill and reinforcement in the least amount of time. Student feedback has validated the usefulness of this approach. This talk will summarize the list of skills and provide examples of intervention, illustrated with student examples.

P358: Beyond numbers: algorithmic problem solving in organic chemistry
Nathan Barrows (Arizona State University, USA)

In recent decades several research groups have investigated the “algorithmic-conceptual” issue by comparing student performance on paired questions. In many cases the algorithmic question involved a standard calculation (e.g. mole conversion) and the conceptual question incorporated a particulate-level representation. Although general chemistry courses have been the primary context for these studies, some of the “conceptual thinkers” and “algorithmic problem solvers” identified must have taken additional chemistry courses. What do algorithmic and conceptual problem solving look like in other contexts? This presentation will describe aspects of the “algorithmic-conceptual” issue identified during a recent study of problem solving in organic chemistry. The participants were 22 undergraduate students enrolled in the second semester of a full-year sequence in organic chemistry. The videotaped think-aloud protocols revealed the participants' problem-solving behaviors as they answered a series of product-prediction questions involving nucleophilic alkyl substitution and elimination reactions. The findings suggest a relationship between functional fixedness and algorithmic problem solving in organic chemistry.

1:15 PM - 4:50 PM STEW 306

S4: Research in Chemical Education - Session 5 of 6

Janet Bond-Robinson (Arizona State University, USA), **Christopher Bauer** (Univ. of New Hampshire, USA)

This symposium, sponsored by the CHED Committee on Chemical Education Research, is a forum

for research conducted on the teaching and learning of chemistry at any level. Presentations will address: 1) the motivation for the research and the theoretical bases in which it is grounded, 2) the methods used to gather and interpret data, and 3) the findings and their significance interpreted in light of theory and method. Authors are being strongly encouraged to bring copies of an extended abstract to share with the audience.

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| 1:15 | Kristen Cacciatore | P359: Student learning in the general chemistry laboratory: Comparison following traditional and inquiry laboratory experiences |
| 1:35 | Vickie Williamson | P360: Students' perception and attitudes towards guided and open inquiry laboratory |
| 1:55 | Cianán Russell | P361: Student conceptions of the purpose and function of lab |
| 2:15 | | break |
| 2:25 | Dawn Del Carlo | P362: Role that performing undergraduate research plays toward becoming a reflective practitioner |
| 2:45 | Jenine Maeyer | P363: Studying the efficacy of an innovative approach to foster learning for prospective science teachers |
| 3:05 | Dominick Casadonte | P364: Project SERVE (Science Enrichment using Retired Volunteer Educators): Lessons learned |

P359: Student learning in the general chemistry laboratory: Comparison following traditional and inquiry laboratory experiences

Kristen Cacciatore (University of Massachusetts Boston, usa), Hannah Sevia (University of Massachusetts Boston, USA)

The science of learning and current science education research converge on the conjecture captured by America's Lab Report (NAS, 2005) that high school students learn science more effectively when engaged in the laboratory in scientific inquiry rather than "cookbook" exercises. In particular, at the high school level, inquiry-based laboratory experiences that are well integrated with content presented in lecture leads to increased mastery of subject matter, development of scientific reasoning, and increased interest in science. We present a controlled research study of two inquiry-based laboratory experiences compared to traditional "cookbook" labs as part of a general chemistry laboratory course at a four-year non-traditional university. The aim is to compare university student achievement in understanding the complexity and ambiguity of empirical work and changes in students' ability to explain science effectively, in addition to comparing changes in mastery of subject matter. Research data have been collected in the form of pre- and post-assessments of student understanding, observations during the laboratory, and interviews with students from both treatment groups. We will present preliminary findings and discuss how we are using this work to encourage institutional change from a traditional laboratory curriculum to one that is inquiry-centered and highly integrated with the lecture.

P360: Students' perception and attitudes towards guided and open inquiry laboratory

Vickie Williamson (Texas A&M University, USA), **Suparna Chatterjee** (Texas A & M University, USA)

Inquiry-based laboratory experiments can play an important part in developing chemical concepts and promoting deeper understanding. This study examined student understanding and attitudes towards guided and open inquiry laboratories near the end of a semester of general chemistry at a

large southwestern university, which utilized both types of inquiry laboratories. The study investigated whether students could differentiate between a guided inquiry and an open inquiry laboratory by asking students to identify scenarios as guided inquiry, open inquiry or neither. The students were also surveyed concerning their attitudes towards both types of inquiry laboratories and if students perceived that they learned more with a guided inquiry laboratory or an open inquiry laboratory. Results indicated that 45.66% students could identify both guided and open inquiry laboratories correctly. Also, students preferred doing a guided inquiry laboratory over an open inquiry laboratory, and they thought they learn more with a guided inquiry lab.

P361: Student conceptions of the purpose and function of lab

Cianán Russell (Purdue University, United States), Gabriela Weaver (Purdue University, USA)
The laboratory, like all portions of a course, has educational aims, but depending on who is asked, those aims may be dramatically different. This study focuses on students' ideas about the purpose and function of the laboratory in undergraduate chemistry courses through qualitative interview analyses. Topics students discuss include visual and kinetic learning, the importance of lab compared to lecture, and the function of lab as repeating lecture.

P362: Role that performing undergraduate research plays toward becoming a reflective practitioner

Dawn Del Carlo (University of Northern Iowa, USA), Holly Hinkhouse (University of Northern Iowa, USA), Leah Isbell (UNI, USA)

Teacher education programs across the nation stress to their candidates the importance of becoming a “reflective practitioner” within their classrooms by adopting basic research methodologies. This emphasis on “teacher as researcher” has focused on the benefits of practicing teachers having control over their own curriculum reform. My experience as a research advisor to pre-service secondary science teachers indicates that experience conducting research – especially qualitative methods – helps future students develop a more sophisticated sense of human behavior and what it means to be a reflective practitioner. This talk discusses the research experiences of at least two pre-service science teaching majors through the observations of their research advisor. I chronicle several “aha” moments as well as hurdles each student had to overcome and why these experiences will ultimately make them better, more reflective and comprehensive educators.

P363: Studying the efficacy of an innovative approach to foster learning for prospective science teachers

Jenine Maeyer (University of Arizona, United States), Vicente Talanquer (University of Arizona, US), Krista Young (University of Arizona, USA)

With demand for qualified science teachers on the rise, the need for high quality teacher preparation programs has become a necessity. As part of the Science Teacher Preparation Program at the University of Arizona, students take a course on “Curriculum Decisions and Assessment in Science” (STCH 420). This course prepares prospective teachers to make knowledgeable curriculum and assessment decisions with the learning goals guiding choices and actions. Although the course was originally designed to have a strong field component in a secondary school classroom, the experience did not expose many of our prospective teachers to exemplary models of learner-centered teaching practices. As a result, they did not necessarily develop the teaching knowledge and skills in the course learning objectives. STCH 420 has recently been paired with a science course for non-science majors (NATS 101) during which prospective teachers work in

teams monitoring, guiding, and assessing the NATS 101 students under the guidance and supervision of the main instructors. Using field notes and recordings from weekly classroom and small group observations, individual interviews, and on-line journal entries and discussions, we are investigating the effects of co-planning and co-teaching on the prospective teachers' thinking, understanding, and skills about planning, instruction, and assessment.

P364: Project SERVE (Science Enrichment using Retired Volunteer Educators): Lessons learned

Dominick Casadonte (Texas Tech University, USA)

This work details the development of an intergenerational chemistry education study involving senior citizens and EC-12 students entitled Project SERVE (Science Enrichment using Retired Volunteer Educators). In this NSF Discovery Corps pilot project the PI trained sixteen senior citizens during the fall of 2004 in age- and pedagogy-appropriate chemical and general science principles. The seniors were sent into eight under-performing lower socioeconomic (LSES) elementary and junior high classrooms in Lubbock, TX in the spring of 2005 in order to act as teacher's aides, tutors, mentors, and/or resource persons. They were responsible for direct interaction with the students in both individual and group formats. This study impacted approximately 500 students in the program area. Assessments included pre- and post content testing for seniors and students, attitudinal and interview assessments of seniors, students, and teachers, observations of dyadic and group senior-student interactions, physical assessments of the senior's well being, and metacognitive analysis. The program will be described and the results of the study will be addressed with regard to the development of a national model for intergenerational EC-12 science education.

1:15 PM - 4:50 PM STEW 318

S14: Research in Chemical Education Using Computers - Session 2 of 2

Michael Sanger (Middle Tennessee State University, USA)

This symposium, jointly sponsored by the Committee on Chemical Education Research and the Committee on Computers in Chemical Education, will describe the use of computers and other forms of technology in performing chemical education research. Presenters will describe research studies where computer use was an integral part of the instructional lesson and not merely used to analyze the data or present the results

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| 1:15 | introduction |
| 1:20 Joseph Chimeno | P365: Rainbow Wheel and Rainbow Matrix: Two effective tools for learning ionic nomenclature |
| 1:40 Kermin J. Martinez-Hernandez | P366: How effective is the computer game model for teaching chemistry? Phase II |
| 2:00 Faik Karatas | P367: ICT usage and competencies of science teachers in Turkey |
| 2:20 Kellie Green | P368: Comparative analysis of online and face-to-face discourse in general chemistry |
| 2:40 Jodie Wasacz | P369: Online collaborative learning in a general chemistry laboratory course: Student-generated inferences and misconceptions |
| 3:00 | break |
| 3:10 Siegbert Schmid | P370: Online pre-laboratory work modules and student performance |

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| 3:30 Barbara Stewart | P371: ChemPrep: Measuring the effect of OWL preparatory courses for general and organic chemistry |
| 3:50 Jordi Cuadros | P372: Assessing the role of online homework in acquiring conceptual and performance competence in introductory college chemistry |
| 4:10 Ramesh Arasasingham | P373: Assessing the effect of web-based animated tutorials on student understanding of structure and bonding |
| 4:30 Sheila Woodgate | P374: BestChoice: A study in interactive learning |

P365: Rainbow Wheel and Rainbow Matrix: Two effective tools for learning ionic nomenclature

Joseph Chimeno (College of Eastern Utah, USA), Michael Sanger (Middle Tennessee State University, USA), Gary Wulfsberg (middle tennessee state University, USA)

This study compared the learning of ionic nomenclature by three different methods: A traditional method where students worked problems, and two methods using similar game formats (Rainbow Wheel and Rainbow Matrix). The statistical analysis of student performance revealed that the game format methods were more effective in helping students develop a working knowledge of chemical nomenclature than the traditional method. All students identified the same factors as being important in their instruction: the role of visualization, the role of the instructor, the role of practice, the role of game playing, and the importance of nomenclature.

P366: How effective is the computer game model for teaching chemistry? Phase II

Kermin J. Martinez-Hernandez (Purdue University, USA), Carlos R Morales (Purdue University, USA), Gabriela Weaver (Purdue University, USA)

The elements of game design that lead to motivation for continued play were evaluated through surveys, questionnaires, and interviews during Phase I, in which seven commercial video games were compared. Our results suggest that certain game types (such as strategy and role-playing) are strongly favored over others (simulations). We also found that there are statistically significant gender differences in the types of games preferred and the individual elements of those games that are considered engaging. Students showed consistently low interest in Chemicus™, the only game that had a strong relation to chemistry. In Phase II, we carried out an in-depth study of Chemicus to examine why students had problems with this game. Half of our student sample played Chemicus for ten hours, answered pre-post surveys of general chemistry concepts, and were interviewed. The other half spent the same amount of time on task and worked on similar concepts in a recitation-type environment. This presentation will focus on findings from Phase II of the project, in which the results from these two groups were compared to explore the use of Chemicus as a learning tool.

P367: ICT usage and competencies of science teachers in Turkey

Faik Karatas (Purdue University, USA), **Yuksel Goktas** (Purdue University, USA)

Rapid developments in information and communication technologies (ICT) have recently been causing drastic changes in teachers' roles. Teachers' shifting roles require them to be at the frontier of applying technological innovations to the teaching-learning process, and all teachers should be equipped with adequate ICT skills and knowledge to perform their profession effectively. The purpose of this study is to investigate science teachers' current state of ICT competencies, perceived obstacles in integrating ICT into their schools, and current status of ICT usage in Turkey. A questionnaire was used to gather data from 138 science teachers (Chemistry N=33,

Physics N=27, Biology N=34, and Science N=38) by the convenience sampling method. The data were analyzed by descriptive statistics including frequencies, means, percentages, and standard deviations of questionnaire items. The findings indicated that majority of the science teachers are competent in basic ICT applications, but their competency levels are low in advanced ICT applications in their fields.

P368: Comparative analysis of online and face-to-face discourse in general chemistry

Kellie Green (Purdue University, United States)

This study compared transcripts from a general chemistry course taught in a partial distance learning format to a traditional face-to-face (f2f) course. The goal of the study was to explore the contribution of each participant to the discourse, number and types of questions posed by participants, and cognitive level of questions posed. The results indicate that the environment makes a difference in the contribution of statements and questions by students and the instructor. Our data indicate that students in the online environment are more involved in the discourse than in the f2f environment. The environment also has gender specific impacts on the contribution to classroom discourse. Male and female students behaved similarly in the online environment, whereas males exhibited significantly greater participation in the f2f environment than female students. These data, along with other findings will be presented and their implications discussed.

P369: Online collaborative learning in a general chemistry laboratory course: Student-generated inferences and misconceptions

Jodie Wasacz (University of Northern Colorado, United States), **Jerry P. Suits** (Univ Northern Colorado, United States), *Jacqueline Hilsenbeck-Fajardo* (Univ Northern Colorado, United States)

The overall goal of this study was to use online collaborative learning to support student-student interactions that result in the co-construction of new knowledge based on their inferences about the relationship between data and theory and the minimization of misconceptions regarding the recording, analysis and interpretation of laboratory data. Our findings indicate that some students need a large amount of teacher intervention to keep them "on task," whereas others can co-construct knowledge by interlacing empirical information from their laboratory work with theory-based conceptions. Most of the students would recommend this novel online communication format; however, some preferred a more structured learning environment. This research was supported by NSF grant Award # 0127583.

P370: Online pre-laboratory work modules and student performance

Siegbert Schmid (The University of Sydney, Australia), *Roy Tasker* (University of Western Sydney, AUSTRALIA), *Alexandra Yeung* (University of Sydney, Australia)

The use of information and communications technology has an increasing influence on teaching activities in higher education. Information and communications technology offers the opportunity to improve students' learning experiences provided it is used in an educationally sound way. Online pre-laboratory instruction is often used to prepare students for laboratory work. In order to inform further development of such modules the effectiveness of a particular online pre-laboratory work module on students' learning and their academic performance in a related practical exercise was investigated for this study. This investigation clearly demonstrated that there was a correlation between students' prior knowledge and the influence of this online module on their performance. Particularly those students with a relatively poor chemistry background, who completed this module, performed significantly better in a laboratory titration assessment than those who did not

complete it.

P371: ChemPrep: Measuring the effect of OWL preparatory courses for general and organic chemistry

Barbara Stewart (University of Maine, USA), Beatrice Botch (University of Massachusetts, USA), Roberta Day (UMass, USA), David Hart (University of Massachusetts, USA), Stephen Hixson (University of Massachusetts, USA), William Vining (SUNY College at Oneonta, USA)
Two self-paced chemistry courses were written to help improve student preparedness for first semester General and Organic Chemistry. These courses are delivered over the web using the OWL (Online Web-based Learning) system developed at the University of Massachusetts. They are designed to take ten to twenty hours to complete and are offered prior to the start of the semester. Evaluation studies in general chemistry during the Spring and Fall 04 semesters show that for those students who completed more than half of the ChemPrep units, course grades and retention rates in the subsequent chemistry courses were higher. SAT and math placement exam scores were used as proxy measures of prior achievement/ability, and ChemPrep/General helped students perform better than their achievement scores would predict. Participation in ChemPrep was voluntary, and more women than men responded. Evaluation studies for the ChemPrep/Organic will be presented, as well as some emerging gender effects in both the general and organic courses.

P372: Assessing the role of online homework in acquiring conceptual and performance competence in introductory college chemistry

Jordi Cuadros (Institut Químic de Sarrià, Spain)

While learning in the school grade levels is a well-characterized process, how learning occurs in college is still underspecified. We will report how different learning opportunities affect achievement in a large college chemistry class that makes use of authentic problem-solving activities supported by online scenario-based homework and virtual laboratories. The results suggest that authentic and contextualized homework provide a means to impact learning in college classrooms. Such homework strongly influences final course achievement, and does so in a manner that is independent of the other main influence on learning: the act of studying for exams. Furthermore, the lack of correlation between prior knowledge and homework suggests this intervention as a good starting point for an inclusive education.

P373: Assessing the effect of web-based animated tutorials on student understanding of structure and bonding

Ramesh Arasasingham (University of California, Irvine, United States)

This study reports how knowledge space theory was used to assess the impact of a Web-based animated tutorial instructional software program on students understanding of the concept of structure and bonding. The software program Mastering Chemistry Web (MCWeb) allows students to practice animated tutorials and problems that accentuate the development and understanding of the concept of structure and bonding. The results of a comparison study between students in multiple sections of a large general chemistry course, some viewing the MCWeb instructional animations in instruction and homework (treatment group) and others not viewing the instructional animations (control group) will be discussed. Data on the effect of these tools in improving students' ability to understand the connections between electron bookkeeping, Lewis structures, shapes, and hybridization will be reported.

P374: BestChoice: A study in interactive learning

Sheila Woodgate (The University of Auckland, New Zealand)

The open-access BestChoice on-line tutorial system designed by the authors has been used since 2002 in New Zealand to support both first-year university students and high school students in their learning of chemistry (4000 active users in 2005). It has 80 modules with 2500 screen views, including 2200 problem pages. The primary focus of BestChoice modules is interactive teaching. The BestChoice teaching model will be described as well as the results of both on- and off-line evaluation studies. These studies both point to the success of the system and suggest how analysis of data pertinent to specific modules can improve these modules. The role that feedback plays in interactive learning will be a particular feature. To look at BestChoice, go to www.bestchoice.che.auckland.ac.nz. Register or enter 'guest' for username and 'user' for password. Choose the General course, then 'BCCE 2006'.

1:15 PM - 5:10 PM STEW 322

S40: Revising the ACS guidelines for two-year and four-year programs: A community dialog of issues and opportunities - Session 1 of 2

Maureen Scharberg (San Jose State University, USA)

Changes in the world of higher education and chemistry curricula have prompted ACS to revise and update its guidelines for four- and two-year programs. This interactive symposium will focus on curricular guidelines, developing student skills and abilities for student success, as well as faculty, facilities, and resource guidelines. Opportunities to facilitate student transitions between institutions will also be discussed. The symposium will include open forums to obtain community input on issues associated with the guidelines revision process.

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| 1:15 | Maureen Scharberg | P375: ACS Guidelines for Chemistry Programs in Two-Year Colleges: A status report |
| 1:25 | William Polik | P376: Changes in the Guidelines and Evaluation Procedures for ACS approval of four-year programs: Curricular Aspects |
| 1:45 | William Polik | P377: Considering the curricular impact of the guidelines |
| 2:15 | | break |
| 2:25 | Joel Shulman | P378: Changes in the Guidelines and Evaluation Procedures for ACS approval of four-year programs: Student skills and abilities |
| 2:40 | Richard Jones | P379: ACS Guidelines for Chemistry Programs in Two-Year Colleges: Opportunities to focus on student skills and abilities |
| 2:55 | Joel Shulman | P380: Fostering and evaluating the development of student skills and abilities |
| 3:25 | | break |
| 3:35 | Tamar (Uni) Susskind | P381: Aligning the guidelines for two- and four-year programs: Student mentoring and advising |
| 3:50 | William Polik | P382: Aligning the guidelines for two- and four-year programs: Faculty, facilities and resources |
| 4:05 | Tamar (Uni) Susskind | P383: Aligning the guidelines for two- and four-year programs: Enhancing student success |

P375: ACS Guidelines for Chemistry Programs in Two-Year Colleges: A status report

Maureen Scharberg (San Jose State University, USA)

In Spring 2005, the Society Committee on Education established a task force to consider the revision of the ACS Guidelines for Chemistry Programs in Two-Year Colleges. A summary of the discussions and feedback obtained from an informal survey and workshop will be presented, along with an overview of future plans.

P376: Changes in the Guidelines and Evaluation Procedures for ACS approval of four-year programs: Curricular Aspects

William Polik (Hope College, USA)

In Fall 2004 the Committee on Professional Training began the process of revising the Guidelines and Evaluation Procedures used for ACS approval of four-year undergraduate chemistry programs. An overview of the process of gathering input will be provided and a document summarizing proposed changes will be shared. The changes related to curricula will be described in more detail.

P377: Considering the curricular impact of the guidelines

William Polik (Hope College, USA)

Breakout groups will discuss how current chemistry curricula fit within the proposed new guidelines and explore how curricular innovations could be implemented.

P378: Changes in the Guidelines and Evaluation Procedures for ACS approval of four-year programs: Student skills and abilities

Joel Shulman (University of Cincinnati, USA)

Community input to the Committee on Professional Training has emphasized the need to focus on the skills and abilities that students develop during their undergraduate education. The proposed guidelines and the CPT evaluation process will be described in more detail.

P379: ACS Guidelines for Chemistry Programs in Two-Year Colleges: Opportunities to focus on student skills and abilities

Richard Jones (Sinclair Community College, USA)

The need to focus on learning outcomes and assessment was highlighted in the outcomes from the Fall 2005 survey and during meetings conducted by the task force on the revision of the ACS Guidelines for Chemistry Programs in Two-Year Colleges. Programs that have assessed their students' skills and abilities will be highlighted. Ways in which such activities could be encouraged by the guidelines will be considered.

P380: Fostering and evaluating the development of student skills and abilities

Joel Shulman (University of Cincinnati, USA)

Breakout groups will explore ways in which the development of student skills and abilities can be demonstrated and evaluated. The resources needed for such evaluation will be discussed.

P381: Aligning the guidelines for two- and four-year programs: Student mentoring and advising

Tamar (Uni) Susskind (Oakland Community College, United States)

Recognizing the critical role that advising plays in fostering student transfer, the task force on the

revision of the ACS Guidelines for Chemistry Programs in Two-Year Colleges recommended that the advising, articulation, and alliances guidelines be revisited. Ways in which they can be strengthened by working with four-year programs will be discussed.

P382: Aligning the guidelines for two- and four-year programs: Faculty, facilities and resources

William Polik (Hope College, USA)

Successful transfer from two- to four-year programs is facilitated when the level of lower division courses are aligned. Expectations regarding the use of instrumentation and library resources during the first two-years of study will be discussed.

P383: Aligning the guidelines for two- and four-year programs: Enhancing student success
Tamar (Uni) Susskind (Oakland Community College, United States)

Breakout groups will explore the concerns that often arise when students transfer and ways in which the guidelines can encourage institutions to address them.

1:15 PM - 5:10 PM STEW 214A

S24: Science Education: Vital Connection of Science to the Public Sphere - Session 3 of 3

Rainer Glaser (University of Missouri-Columbia, USA)

Pervasive connections exist among science and the political, economic and sociological foundations of society and the interactions between societies. Every modern society must constantly review and negotiate the moral, ethical, and philosophical aspects of these connections. All societies face the central challenge of achieving successful progress in light of “inform & consent”-based interdisciplinary collaboration. In an environment of disciplinary specialization and increasing discipline-based competition, systematic change can only be achieved with interdisciplinary approaches that are designed with respect for society’s true complexity. The symposium brings together speakers with expertise in various science disciplines, the theory and practice of education, sociology, political science, journalism, and art. The speakers represent all ranks and various types of institutions and share a common interest in interdisciplinary science education. The speakers will share their insights and experiences, present and argue their ideas, and provide guidance to improving “science communication.”

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| 1:15 | introduction |
| 1:20 Lane Last | P384: The Art of Imaging Science and Collaboration |
| 2:10 Howard Peters | P385: KIDVENTION-Teaching Innovation and Invention to Children in the Community |
| 2:30 Sheryl Tucker | P386: Filling the Pipeline: Sharing the “Magic of Chemistry” with Junior Girl Scouts |
| 2:50 Juan Lopez-Garriga | P387: Expository Programs: An Approach to Enhance Science Education |
| 3:10 | break |
| 3:20 Susan Schelble | P388: Extending "Chemistry is in the News" to High School Programs |
| 3:40 David Harpp | P389: Lecture Retrieval via the Web – Better than Being There? |

P384: The Art of Imaging Science and Collaboration

Lane Last (University of Tennessee at Martin, USA)

The practices of an increasing number of fine artists are firmly rooted in their interest and understanding of the importance of science to the larger society. These works range in medium from computer-based visualizations to traditional media works, but what they share is a passion to communicate about the research, processes, and effects of scientific inquiry in our culture. What visual artists do not share is the subtlety and sophistication of knowledge that the researcher or theoretical scientist brings to his/her practice daily. I, an artist with a strong affinity for scientific-based work in my research, find myself working in the midst of this dilemma often. I have the imagination, aesthetic, and technical skills but not knowledge or accuracy of interpretation to create works that are visually engaging and communicate ideas effectively. This situation suggests to me that collaborations between the disciplines could develop more sophisticated and accurate scientific imaging, create visualizations for text and other sources that could positively engage younger audiences with science through art, and foster interdisciplinary dialogues between researchers in both fields. I will show examples of works and a typical visualization project at various stages to hopefully demystify the process. I will also offer some suggestions for working collaboratively with artists developed from my own personal experiences and an understanding of issues facing the visual artist.

P385: KIDVENTION-Teaching Innovation and Invention to Children in the Community

Howard Peters (Peters Verny, US)

The Silicon Valley ACS Local Section has had several KIDVENTIONS which teach innovation and invention to students in grades 4-12. This talk will focus on the authors' organizing of a KIDVENTION at the Spring 2000 ACSnational meeting in San Francisco- the timing, funding, volunteers needed, equipment and materials, and an explanation of the SCAMPER brainstorming session to prepare the student participants. Suggestions for organizing local KIDVENTION programs is discussed. contact peters4pa@aol.com

P386: Filling the Pipeline: Sharing the “Magic of Chemistry” with Junior Girl Scouts

Sheryl Tucker (University of Missouri, USA)

The “Magic of Chemistry” is a hands-on, inquiry-based educational program, designed to ignite and retain girls’ interest in science at an age where national studies indicate they begin to lose this curiosity. It has been nationally recognized by the American Chemical Society (ACS), Girl Scouts of the USA, National Science Foundation and White House. Program workshops are held on Saturdays twice a year, during National Chemistry and National Girl Scout Weeks, on the University of Missouri~Columbia (MU) campus. Using ACS resources, three different workshops — “Case of the Unsigned Letter”, “Fun with Polymers”, and “Chemistry of Color” — were developed and rotate annually. This format allows junior Girl Scouts (fourth through sixth graders) to attend a different program every year. Four hundred girls from 18 mid-Missouri counties, served by the Girl Scouts — Heart of Missouri Council, participate each year. In 2003, the program expanded to Truman State University, which serves the Becky Thatcher Council. At its most basic level, the “Magic of Chemistry” program educates the general public about the importance of chemistry. More importantly, it fosters the girls’ sense of confidence and interest in scientific discovery and promotes life-long learning. The impact this program has on these young girls is

illustrated by comments, such as “Wow, this is chemistry!”. Two thousand Girl Scouts, 950 volunteers and 13 burnt pickles later, this presentation describes the experience of bringing a large-scale community science program to fruition.

P387: Expository Programs: An Approach to Enhance Science Education

Juan Lopez-Garriga (University of Puerto Rico, Mayaguez Campus, USA)

Our initiative, Graduate and Undergraduates Enhancing Science and Technology is an expository program, which a core university students (fellows) with multidisciplinary knowledge, experiences, and skills in science and technology. Three expository initiatives form the coherent link between the fellows with teachers, students and general public K-12 schools: (a) Science on Wheels that promotes the study of science by presenting demonstrations, (b) Global Learning and Observations to Benefit the Environment (GLOBE) that integrates to the curriculum a set of protocols and environmental measurements, and (c) Calculator Based Laboratory (CBL), which uses graphic calculator and sensors to integrate mathematics, science, and technology to decrease the educational and technological gap between cultures. The fellows have been trained in the activities and leadership providing them the tools to lead (a) science demonstrations, (b) teachers weeklong workshops, (c) Saturday academies, and (d) weekly visit to schools. From the year 1991 to 2005, 273 science shows consisting of several demonstrations has been presented to more than 60,000 individuals (teachers, students and general public). Furthermore, from 2001-2005, seventy five fellows trained in GLOBE and CBL 1,204 teachers and 13,029 students. The result has been a significant community support for science and technology as well as an increase in the number of freshmen students that pursue careers in science at the University of Puerto Rico, Mayagüez Campus. A larger increase from 31% to 48% has been observed in the number of freshman students choosing Chemistry as their field of study. These are direct and measurable impacts of the expository programs lead by university students into future of science and technology education in the society.

P388: Extending "Chemistry is in the News" to High School Programs

Susan Schelble (Metropolitan State College of Denver, USA)

The “Chemistry is in the News” project is perfectly suited for adaptation in high school curricula. It’s built-in interaction between peers would allow course materials to meet the needs of several schools within a large school district or between several small school districts. “Chemistry is in the News” meets commonalities found in 90/90/90 schools (i.e. schools that are at least 90% combined minority, at least 90% free lunch, and at least 90% successful on standardized assessments). The successful pedagogical features, such as focus on achievement, emphasis on writing in content areas, frequent assessment, multiple chances for improvement and external scoring of student work are all embedded in “Chemistry is in the News”. Public schools often operate with little budget for interschool face-to-face interaction, so the need for electronic learning opportunities is paramount in these institutions. A preliminary study of peer-evaluations between Colorado and Missouri organic chemistry students indicates that students perform and evaluate with higher quality, when they believe the peers are from an institution other than their own. This same outcome seems possible when high school peers from traditional interactions such as interschool sports/music/debate are afforded a chance to produce and evaluate news portfolios in an interschool fashion.

P389: Lecture Retrieval via the Web – Better than Being There?

David Harpp (McGill University, Canada)

Since the advent of inexpensive tape-recorders in the 1970s, students have been capturing the audio of classes for home study. For the past 5-6 years, PowerPoint delivery has relegated 35mm slides and the overhead projector to museum status. Blackboard and chalk still reign in some disciplines but the visual era is fully upon us and given the relative ease of lecture preparation using PowerPoint, it is likely that visual lectures will become more and more prevalent. Since the fall of 2000 we have been using an evolving technology of lecture retrieval that amounts to a screen-capture slide show. We call the system COOL for COursesOnLine. It is now possible to make classes available 24/7 for students with internet connections. Over the past 6 years, over 30,000 McGill students have had the opportunity to review classes in a variety of courses including General, Organic and Physical Chemistry, Pathology, Pharmacology, Microbiology, Computer Science, Physics, Physiology and several different large Biology Courses just to name some. The full scope of this technology will be presented with student feed-back and faculty reaction. In addition, comments on the use of this technology with respect to our Office for Science and Society will be made.

P390: Point Counter-Point Open Discussion: Chemistry in the Public Eye

Rainer Glaser (University of Missouri-Columbia, USA), Peter Atkins (Lincoln College, Oxford University, UK), David Harpp (McGill University, Canada)

This open forum will engage attendees and presenters of this symposium and the plenary speakers in a candid discussion of important issues related to the public understanding of chemistry.

1:15 PM - 4:50 PM STEW 206

S41: Teaching to the National Science Standards: Using Chemistry Content to Connect Concrete Concepts to Abstract Ideas - Session 1 of 1

Amy Lou Keep (Stevenson HS, USA)

According to the National Standards (Physical Science Content Standard B), high school students should develop an understanding of the relationship between three domains: macroscopic (observable phenomena); microscopic (molecules, atoms, and particles); and symbolic (formulas, equations, and reactions). Developing and refining these relationships are challenging for many students. A strong chemistry course that provides learning experiences and activities that expand students' knowledge base as well as connect to their prior knowledge is essential. Teaching activities will be presented that relate concepts such as atomic structure with reactions, forces, energy transfers, and entropy. These topics provide excellent vehicles for bridging the gap between the concrete concepts that students have and the abstract ideas we would like for them to develop. These same topics also provide many opportunities to identify and clarify common misconceptions.

1:15 introduction

1:20 Kathy Kitzmann P391: Analogies for teaching chemistry

1:40 Arcelia Ramirez P392: Magnets, analogies and energy changes

2:00 Leonard Fine P393: Lighting the high school chemistry course with light bulbs and LEDs: Content and contexts (Part 1)

| | | |
|------|--------------------|---|
| 2:20 | John Deming | P394: Can your students provide evidence of the existence of atoms? |
| 2:40 | Amy Lou Keep | P395: Are these results good? |
| 3:00 | | break |
| 3:10 | Joe Shane | P396: Scientific writing and journalism as vehicles for developing understanding of abstract chemical principles |
| 3:30 | Jeffrey Paradis | P397: Bridging the macroscopic, sub-microscopic and symbolic: Hands on activities to help students learn chemistry |
| 3:50 | Grace Neff | P398: How bonding affects the observable properties of materials: A 5-day summer workshop for middle & high school chemistry teachers |
| 4:10 | | discussion |

P391: Analogies for teaching chemistry

Kathy Kitzmann (Mercy High School, USA)

Many topics covered in the high school chemistry curriculum can be made more understandable through the use of analogies, models, and everyday examples. The presenter will share some of the ones she has found most successful during her 31 years of teaching.

P392: Magnets, analogies and energy changes

Arcelia Ramirez (Escuela Nacional Preparatoria, Mexico)

One of the most frequent problems in learning chemistry is the understanding of abstract concepts and microscopic behavior which require models for their explanation. Analogies can lead to better understanding and retention of these abstract concepts. Analogies that use the students' every day experiences are even more effective. This paper will discuss how we use the behavior of magnets to increase the students' understanding of the potential and kinetic energy transformations that occur during physical and chemical changes. This experience has proven to foster a better understanding of the energy requirements necessary for these processes.

P393: Lighting the high school chemistry course with light bulbs and LEDs: Content and contexts (Part 1)

Leonard Fine (Columbia University, United States), **Stacey Brydges** (Columbia University, United States), **Luis Avila** (Columbia University, United States)

For nearly a century, the incandescent light bulb has served as a useful metaphor for illuminating the footpath into science and engineering through early introduction to the elements of chemistry, the properties of materials, and the interaction of matter and energy. With the emergence of a new technology and metaphor, the light-emitting diode (LED), educators now have an even more effective pedagogical tool for reinforcing chemical relationships and historical, as well as social, perspectives in science. Fiat lux!

P394: Can your students provide evidence of the existence of atoms?

John Deming (The University of Montana, United States), **Mark Cracolice** (The University of Montana, USA)

At all levels of science education—elementary, secondary, and post-secondary—instructors challenge students to describe what they see macroscopically in terms of particles, namely atoms and molecules. However, few instructors begin by providing students with data from which they

can conclude that atoms actually exist. We propose using an inquiry approach to follow the historical development of scientific concepts to justify the existence of atoms. With this approach, problems are introduced in the same context as they were for the original investigators. Thus, meaningful problems are brought to students. Students will have the opportunity to process the data they have generated in lab in a data-to-concepts direction. More importantly, they will understand the empirical evidence supporting the existence of atoms and the ramifications of those results from a historical perspective. In this case, the process of determining the best explanation from available evidence is most important. This paper focuses on one chemistry unit that utilizes history to provide a framework for teaching atomic theory.

P395: Are these results good?

Amy Lou Keep (Stevenson HS, USA)

Two ways to compare lab results are by comparing to standards and by comparing to other results. Class data has been collected for several years and is updated annually. This allows students to compare without penalty. It also opens the door for discussions of lab error, misperceptions, and the need for repetition. The result is positive and allows students to make real connections to the concept of laboratory error.

P396: Scientific writing and journalism as vehicles for developing understanding of abstract chemical principles

Joe Shane (Shippensburg University, USA), Jonathan Nowicki (Noblesville High School, USA)

Chemistry and science teachers at all levels use writing as a medium for students to demonstrate their understanding of abstract chemical principles and the connections to everyday observations and laboratory experiments. In this presentation, we will outline two variations of writing in the chemistry classroom; in-class essays and scientific journalism where students write not only to learn, but also to teach others (e.g. peers, parents, younger students). We have discovered that when students in these two contexts, that their grasp of abstract chemical concepts improves. We will also discuss the specific assessment procedures that we use with these writing activities.

P397: Bridging the macroscopic, sub-microscopic and symbolic: Hands on activities to help students learn chemistry

Jeffrey Paradis (CA State U-Sacramento, USA)

A series of guided-inquiry learning experiences based on science education research findings has been developed at California State University Sacramento. The student-centered activities seek to consciously address the macroscopic, sub-microscopic and symbolic domains while addressing most traditional chemistry topics. The author will discuss the philosophy used to develop the materials, share examples of activities and present assessment results. In addition to having been successfully used in professional development for in-service and pre-service K-8 teachers, these materials are well suited for use in High School chemistry and university GE science classes. A collection of these activities was published by Benjamin Cummings in Spring 2006.

P398: How bonding affects the observable properties of materials: A 5-day summer workshop for middle & high school chemistry teachers

Grace Neff (Cal Poly State University, United States)

This 40-hour, intensive workshop targeted 8th grade and high school chemistry concepts. The content and activities focused on bonding and how it relates to the observable properties of

materials including metals, semiconductors and polymers. Goals for the week included content knowledge enhancement and hands-on inquiry-based activities that make use of solid state materials. Participants also completed a 4+ hour Materials Engineering Lab in which they studied steel processing, polymer tensile-strength testing, Charpy impact test, and cold-working of metals. All of the hands-on activities/lab experiments the participants completed involved investigating material properties and relating these properties to bonding. Many of these activities were scaled-down versions of the Materials Engineering Labs, suitable for use in the classroom. For example, cold-working and steel processing were accomplished using wires, and polymer tensile strength testing was accomplished using a variety of polymer samples like trashbags, along with ring stands, binder clips and weights. Participants adapted one of the hands-on activities studied in the workshop for use in their own classroom.

1:15 PM - 4:50 PM STEW 214B

S33: Using JCE Resources Effectively - Session 2 of 2

Jon Holmes (University of Wisconsin Madison, United States), **John Moore** (Univ of Wisconsin-Madison, USA)

Have you used a JCE Tested Demonstration in your teaching? Have you used a JCE laboratory experiment and the Project Chemlab index of laboratory experiments to enhance your laboratory program? Have you used a JCE Classroom Activity with your students or in an outreach program? Have you used JCE software in your classes? Have you used Chemistry Comes Alive! videos to show your students chemistry that would otherwise not be available to them? Have you used the JCE Digital Library offerings (JCE WebWare, JCE SymMath, and others)? Have you used JCE in some other way? High school and college teachers will offer short papers describing how resources from the Journal of Chemical Education have been incorporated into classes and curricula. Presenters will share their ideas and successes, large and small, with others who may be interested in doing likewise.

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|------------------------------|---|
| 1:15 | introduction |
| 1:20 Jon Holmes | P399: JCE Online: a gold mine of all things JCE |
| 1:40 Hal Harris | P400: Using "Hal's Picks" in your teaching |
| 2:00 Ed Vitz | P401: The history of Tested Demonstrations and future of DigiDemos in JCE |
| 2:20 William Coleman | P402: Will a WebWare a day keep boredom away? |
| 2:40 | break |
| 2:50 Theresa Julia Zielinski | P403: Using symbolic mathematics in the physical chemistry curriculum |
| 3:10 David Hanson | P404: Quantum States of Atoms and Molecules: a living textbook |
| 3:30 Theresa Julia Zielinski | P405: Quantum States of Atoms and Molecules: Question database |
| 3:50 George Long | P406: Curriculum support for on-line learning communities |
| 4:10 William Coleman | P407: Why do we have yet another molecule collection? |

P399: JCE Online: a gold mine of all things JCE

Jon Holmes (University of Wisconsin Madison, United States)

JCE Online contains a wealth of resources: Journal articles dating back to 1966 and beyond, supplemental materials for many recent articles, JCE Digital Library collections, discussion forums, CLIC (resources for high school chemistry and science teachers), features available only online (Biographical Snapshots, Web-Ed articles, Hal's Picks), various means of searching for JCE resources, information about JCE, and more. This presentation will focus on the resources not presented elsewhere in this symposium. We hope to uncover some nuggets that may lie buried under the large mass of materials that you can find at JCE Online.

P400: Using "Hal's Picks" in your teaching

Hal Harris (University of Missouri-St. Louis, US)

"Hal's Picks" is a popular feature of the online Chemical Education Resource Shelf (CERS) of the Journal of Chemical Education. CERS provides comprehensive information about virtually all chemistry textbooks and commercial software in print, but Hal's Picks is a monthly recommendation of books that would not be adopted for courses. Instead, they are materials that supplement, enhance, and support the teaching of science. The recommendations include history, physics, biology, mathematics and computers, pseudoscience and environmental topics, as well as chemistry. Textbooks are important, but "Hal's Picks" can enliven teaching. Some of "Hal's Greatest Hits" will be described.

P401: The history of Tested Demonstrations and future of DigiDemos in JCE

Ed Vitz (Kutztown University, USA)

The development of lecture demonstrations from the earliest in the Journal (in Volume 1, 1924), to the latest Tested Demonstrations will be delineated, and the possibilities that DigiDemos provides for the future will be considered. The amazing pedagogical power of good demonstrations will be discussed and illustrated with examples from DigiDemos and Tested Demonstrations.

Web Sites:

<http://jchemed.chem.wisc.edu/JCEDLib/DigiDemos/index.html>

<http://jchemed.chem.wisc.edu/AboutJCE/Features/featureDetail.php?recordID=59>

<http://faculty.kutztown.edu/vitz/TD/TDhome.html>

P402: Will a WebWare a day keep boredom away?

William Coleman (Wellesley College, U.S.)

The JCE Digital Library WebWare Collection provides a number of web-based applications for use in the classroom, laboratory, computer room, and anyplace else where students have internet access. The majority of these applications are quite interactive and open-ended. This presentation will focus on the use of WebWare as source of classroom demonstrations, cooperative learning activities, problem sets and examinations.

P403: Using symbolic mathematics in the physical chemistry curriculum

Theresa Julia Zielinski (Monmouth University, USA)

Over 100 symbolic mathematics documents are currently available through the JCE Symbolic Mathematics collection or through the SymMath web page maintained at Monmouth University. These documents are a rich resource that may effectively and efficiently enrich the physical chemistry curriculum. This presentation will focus on how these materials can be incorporated into a course. Some insights will be presented that show how the materials may improve student

learning.

P404: Quantum States of Atoms and Molecules: a living textbook

David Hanson (Stony Brook University - SUNY, USA)

In the December 2005 issue, JCE inaugurated the "Living Textbooks for Chemistry" series with the release of "Quantum States of Atoms and Molecules" by Hanson, Harvey, Sweeney, and Zielinski. This ebook, providing an introduction to quantum chemistry, has many unique features. As part of the JCE LivTexts project, contributions from others will continually provide learning modules that can be used in a variety of contexts and enhancements that facilitate student learning. The vision for the Quantum States ebook, how it can be used, and how contributions can be submitted will be described.

P405: Quantum States of Atoms and Molecules: Question database

Theresa Julia Zielinski (Monmouth University, USA), **Erica Harvey** (Fairmont State University, USA)

In November 2005 JCE launched the "Living Textbooks for Chemistry" collection with the release of Quantum States of Atoms and Molecules by Hanson, Harvey, Sweeney and Zielinski. A database of multiple choice questions has been created to support learning and assessment for students using this text. Questions in the database were constructed using images, concepts, and equations from the text. Questions are grouped by text chapter. The database has been used with WebCT/Vista and DesireToLearn course management systems. The method of using the questions will be briefly outlined and plans for the future of the collection vis a vis JCEQbank will be highlighted.

P406: Curriculum support for on-line learning communities

George Long (Indiana Univ. of PA, USA)

One of the main functions of the internet is to connect people. The ease of communication has allowed the development of communities based on the interests of people rather than their location. In Chemistry education, this has allowed the development of on-line learning communities that connect students and teachers engaged in the study of chemistry. The Physical Chemistry on-line consortium, and now, JCE's LrnCom online column provides support, and curricula for those interested in on-line activities. The presentation will discuss the scope, and the implementation of the materials available to support on-line learning communities.

P407: Why do we have yet another molecule collection?

William Coleman (Wellesley College, U.S.)

The JCE Digital Library Featured Molecules Collection provides interactive structures of molecules drawn from specific articles in the print version of JCE. They allow students to examine structures within the context of these papers, and enhance student abilities to relate two-dimensional representations of structure to the three-dimensional structure of molecules, ranging from the very simple to the quite complex. The structures may also be used as stand-alone examples of structure and bonding and as part of an introduction to computational chemistry.

Workshops

Tuesday, August 1 afternoon

W25: Cookin' with Chemistry

1:30 PM - 4:30 PM STON 229

Sally Mitchell (Syracuse University, USA)

Come hungry for learning and try innovative lessons with practical applications. This workshop will investigate how to use food and the processes of cooking to teach basic concepts of chemistry and biochemistry including bonding, chemical reactions, solutions, and stoichiometry. Leave the session with a recipe for successful integration of this practical and interesting topic into your existing curriculum.

Capacity: 24 Fee: \$45

W26: Creating and Validating an Energy Level Model of the Atom

1:30 PM - 4:30 PM WTHR 212

John Eix (Upper Canada College - Retired, CA)

In this workshop you will use Excel and successive ionization energies to develop an energy level model of the atom. Then use the model to predict a spectral line for helium and check it using a diffraction grating spectrometer.

Capacity: 20 Fee: 0.00

W27: More Small Scale Reactions

1:30 PM - 4:30 PM BRWN 2134

Viktor Obendrauf (University of Graz, Austria)

The fun and learning continue with more small scale reactions for use with student activities and in demonstrations. As in "Small Scale Gas Reactions," participants will prepare their own kit of microscale apparatuses. However, different student activities will be covered in this workshop, so participants may wish to attend both "Small Scale Gas Reactions" and "More Small Scale Gas Reactions." Workshop activities include: NO_x-tube, wood gas generation tube, syringe cannon, and gas generation (additional experiments with hydrogen chloride, chlorine, bromine, acetylene).

Capacity: 0 Fee: 25

W28: Nuts and Bolts of Chemical Education Research: Development and Validation of Survey Instruments

1:30 PM - 4:30 PM STEW 320

Katherine Havanki (Catholic University of America, USA)

The purpose of this workshop is to introduce participants to the procedures involved in producing validated and reliable surveys that are theory-based. Participants will engage in group work to develop sample survey questions on a particular topic. Statistical and qualitative procedures necessary to determine the reliability and validity of the survey will be presented. Participants will have an opportunity to practice interpreting sample statistics. The cost of the workshop includes the price of a book that will prove helpful to the workshop participants both during and after the workshop.

Capacity: 35 Fee: \$55

W29: The Model-Observe-Reflect-Explain (MORE) Thinking Frame: Prompt Student

Reflection in Your Laboratory

1:30 PM - 4:30 PM BRWN 1134

Dawn Rickey (Colorado State University, United States)

The Model-Observe-Reflect-Explain (MORE) Thinking Frame is an instructional tool that has been shown to promote reflection and deeper understanding of chemistry ideas in the general chemistry laboratory. The MORE Thinking Frame has been successfully implemented at a variety of institutions including research universities, a primarily undergraduate institution, a 2-year college, and a high school. It has been implemented with modular labs specifically written to employ MORE and with standard laboratories. This workshop will introduce participants to the MORE Thinking Frame and how to use the tool in their laboratory program. We will conduct and discuss sample MORE activities and discuss how to add MORE to standard lab experiments. All participants will be given an implementation guidebook with sample MORE activities and lessons learned from instructors at all levels. Participants are welcome to bring a lab from their curriculum to practice applying MORE to their program. This workshop is intended for instructors at the college and high school levels. To receive further information about MORE, please send an email request to Dawn Rickey.

Capacity: 24 Fee: \$10.00

W30: Vernier Hands-on Chemistry with Computers; Section 1

1:30 PM - 4:30 PM BRWN 2125

Dan Holmquist (Vernier Software & Technology, USA)

This hands-on workshop will allow participants to collect and analyze chemistry data using Vernier LabPro with computers running Logger Pro software. Data will be collected using sensors such as Temperature, Pressure, pH, Conductivity, and Colorimeters. A variety of experiments from the popular Vernier lab manuals Chemistry with Computers and Advanced Chemistry with Vernier will be offered.

Capacity: 40 Fee: \$0

Wednesday, August 2 morning

8:00 AM - 8:50 AM

L8: The Americans with Disabilities Act: What it really means for you

Heather Stout (Purdue University,)

8:00 AM - 8:50 AM

L9: The challenge of interdisciplinary STEM service classes: How can physics, chemistry, math, and computer science support a redesigned biology curriculum?

Edward F. Redish (University of Maryland, USA)

One of the most dramatic trends in science in the past twenty years has been the growing strength and sophistication of the biological sciences ranging over subjects as diverse as genomics, neuroscience, and mathematical ecology. Biologists nationally have begun to call for a re-thinking and reform of biology education – one that includes a strong base in chemistry, physics, math, and computer science.* From the experience of forty years of attempts at curriculum reform in physics, it is clear that a successful education reform in a discipline is likely to require discipline-based

education research and an improved understanding of the discipline's "hidden curriculum" – the habits of thought students need to learn along with the "facts and figures" of the content. In this talk I will present the implications of some of my own research into the "hidden curriculum" in physics and consider its implications for how chemists, physicists, and mathematicians might coordinate the reforms of their support courses with the coming reforms in biology education. * BIO 2010 (National Academies Press)

Symposia sessions

Wednesday, August 2 morning

8:00 AM - 9:45 AM STEW 206

S42: In Honor of Babu George---A Human Catalyst - Session 1 of 1

Ron Perkins (26 Dickinson Road, USA)

This symposium is dedicated in loving memory to Babu George. His countless contributions to the chemical education community continue to inspire us all to be what he was...a human catalyst. A person of limitless vision, unabounding compassion, and exhaustive drive, Babu made things happen. Best known for his ability to unite elementary, high school and college educators, Babu laid a foundation for people to come together and collaborate. He strengthened our community, provided workshops to make us better teachers, created programs for children giving us excited students and future colleagues, and he supported us, extending his friendship and resources. Presenters will provide insights to the life and contributions of Dr. Babu George.

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| 8:00 | introduction |
| 8:05 Betty Catelli | P408: A High School Teacher's Thanks to Babu George |
| 8:15 Lee Marek | P409: Babu, A Macro Catalyst |
| 8:25 Doctor DeMento (Jerry DeMenna) | P410: "Higher Level" Reactions |
| 8:35 C Marvin Lang | P411: "No Problem" |
| 8:45 Diane Bunce | P412: Babu George- A chemical educator and friend to all |
| 8:55 Robert Becker | P413: Dr George remembered |
| 9:05 Laura Slocum | P414: His legacy lives on |
| 9:15 Bassam Z. Shakhashiri | P415: A Tribute |
| 9:25 Mickey Sarquis | P416: Work Remembered, Work Continued |
| 9:30 David Katz | P417: A teacher's teacher |
| 9:35 | discussion |

P408: A High School Teacher's Thanks to Babu George

Betty Catelli (Southington High School, USA)

The impact of Babu George on precollege science education, especially in Connecticut, cannot be overstated. A high school teacher will share some memories of Dr. George and talk about his influence on her career.

P409: Babu, A Macro Catalyst

Lee Marek (UIC, UN)

In 1998 Babu asked me to give a talk/demos for his History Of Chemistry Symposium. In a moment of weakness I said yes because it was Babu. I mean no big deal, I had given talks at Sacred Heart University before. When I got the program I freaked! Leonard Fine with a talk - A Tribute to Hubert Alyea, William B. Jensen, Mary Ellen Bowden and Derek Davenport speaking on Linus Pauling! These people know what they are talking about, my heroes in the history of chemistry! Babu did nothing small. Like Reg Friesen he was able to bring people together and ran super meetings. Even at meetings other than his own he would act as a catalyst for people to precipitate together for sharing and exchanging of ideas. I expect to see Babu walking across the registration floor at a Chem Ed or BCCE just like I expect to see Cliff Schrader at a NSTA meeting. Thanks Babu for working behind the scenes to make the teaching of chemistry that much better.

P410: "Higher Level" Reactions

Doctor DeMento (Jerry DeMenna) (Sacred Heart University, US)

Six years ago Dr. George attended a manufacturer's workshop where I was presenting some Analytical Instrumentation for undergraduate teaching. He saw, and appreciated, the unbridled enthusiasm for learning in this seminar and provided both the "catalyst" and the "medium" to spread the Good News of Chemistry & Science! He's gone, but he's still teaching all of us!

P411: "No Problem"

C Marvin Lang (Univ Wisc - Stevens Point, USA), Don Showalter (University of Wisconsin-Stevens Point, USA)

We said that "we would need some potassium tricyanocuprate(I), for a chemiluminescent clock reaction as part our workshop." "NO PROBLEM" was Babu's immediate response. And that was his unique response to any and all requests we ever had during numerous workshops, presentations or lectures conducted at his request at Sacred Heart University for nearly 20 years. That will be the legacy of Dr. Babu George ... make it happen and there'll be No Problem!

P412: Babu George- A chemical educator and friend to all

Diane Bunce (Catholic University of America, USA)

To know Babu George was to know a human whirlwind. He had a way of capturing your imagination and creativity and melding it to his own vision of helping students, whether they were undergraduates or high school teacher colleagues, learn and appreciate chemistry. One never seemed to understand how Babu worked his magic but it was clear that once you met him, you would walk away a different person—one more dedicated to helping spread the word that chemistry is something everyone can learn and enjoy. This presentation will discuss some of the ways Babu affected the members of the chemical education community

P413: Dr George remembered

Robert Becker (Kirkwood High School, USA)

It is hard to quantify all that Dr. George accomplished on behalf of Chemistry teachers in Connecticut and across the country. His tireless and selfless contributions were always behind the scenes... never in the spotlight. Like a catalyst, he made everything else run smoothly, but never seem to become exhausted. Dr. George... this one's for you!

P414: His legacy lives on

Laura Slocum (University High School of Indiana, USA)

Throughout Dr. George's life his passion for science, especially chemistry, has impacted thousands. He has shared this passion with teachers and students throughout the world in many ways. I had the rare pleasure of seeing Dr. George present his favorite demo – Lemon Shake – while I was a graduate student at Ball State University. In this presentation, I will share the instructions for this demonstration and Dr. George's impact on my life.

P415: A Tribute

Bassam Z. Shakhshiri (UW-Madison,)

Babu George was thoughtful and caring in everything he did for chemistry and science education. He was effective and pleasant.

P416: Work Remembered, Work Continued

Mickey Sarquis (Miami University, USA), **Lynn Hogue** (Miami University, USA)

Babu George had a vision of chemical education that exceeded mere mortals'. His efforts to bring improved science education to all teachers and students are legendary. This talk will share behind the scenes anecdotes, experiences, and little-known stories of working with the master.

P417: A teacher's teacher

David Katz (Pima Community College, USA)

As one of Babu George's early workshop presenters, we had a long working relationship and shared many ideas. We innovated new activities and demonstrations for each new workshop. His dedication and caring was beyond description.

9:00 AM - 12:00 PM STEW 214D

S9: Building the Community of Green Chemistry Educators - Session 2 of 3:

Greening the curriculum - green chemistry courses

Kathryn Parent (American Chemical Society, USA), **Julie Haack** (University of Oregon, USA)

Chemistry is a rapidly evolving discipline and societal pressures and economic incentives are demanding that chemists develop new ways to carry out vital chemical processes using environmentally benign ("green") methods. By incorporating green chemical principles into the chemistry curriculum, educators have the opportunity to transform student perceptions about the role chemistry plays in our society and to prepare future scientists, educators and policy makers to address the national need to discover and develop sustainable chemistry for the future. This symposium focuses on community development (high school and university) of green chemistry educators by showcasing new materials, summarizing newly available electronic tools, and highlighting a diverse array of outreach activities. Educators will receive ideas and support for incorporating green chemistry throughout diverse teaching environments.

9:00 introduction

9:05 Richard Gurney P418: Consumption: Chemistry and conscience: The Tao of Shoe, a learning community between green chemistry and environmental ethics

9:25 Adam Kiefer P419: Green chemistry in an environmental chemistry option for undergraduates

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| 9:45 | Harshavardhan Bapat | P420: Green chemistry, science and technology for the nonscience major |
| 10:05 | Ganapati Yadav | P421: Development of a new course on "Catalytic Green Science and Technology" |
| 10:25 | | break |
| 10:35 | Denyce Wicht | P422: Development of a "Short Course" in green chemistry |
| 10:55 | Martha Gwen Sibert | P423: Green chemistry in the high school chemistry classroom |
| 11:15 | Sheryl Mebane | P424: Chemistry Literacy Network |
| 11:35 | | discussion |

P418: Consumption: Chemistry and conscience: The Tao of Shoe, a learning community between green chemistry and environmental ethics

Richard Gurney (Simmons College, United States), Sue Stafford (Simmons College, USA)

Consumption: Chemistry and Conscience, will be an interdisciplinary course designed to appeal to and stimulate students' increasing social conscience. By integrating the theory of moral philosophy with the practical knowledge of green chemistry, the learning community will provide students with a unique opportunity: they will be able to approach environmental problems with a deep understanding of the assumptions and world views underlying and generating those problems, and apply scientific knowledge as a means of solving those problems. The aims of the learning community are to provide a grounding in key issues in environmental ethics, to raise awareness of differing viewpoints, and to understand the consequences for the actions of individuals, organizations and government. The course will be driven by an activist approach, and this, coupled with group projects, will give students an opportunity to see their knowledge and values made concrete. The goal of Chemistry and Consumption portion of the course is to establish chemical principles on a need-to-know basis within a contextual framework of significant social, political, economic and ethical issues. This course will present the scientific principles as needed, in a manner intended to better prepare students to be well-informed citizens.

P419: Green chemistry in an environmental chemistry option for undergraduates

Adam Kiefer (University of Illinois, USA), **Patricia Shapley** (University of Illinois, USA)

The new Environmental Option at the University of Illinois is designed to provide a background in environmental chemistry that is sufficient in breadth and depth to prepare a person to work as an environmental chemist in the public or private sector or to pursue an advanced degree in the field. Undergraduate chemistry majors take "Chemistry of the Environment" in the second year and study chemical composition and reactions in the Earth's atmosphere, groundwater, and crust, along with information on alternative energy and on pollution. In the junior and senior years, students choose 3 advanced level environmental courses including "Green Chemistry". This is an interdisciplinary course with a focus on sustainability in chemical industries. It includes extensive web-based resources and can be either an on-campus or a distance education course. Lectures and weekly student projects concern the modification of engineering practices and chemical processes to reduce waste, energy consumption, and hazards; the development of new catalytic processes and new chemical products; and the economic analyses of chemical processes.

P420: Green chemistry, science and technology for the nonscience major

Harshavardhan Bapat (University of Illinois at Springfield, USA), **Stanley Manahan** (University of Missouri, USA)

This paper describes materials for two courses in chemistry, science, and technology that can be taught to nonmajors. The first of these is based on material from the book *Green Science and the Ten Commandments of Sustainability* by Stanley Manahan. It presents chemistry from a very fundamental viewpoint emphasizing green chemistry and sustainability throughout. In addition to basic green chemistry it includes units on energy; the atmosphere; the hydrosphere; the biosphere; the anthrosphere and industrial ecology; terrorism, toxicity, and vulnerability; and a set of ten principles of sustainability. The second course is based upon the book *Environmental Science and Technology*, 2nd ed., by Stanley E. Manahan that addresses sustainable science and technology in an organizational framework based upon the five environmental spheres: The atmosphere, hydrosphere, geosphere, biosphere, and anthrosphere.

P421: Development of a new course on "Catalytic Green Science and Technology"

Ganapati Yadav (University of Mumbai, India)

The focus of chemical manufacture will shift from the developed nations to China and India. The new generation of undergraduates and graduates must learn the principles of Green Chemistry and Engineering. The author was responsible for the development of a new course for the Michigan State University, East Lansing on "Chemistry of Chemical Processes" during 2001-2002, which included green chemistry. He subsequently has developed another course for B.S. students of Chemical Engineering for the Mumbai University students. Indeed, his efforts have resulted into the establishment of the first ever "Centre for Green Technology" which is funded by the University Grants Commission, Govt. of India during 2005. Students of this course are taken to the realms of chemical and allied industry and conveyed the message of Sustainable Development and Responsible Care through several industrial examples and also new developments which have potential for industrial practice. There have been considerable advances in the development of tools, equipment, knowledge and practices needed to develop products which meet the environmental criteria. The enviro-conscious citizens of the world not only want industries to practice safe technologies and raw materials but also enviro-friendly long lasting and easily-disposable and biodegradable products. This course has been quite useful in changing the perception of the students. Indeed, now we have started a graduate program in this area.

P422: Development of a "Short Course" in green chemistry

Denyce Wicht (Suffolk University, US)

Green Chemistry, a cross-registered Chemistry and Environmental Studies course designed specifically for students interested in chemistry, biochemistry, engineering, environmental studies, materials science and other related fields, was designed and taught during the January 2005 Wintersession at Wellesley College. Emphasis was placed on the theory and practice of the Twelve Principles of Green Chemistry with specific examples discussed in detail pertaining to atom economy, renewable feedstocks, catalysis, and solvents. This talk will describe the outline of the course and detailed aspects of course content, including the green chemistry product or process topics chosen and presented by the students during the final week of the course. Finally, course evaluations and future efforts to improve and expand the course curriculum will be discussed.

P423: Green chemistry in the high school chemistry classroom

Martha Gwen Sibert (Roanoke Valley Governor's School, USA)

High school students tend to have a great interest in and an awareness of the environment, thus, the chemistry classroom is an ideal place to support this interest and further enhance students' understanding of the world. The ACS's Green Chemistry Program, along with that of the EPA, provides great information about green chemistry and green engineering. An assignment based on this information was first developed five years ago for the second-year chemistry students at the Roanoke Valley Governor's School in Roanoke, VA. It has been modified and expanded each year as the topic has become even more important. Students become excited about the assignment as they start looking up the answers for their parts of the assignment and as they decide how to present the information to the rest of the class. The result has been flyers, brochures, posters, newspaper articles, PowerPoint presentations and even models, showing what the students have learned. The assignment may be viewed at the following URL:

http://www.chem.vt.edu/RVGS/APChem/Homework/Green_chemistry.doc

P424: Chemistry Literacy Network

Sheryl Mebane (UC Berkeley, USA)

The Chemistry Literacy Network synthesizes contributions from three research fields to design and pilot classroom and extracurricular environmental and green chemistry education programs that increase student understanding, inform environmental justice actions, and provide access to knowledge for underserved communities. In Phase I, the observation and analysis, using mixed research methods, of successful programs teaching green or environmental chemistry in various settings, a chemistry knowledge survey of selected populations of laypeople, and the linking of community and academic groups through the network will occur. The paper summarizes the foundational literature review undergirding the project and developing the concept of chemical literacy interwoven with social impact. Also reported are the network's progress and preliminary data, perhaps addressing the experienced curricula for chemistry students, the program's potential impact in underrepresented minority communities or collaborating laypeople's conceptual understanding of chemistry.

9:00 AM - 12:00 PM STEW 202

S43: Chemistry Across Borders - Session 1 of 2

Carmen Gauthier (Florida Southern College, USA)

This symposium will explore the practice of chemistry education in other parts of the world. Speakers will give examples of successful collaborations and then discuss current projects and future directions. This is an opportunity to expand horizons and learn from other educators' experiences.

| | |
|-------|---|
| 9:00 | introduction |
| 9:05 | Morton Hoffman P425: Chemistry Education Worldwide |
| 9:25 | Dan Bedgood P426: Can Higher Education be Outsourced to India? Distance education at Charles Sturt University |
| 9:45 | Luis Montes P427: Geographic Perspectives of Chemistry |
| 10:05 | Willy Hunter P428: Chemistry Education in the Netherlands and the USA |
| 10:25 | break |
| 10:35 | Geoff Rayner-Canham P429: Taking Chemistry to Remote Communities: Challenges and Successes |

10:55 Manuel Martinez P430: Activities of the Division of Chemical Education of the Chilean Chemical Society

11:15 Cecilia Collado P431: Chemical Education in CHILE : Programs ,Actions and Trends

P425: Chemistry Education Worldwide

Morton Hoffman (Boston University, USA)

The Committee on Chemistry Education (CCE), established in 2002, is a standing committee of IUPAC; it meets every two years during the IUPAC General Assembly, and in the alternate years during the International Conference on Chemical Education (ICCE), which it oversees. With an international membership of more than forty, CCE coordinates the educational activities of IUPAC, promulgates good education practice worldwide, and promotes the public understanding of chemistry. CCE also provides seed money to initiate international chemistry education projects, and sponsors a number of programs in developing countries and regions. The activities of CCE are reported in publications of IUPAC and national chemistry organizations.

P426: Can Higher Education be Outsourced to India? Distance education at Charles Sturt University

Dan Bedgood (Charles Sturt University, Australia)

Clothing, automobiles, and now software design are being outsourced to countries with lower salaries. Will this happen in higher education? Charles Sturt University is the largest provider of tertiary distance education in Australia; approximately 2/3 of the 30,000 enrolled students study from home. This talk will describe the methods used to produce and deliver a University education by distance.

P427: Geographic Perspectives of Chemistry

Luis Montes (Univ. of Central Oklahoma, USA)

One of the great advantages of science is its 'placelessness' or universal nature, and this is no less true in chemistry. After all, we are taught early in our chemistry courses that water is always two atoms of hydrogen and one atom of oxygen, no matter where the water originated. So how can a geographic perspective – or having a sense of the 'placeness' of chemistry – add anything to chemistry? Although chemical principles are expected to hold everywhere they were not developed everywhere. In this presentation I will briefly summarize some ways in which geography can be tied to chemistry education – from the names of elements to the locations of their discoveries. This understanding can aid teachers as they incorporate the history and nature of science in to their chemistry classes. I will also suggest a few ways in which viewing the early days of chemistry through geographic glasses can add to and expand on our understanding of the development of chemistry.

P428: Chemistry Education in the Netherlands and the USA

Willy Hunter (Illinois State University, USA)

In this paper I will describe six things I learned about teaching chemistry while spending a year in the Netherlands. Not surprisingly, three of the things I learned concern the state of chemistry teaching in the USA and three concern the Netherlands. Included will be a discussion of the teacher's views of the curriculum, classroom atmosphere, teacher education, teacher's daily preparation, and guilt associated with being a chemistry teacher.

P429: Taking Chemistry to Remote Communities: Challenges and Successes

Geoff Rayner-Canham (Grenfell College, Canada), *Christina Smeaton* (University of Windsor, Canada), *Amy Snook* (Sir Wilfred Grenfell College, Canada)

For the last three years, we have been taking a chemistry presentation to Labrador, Canada. The communities are small and isolated and several have high proportions of aboriginal students. Some communities are accessible by ferry plus truck while others are air-accessible only. We have put together a presentation of live demos, slides, and video clips that attempt to convey the importance of chemistry in their lives and the way in which chemistry will change their futures. It is our hope that the show will provide the inspiration for some of the students to consider proceeding to college to study for a chemistry-related career. We will discuss the challenges and the successes and the way in which we have had to adapt the presentation during our steep learning curve.

P430: Activities of the Division of Chemical Education of the Chilean Chemical Society

Manuel Martinez (Universidad de Santiago, Chile)

The Division was created in 1984 during a meeting of the Chilean Chemical Society. The author of this abstract was in charge from 1986 through 1994. Later, from 1997 through 2003, the author was elected Vice-president of the Chilean Chemical Society, and from there, it was possible to improve the activities of the Division. While in charge of the Division, two main activities were proposed that remain active until present time: Chilean Chemistry Olympiads that were organized for the first time in 1992, and the Chemical Education Encounters organized for the first time in 1987. Nowadays, 13 Chemistry Olympiads have taken place, organized by 11 main Chilean universities, located in different cities, with the sponsorship of some private Foundations, the Council of Chilean University Presidents, and the Ministry of Education since 2002. 9 Encounters, with the sponsorship of 9 Chilean universities, also were located in different cities. In this presentation, a brief description of these activities will be presented, where the author has actively been involved. The impact they had in the way chemical education has been developed in Chile will be discussed, and some future directions will be given.

P431: Chemical Education in CHILE : Programs ,Actions and Trends

Cecilia Collado (Universidad de Concepcion, CHILE), **Jorge Plaza de los Reyes** (Universidad Catolica de la Santisima Concepcion, Chile)

Chile is an emerging country that has evolved from a centralized educational system, through diverse initiatives, collaborations and programs. Globalization has forced society to put heavy pressure on Education to prepare future scientists, teachers and policy makers, in order to keep sustainability for development and growth, as well as the need to guarantee scientific literacy and comprehension of fundamental chemical knowledge, within all the community. An overview of the different aspects of Chemical Education in Chile: teaching, research and cooperation, across the formal system and non formal areas, will be described. Main goals for the next decade, national and international collaborations and institutions committed, will be also visited.

9:00 AM - 12:00 PM STEW 214C

S19: Chemistry Educators and Nanotechnology Development - Session 2 of 2

Eric J. Voss (Southern Illinois University Edwardsville, USA), **Alireza Mansoub Basiri** (Farda Institute, Iran)

Educators play an important role in the development of new technology because they can positively affect students who may become the managers or policy makers in new technologies.

We are now in the first step of nanotechnology development. If we help students understand what nanotechnology is and how it can affect their lives, we help improve nanotechnology development. This symposium will show how chemistry educators can acquaint their students with nanotechnology concepts such as manipulation and the nano scale and also generate informed interest in nanotechnology.

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| 9:00 | | introduction |
| 9:05 | Lon Porter | P432: Exploring nanoscience and nanohype: a liberal arts approach to emerging interdisciplinary science and technology |
| 9:25 | Ed O'Sullivan | P433: Molecular literacy project |
| 9:45 | Ralph Gerber | P434: From the research bench to the teaching laboratory - gold nanoparticle layering |
| 10:05 | | break |
| 10:15 | Kelly Hutchinson | P435: Introducing nanoscience and technology in the secondary schools |
| 10:35 | Eric J. Voss | P436: Nanoscale science and engineering experiments and demonstrations in first-year undergraduate courses |
| 10:55 | | discussion |

P432: Exploring nanoscience and nanohype: a liberal arts approach to emerging interdisciplinary science and technology

Lon Porter (Wabash College, USA)

Nanotechnology is everywhere these days! Browse the newspaper, surf the web, or look to recent works of science fiction. The manipulation of matter on the nanometer scale has been termed nanotechnology, an exploding field still in its infancy. Much of the driving force for building tiny devices and features on the nanoscale is their importance for existing and emerging technologies such as microelectronics, electromechanical systems, sensors, molecular computing, and a myriad of other applications. In response, we have designed a new course; open to undergraduate students that have completed at least one semester of chemistry, which focuses on the basic science behind the science fiction and the "hype." Nanotechnology provides an excellent way of learning to look at the amazing opportunities that arise when various fields of science intermingle. We utilize this as an opportunity for applying the fundamentals we learn in our subdisciplinary courses to applications and problems with a broader scope. The course revisits the origins of the field and spotlights current advances. Utilization of a central text is supplemented by the use of the primary chemical literature as well as selected works of quality science fiction. Furthermore, students consider the social, political, economical, environmental, and ethical ramifications of a "nanotech revolution." In addition to lecture and discussion, students participate in laboratory exercises and a major writing assignment. This talk will expand upon our recent work that has been accepted for publication in JCE.

P433: Molecular literacy project

Ed O'Sullivan (Parkland College, USA), **David Wilson** (Parkland College, Champaign, IL, USA), David Wilson (Parkland College, Champaign, IL, USA)

This NSF-supported project is developing new materials that use highly interactive molecular dynamics and quantum mechanics models, and embed these models in learning activities that are

appropriate for both core science courses and specialized courses teaching biotechnology and nanotechnology workplace competencies. All activities are available for download at no cost at <http://molit.concord.org>. Many of the numerous exercises are appropriate for undergraduate and high school chemistry, including those covering topics such as Atomic Structure, Ionic Compounds, Chemical Equilibrium, Chemical Kinetics, and Mass Spectrometry to name a few. In developing these materials, the Concord Consortium (Concord, MA) has worked with community colleges (including Parkland College, Middlesex Community College, Roxbury Community College, and Wachusett Community College), biotechnology and nanotechnology companies, and COD, an educational non-profit in Texas, which will provide national dissemination. The presentation will focus on a demonstration of representative activities.

P434: From the research bench to the teaching laboratory - gold nanoparticle layering

Ralph Gerber (NC State University, USA), Maria Oliver-Hoyo (North Carolina State University, United States)

The emphasis currently being placed on research and development of nanotechnology strongly supports the introduction of nano-science techniques and methodology into the undergraduate chemistry laboratory curriculum. The experimental procedures presented within are designed for 1st or 2nd year general or organic chemistry students allowing for experimentation with synthetic, mechanistic, and measurable properties of gold nanoparticles and layering techniques. Methodology involves the synthesis of gold colloidal suspensions, attachment of a functional group to glass and creation of self assembled monolayers (SAMs) through deposition of gold nanoparticles, measurements of wavelengths, absorbance and electrical properties of multiple layers of gold nanoparticles utilizing an inexpensive and easy to construct analog/digital meter. Educational emphasis includes an understanding of the nano-scale and an exposure to nano technology through the synthesis and layering of gold nanoparticles.

P435: Introducing nanoscience and technology in the secondary schools

Kelly Hutchinson (Purdue University, USA), George Bodner (Purdue University, US), Nick Giordano (Purdue University, USA)

Even though nanoscience and technology are a part of everyday living, few members of the general public are aware of the field's applications to their daily lives. We are therefore interested in research in the area of Nanoscale Science and Engineering Education (NSEE) teaching and learning as part of the National Center for Learning and Teaching in Nanoscale Science and Engineering (NCLT), a collaborative project between Purdue University, the University of Michigan, and Northwestern University. The goal of the NCLT is to introduce real-world examples of nano-concepts into the secondary school science curriculum to assist students in learning about the field. This presentation will discuss quantitative and qualitative data in the form of surveys and interviews that investigate students' understanding of size and scale and the particulate nature of matter and students' interest in nanoscience phenomena. The use of alternative avenues, such as scanning probe microscopy, for presenting nanoscience and technology concepts in future investigations will also be discussed.

P436: Nanoscale science and engineering experiments and demonstrations in first-year undergraduate courses

Eric J. Voss (Southern Illinois University Edwardsville, USA), Mark Bolyard (Southern Illinois University Edwardsville, USA), Nader Saniei (Southern Illinois University Edwardsville, USA),

Michael Shaw (Southern Illinois University Edwardsville, USA), Paul Wanda (Southern Illinois University Edwardsville, USA)

With support from an NSF Nanotechnology Undergraduate Education (NUE) grant, an interdisciplinary team of chemists, biologists, and engineers has incorporated nanoscale science and engineering experiments and demonstrations into introductory courses at Southern Illinois University Edwardsville (SIUE). The first-year courses form the foundation of the science curriculum, and approximately 1000 science and engineering students each year are introduced to nanoscale topics as a result of this project. The project also involves an annual one-day Teachers Exploring the Nanoworld (TEN) professional development workshop for high school science educators from Southwestern Illinois and the Metro East St. Louis Region. Teachers attending the workshop will be able to incorporate examples from nanoscience into their curricula, resulting in ?nano-aware? students feeding into colleges and universities. In addition to the local and regional impact, educational materials resulting from these efforts are broadly disseminated through the web-based Nanoscale Video Lab Manual and Nanoworld Cineplex of Movies, <http://mrsec.wisc.edu/nano>.

9:00 AM - 12:00 PM STEW 218AB

S10: Computation, Modeling and Molecular Visualization across the Chemistry Curriculum - Session 3 of 4

Richard Ulsh (Univ. Pittsburgh at Johnstown,), **Elisabeth Bell-Loncella** (University of Pittsburgh at Johnstown, USA)

This symposium will highlight the various ways faculty have used visualization, simulation, molecular modeling, mathematical software, and related computational methods to enhance and expand the learning experience in the undergraduate chemistry curriculum – in the classroom, in the laboratory, and in research. Papers describing specific activities for individual courses as well as department initiatives to integrate computation across the curriculum will be included.

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|-------|-------------------------|---|
| 9:00 | | introduction |
| 9:05 | Richard Ulsh | P437: When molecular orbitals call the shots |
| 9:25 | Ted O'Brien | P438: Computational chemistry projects as a component of advanced inorganic chemistry |
| 9:45 | Paul Seybold | P439: Agent-based models for teaching chemistry |
| 10:05 | Dave Finster | P440: Using computational chemistry to develop student research skills |
| 10:25 | | break |
| 10:35 | William Ilsley | P441: Application of computational methods in the undergraduate curriculum |
| 10:55 | Elisabeth Bell-Loncella | P442: Computation and molecular visualization across the chemistry curriculum at the University of Pittsburgh |
| 11:15 | Renee Cole | P443: Using Odyssey to encourage student visualization in chemistry |
| 11:35 | | discussion |

P437: When molecular orbitals call the shots

Richard Ulsh (Univ. Pittsburgh at Johnstown,)

The general approach to molecular orbitals in undergraduate chemistry classes tends to be from a

structural perspective. This project is designed to introduce junior/senior level physical chemistry students to ways of utilizing molecular modeling to visualize the influence of molecular orbital symmetry on conjugated pi system reactivity. Using CAChe software, students explore the role of frontier orbital symmetries in the simplest type of pericyclic reaction, the electrocyclic reaction involving the cyclization of a conjugate polyene. Of the two ways of inducing electrocyclic reactions, thermal and photochemical, the photochemical is the most revealing of the role of orbital symmetry as it changes the symmetries of HOMO and LUMO and thereby changes the reaction stereochemistry. Thus, this project aims to integrate the concepts of orbital symmetry, photochemical reactivity and stereochemistry using molecular modeling on a series of conjugated pi systems. A summary of student perceptions will be presented along with details of the modeling project.

P438: Computational chemistry projects as a component of advanced inorganic chemistry
Ted O'Brien (IUPUI, USA)

A computational chemistry project was added to the curriculum of the advanced undergraduate inorganic chemistry course offered at IUPUI. A list of projects illustrating topics ranging from ligand field theory to molecular structure and thermodynamics was developed. Students selected projects from the list, and carried them out using the Spartan '04 program. A written report about the project was required for a portion of the course grade. The reactions of the students to the assignment and its effectiveness in teaching concepts in inorganic chemistry were gauged with an anonymous survey of more than twenty students. Details of the projects, their development, and student feedback are all discussed.

P439: Agent-based models for teaching chemistry
Paul Seybold (Wright State University, USA)

Agent-based models have great potential for teaching students the principles governing the behaviors of complex chemical systems. This talk will describe cellular automata models illustrating first- and second-order reaction kinetics, phase transitions, and the partitioning of chemicals between different solvents. The models are visual, dynamic, and yield realistic portrayals of the actual molecular events. The customary differential equation-based solutions appear as limiting cases. Students are free to change conditions and observe the consequences, thereby encouraging "what if" in silico experiments.

P440: Using computational chemistry to develop student research skills
Dave Finster (Wittenberg University, USA)

The ease with which computational models of molecules can be constructed using commercial software allows students to pose questions and seek answers in a fashion not readily accessible some years ago. One particular example of this is a project-oriented exercise that has students develop questions about acid-base strength and then pursue an analysis using CAChe. The goal of the project is not so much to seek the "right answer" to a question, but rather to have the students consider how best to construct the question, how to design the calculations (including model selection) to answer the question, and then to critically review the quality of the results.

P441: Application of computational methods in the undergraduate curriculum
William Ilsley (Middle Tennessee State university, USA)

In 1999 we obtained a NSF Grant that provided funds to set up a computational lab for use in our

undergraduate curriculum. The lab was designed to provide the students with experience using a variety of software packages and different computational platforms. The packages provided are Gaussian03W, Spartan04, ChemOffice, CAChe Worksystem, RASMOL, and others, loaded on PCs, Macs, and SGI O2 Machines. Since the creation of the lab, the software provide in the lab has been used across much of our undergraduate curriculum. This presentation will highlight the various ways our faculty have utilized the software to enhance and expand student learning in the classroom, laboratory, and research.

P442: Computation and molecular visualization across the chemistry curriculum at the University of Pittsburgh

Elisabeth Bell-Loncella (University of Pittsburgh at Johnstown, USA)

Molecular modeling and simulation methods play a vital and growing role in modern chemical research. For example, as chemists, we translate the formula for water into a stick figure with one oxygen and two hydrogen atoms and use ball-and-stick “tinker toys” to represent the structure. However, such crude models cannot demonstrate relative size, the bond angles, or the distance between molecules. Computational software provides visualization capabilities, and also allows students to compute energies and molecular properties that are important in understanding chemical reactions. At the University of Pittsburgh, we have brought together chemistry faculty from the Johnstown, Pittsburgh and Titusville campuses to develop a coherent strategy for using modern computational chemistry software to enhance learning of chemical concepts, at all instructional levels. A series of objectives guided the implementation of this project: (1) provide training of both faculty and students; (2) develop targeted course activities; and (3) create a web site to act as a central distribution center for materials and to provide training for each new generation of students. The CAChe software package from Fujitsu, licensed by the University, is the central vehicle for this project. Selected examples of these projects are presented here.

P443: Using Odyssey to encourage student visualization in chemistry

Renee Cole (Central Missouri State University, USA)

The Odyssey computer program uses three-dimensional graphics and dynamics simulations in a range of activities to assist students in chemical visualization. Worksheets have been developed in a guided inquiry format to address specific activities within Odyssey. The use of these workshops with Odyssey is intended to help increase students' ability to visualize the particulate nature of matter and dispel common misconceptions. Misconceptions that have been targeted so far include intermolecular forces, covalent bonding and structure, phase changes, and acid strength. Questions that have been addressed with this project are a comparison of student interactions with the program with and without the use of worksheets and pairs versus individual work. Preliminary work has also been done analyzing the impact of the use of these activities on the development of spatial abilities and attitudes.

9:00 AM - 12:00 PM STEW 302

S44: General Chemistry: Improving General Chemistry Instruction Through Lab Practical Assessment - Session 1 of 1

Sherril Soman (Grand Valley State University, USA)

At the college level, general chemistry serves as an introduction to the techniques and scientific reasoning skills that students will use their entire chemistry career. Due to the hands-on nature of the lab experience, the lab practical is an appropriate method used to test students' acquisition of

requisite techniques and skills taught over the course of the semester. Presentations will address 1) lab practical assessment data related to students' conceptual understanding of laboratory techniques, 2) students' perceptions of the lab practical experience and 3) lab practical administration methods.

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|-------|-------------------|--|
| 9:00 | | introduction |
| 9:05 | Sherril Soman | P444: Using lab practical assessments to inform curriculum revision in General Chemistry |
| 9:25 | Laura Lee | P445: Assessment at mid-year: Lab practicals at the end of the first semester |
| 9:45 | Bobby Stanton | P446: Practical laboratory final exams featuring MeasureNet to assess student learning |
| 10:05 | Liz Gron | P447: How to recognize success and failure: Practical assessment of a new General Chemistry laboratory |
| 10:25 | | break |
| 10:35 | Katherine Bichler | P448: Use of a practical titration exercise to assess student learning in the General Chemistry laboratory |
| 10:55 | Jerry P. Suits | P449: Use of laboratory practicals in General Chemistry to assess high-level investigative skills |
| 11:15 | Robert Eierman | P450: Use of student-centered laboratory projects as assessment tools in General Chemistry |
| 11:35 | | panel discussion |

P444: Using lab practical assessments to inform curriculum revision in General Chemistry
Sherril Soman (Grand Valley State University, USA)

In 2002 the chemistry department conducted a major restructuring of its curriculum including content changes and an increase in the lab hours of the general chemistry sequence from two hours to three hours in order to enrich the lab experience for students enrolled in these general chemistry courses at GVSU. A statistical analysis was used to investigate the trends in performance on similar lab practical tasks under the old and new curricula. From the trends in data we identified tasks with significant changes in performance and matched those points with revisions made to the laboratory curriculum. This information was also used to inform further revisions to lab experiments in cases where the analysis did not show an improvement in student score. Assessment data and results from the lab practical will be presented in addition to examples of specific procedural modifications that were made based on these results.

P445: Assessment at mid-year: Lab practicals at the end of the first semester

Laura Lee (Lock Haven University of PA, USA), Kurt Rublein (Lock Haven University, USA)
We have administered a lab practical at the end of the first semester of general chemistry at Lock Haven University for the past five years. Our practical emphasizes measurement and laboratory skills. The rationale for adopting the lab practical, methods for administering the practical, and student perceptions of the practical will be presented. Correlation between scores on the lab practical and overall lab performance and performance in the class will be explored.

P446: Practical laboratory final exams featuring MeasureNet to assess student learning

Bobby Stanton (University of Georgia, United States), Lin Zhu (University of Georgia, United States)

During Fall semester 2005, we implemented Laboratory Practical Final Examinations into the General Chemistry laboratory curriculum to assess students' mastery of chemical concepts, basic laboratory techniques, and their ability to implement the scientific method. We observed some unusual patterns in students' abilities to perform certain types of laboratory techniques. For example, a majority of students were able to determine the concentration of an unknown acid via titration, but relatively few students were able to determine the concentration of an unknown base via titration. Understanding the reasons for these observed differences will allow instructors to enhance their students' laboratory learning experience.

P447: How to recognize success and failure: Practical assessment of a new General Chemistry laboratory

Liz Gron (Hendrix College, USA)

Hendrix College is in the thick of redesigning our introductory chemistry laboratories to teach green, analytical chemistry using environmental samples. Our new program is known as the Green-SWAT laboratories. It was important to us to include assessment as an integral part of the program so that we could monitor student achievement and subsequently make appropriate modifications to the program. We have collected data in the form of student self-assessment surveys, written and laboratory practical results as well as requiring students use standards to measure precision and accuracy of their results. The results from this data and methods of data collection are presented in context of the Green-SWAT program.

P448: Use of a practical titration exercise to assess student learning in the General Chemistry laboratory

Katherine Bichler (UW-Manitowoc, US)

The Chemistry Department of the UW Colleges has been actively involved in assessing student learning in the classroom for several years. Until last year, however, there was not a program in place to assess student learning in the laboratory sections of our courses. Because of that need and with the support and encouragement of the ACS Exams Institute, a prototype assessment tool for general chemistry laboratories was developed. The tool consists of a multiple choice portion which is based upon the ACS standardized exam format and a practical portion based upon the titration technique. In the practical portion of the assessment tool, students are presented with a problem (determine the concentration of a sulfuric acid solution) and a list of materials available to them. They are instructed to develop a procedure, carry out their procedure, and determine the concentration of the acid. While the multiple choice portion of this sort of exam is easy to evaluate and normalize, it is less obvious how one goes about quantifying the student results for the practical portion. Data from three semesters at various UW Colleges campuses will be presented, along with preliminary efforts to standardize the assessment and make it a more practical tool for wider use.

P449: Use of laboratory practicals in General Chemistry to assess high-level investigative skills

Jerry P. Suits (Univ Northern Colorado, United States), Sari A Suits (, United States)

Practical laboratory examinations can provide useful feedback regarding the quality of the laboratory experience and the extent to which students have learned laboratory techniques and

high-level investigative skills. The author has used this assessment format over a seven-year period to serve as the capstone experience for students at the end of the semester. When students are aware of this requirement throughout the semester, they tend to value and organize their laboratory reports, which can serve as “valuable resources” during the end-of-semester laboratory practical examinations. The examination begins with students reading a problem statement that is roughly similar to one of the experiments they have performed during the semester and writing a modified procedure to accomplish the objective. An evaluation rubric was developed to determine the levels of student competence on high-level investigative skills, such as student-written procedures, the quality of their observations, data and results, and their discussion of results.

P450: Use of student-centered laboratory projects as assessment tools in General Chemistry

Robert Eierman (UW-Eau Claire, USA)

Academic prompts and performance tasks are superior methods for assessing student understanding of complex material and skills. Laboratory projects in which students develop their own procedure to solve a problem have been used as assessment tools in several UWEC Chemistry courses. Students are required to apply concepts and techniques learned in previous laboratory experiments as well as lecture to successfully complete the projects. Projects have proven to be a challenging and stimulating activity for the students and an effective method for assessing student understanding. Several projects have been included in the laboratory of a redesigned general chemistry course. The design and implementation of the projects will be described along with the means by which student success is measured. The impacts of the projects on the laboratory program will be discussed.

9:00 AM - 12:00 PM STEW 318

S45: Peer-Led Team Learning (PLTL) - Session 1 of 2

Jack Kampmeier (univ rochester, usa), **Pratibha Varma-Nelson** (Northeastern Illinois University, US)

The goal of this symposium is to provide an opportunity for new implementers of the PLTL model to present their data, experiences with implementation of the model in their courses, and discuss the future of PLTL at their institutions.

| | | |
|-------|-------------------|---|
| 9:00 | | introduction |
| 9:05 | Steven Girardot | P451: Implementing PLTL for “At Risk” General Chemistry Students: Lessons Learned from a Pilot Program |
| 9:30 | Ayoni Akinyele | P452: Outcomes of Implementing PLTL in Chemistry for Health Sciences |
| 9:55 | Anne Bentley | P453: Peer-Led Team Learning in a Research-Based First-Year Laboratory Course: A Novel Implementation |
| 10:20 | Dustan Smith | P454: Preparation and Development of Peer Leaders for Lab and Their Interactions with Students |
| 10:45 | | break |
| 10:55 | Allen Schoffstall | P455: The LIONS Program: Using Peer Tutors to Improve Learning in Organic Chemistry |
| 11:20 | Teresa Eckart | P456: To Journal or Not to Journal - That is Not the Question: Fundamentals for Reflective Peer Leader Training |

P451: Implementing PLTL for “At Risk” General Chemistry Students: Lessons Learned from a Pilot Program

Steven Girardot (Georgia Institute of Technology, USA)

The Georgia Institute of Technology is a research-extensive university that specializes in STEM fields. Each fall, approximately 1400 freshmen (60% of the entering class) take General Chemistry. The course is taught in the large lecture format (approximately 200 students per section) and incorporates traditional recitations (with approximately 20-30 students each). Given the success of the Peer-Led Team Learning (PLTL) instructional model in General Chemistry programs at other institutions, a team of faculty from the School of Chemistry and Biochemistry and the Center for the Enhancement of Teaching and Learning (CETL) proposed to pilot PLTL in the Fall 2005 semester. The pilot involved offering one PLTL section (the experimental section) and one recitation section (the control section) taught by the same instructor. The recommended elements of the PLTL model were to be incorporated into the pilot with one major exception- only students predicted (based on high school records) to be “at risk” for poor performance in General Chemistry were invited to enroll in the workshop course. Out of the 368 invited students, 89 (24%) opted to enroll in the PLTL section. The evaluation of the pilot compared students in the experimental section with those “at risk” students (N = 84) in the control section. Two outcomes were examined: student performance (both letter grades and learning of content) and student attitudes. This presentation will discuss the results of this evaluation and the ramifications of restricting PLTL to “at risk” General Chemistry students.

P452: Outcomes of Implementing PLTL in Chemistry for Health Sciences

Ayoni Akinyele (Howard University, USA), Roland Byrd (Howard University, USA), Sharon Fletcher (Howard University, USA)

Students enrolled in Chemistry for Health Sciences courses are required to obtain a "C" or better in these courses in order to proceed to the clinical level in their academic careers. We were concerned because too many students fail to attain their maximum potential for learning the subject under the present traditional lecture/recitation method, resulting in poor grades and delays in moving forward. The impact on grades, retention, enrollment and learning gains during four semesters of implementing PLTL in these courses will be presented. Plans to ensure continued implementation and expansion of the program will be discussed.

P453: Peer-Led Team Learning in a Research-Based First-Year Laboratory Course: A Novel Implementation

Anne Bentley (Purdue University, USA), William Fornes (Purdue University, United States), Cianán Russell (Purdue University, United States), Pratibha Varma-Nelson (Northeastern Illinois University, US), Gabriela Weaver (Purdue University, USA), Donald Wink (UIC,)

As part of the Center for Authentic Science Practice in Education (CASPiE), a series of peer-led team learning (PLTL) workshops has been created to provide students with skills necessary to undertake scientific research. In this novel implementation of the PLTL model, students enrolled in the CASPiE laboratory course meet with peer leaders to discuss topics relevant to scientific research. Examples of workshop themes include proper laboratory notebook techniques, experimental design, working with data, scientific ethics, and the preparation of posters and abstracts. We have collected survey and interview data about CASPiE PLTL from peer leaders and

students. The application of these materials and this approach to a laboratory course is of particular interest since this is a new extension of the PLTL model. This presentation will introduce the workshop materials we have developed, describe the implementation of the workshops, and discuss the findings from our data about the success of the approach.

P454: Preparation and Development of Peer Leaders for Lab and Their Interactions with Students

Dustan Smith (Ball State University, United States), Marcy Towns (Ball State University, USA)
Since 1990, Peer Led Team Learning (PLTL) has been used to enhance the learning of undergraduate chemistry students in many classroom and recitation settings. In the past year, this PLTL concept has begun to be applied to a laboratory setting through the Center for Authentic Science Practice in Education (CASPiE). The CASPiE project is currently being conducted at several institutions with the support of a National Science Foundation grant (#0418902). In this presentation, implementation aspects for the CASPiE project at Ball State University will be presented. Particularly the training of peer leaders and their preparation for interactions with students conducting research in the general chemistry lab will be addressed.

P455: The LIONS Program: Using Peer Tutors to Improve Learning in Organic Chemistry

Allen Schoffstall (University of Colorado at Colorado Springs, USA), Larry Augenstein (University of Colorado at Colorado Springs, USA), Barbara Gaddis (UCCS, USA)
The Leadership in Organic Networking for Students (LIONS) Program is a peer-led team learning approach to learning organic chemistry. In the classroom, LIONS were paired with groups of organic chemistry students to work on challenging exercises during eight different class periods over the sixteen-week semester. In addition to facilitating problem-solving sessions in the classroom, the LIONS met their students outside the classroom, for individual and group tutoring sessions, sponsored by the Science Learning Center. In this presentation, we will present examples of LIONS exercises, discuss learning outcomes of the project, and suggest ways to implement this project in large lecture courses.

P456: To Journal or Not to Journal - That is Not the Question: Fundamentals for Reflective Peer Leader Training

Teresa Eckart (USF, USA), Jennifer Lewis (University of South Florida, United States), Pratibha Varma-Nelson (Northeastern Illinois University, US)

Research demonstrates that students and teachers benefit from reflective practice, and journaling has been found to be effective for promoting reflective practice in a variety of disciplines. Peer leaders are typically asked to produce reflective journal entries about their ongoing experiences as peer leaders. For trainers of peer leaders, these journals provide a window into the development process and therefore inform training decisions. This paper presents the results of an investigation into the contents of peer leader journals from two different universities in the United States. Journals range in style and format from simple accounts of what happened during a peer leading session to complex analyses that include suggestions for changes in practice. Some journals describe struggles with affective issues, with both the peer leader's own feelings and their impressions of the emotions of the students in the teams they lead as part of the discussion. A qualitative analysis of these diverse journals answers questions such as: What can be learned from reading peer leader journals? How can these journals be utilized by others in the future? What do journals reveal as relevant issues for the training of peer leaders? In addition to answering the

above questions, this paper provides samples and templates to use for different journal writing assignments so that those responsible for peer leader training can tailor journal assignments as desired.

9:00 AM - 12:10 PM STEW 310

S46: Physics Education Research for Chemistry Instructors: Facing Joint Challenges and Practical Concerns - Session 1 of 2

Tom Greenbowe (Iowa State University, USA)

Chemistry educators and physics educators are concerned with many of the same issues about teaching and learning science. Physics education researchers have carried out systematic discipline-based studies of student learning. These studies incorporate a theory base, a careful collection and analysis of data, and interpretation of results that can be generalized. These investigations have revealed a wide gap between the objectives of most physics instructors engaged in traditional forms of instruction and the actual level of conceptual understanding attained by the majority of their students. This symposium provides an opportunity for physics education researchers to share the advances that have been made in their field with chemistry educators.

| | | |
|-------|-------------------|--|
| 9:00 | | introduction |
| 9:05 | Peter Shaffer | P457: Improving student learning K-20+: The role of discipline-specific research |
| 9:35 | Ronald Thornton | P458: Effective Methods for the Use, Creation, Analysis, and Interpretation of Short Answer Conceptual Evaluations |
| 10:05 | Nancy Grim Hunter | P459: Teacher Quality Enhancement: Lessons Learned from the Force Concept Inventory |
| 10:25 | | break |
| 10:35 | Rebecca Lindell | P460: A Classification Scheme for Categorizing Concept Inventories |
| 10:55 | David Meltzer | P461: Investigations into student learning of thermodynamics |
| 11:25 | John Thompson | P462: Investigating Upper-Division Student Understanding of Thermal Physics |

P457: Improving student learning K-20+: The role of discipline-specific research

Peter Shaffer (University of Washington, US)

Systematic investigations reveal that many students emerge from traditional introductory (and often more advanced) physics courses without having developed a coherent conceptual understanding of some important basic topics. Insights from such research can help guide instruction to improve student learning as well as inform the preparation of graduate teaching assistants and K-12 teachers. Specific examples that have implications for other science disciplines will be used to illustrate this process.

P458: Effective Methods for the Use, Creation, Analysis, and Interpretation of Short Answer Conceptual Evaluations

Ronald Thornton (Tufts University, USA)

Carefully constructed short answer or multiple choice conceptual evaluations can be very valuable as a means to evaluate student learning and thus curricular changes. They are also relatively easy to misuse and very difficult to construct. I will discuss important considerations when using, creating, analyzing, and interpreting such evaluations relevant to any science. A short case study, taken from physics, comparing the Force Concept Inventory and the Force and Motion Conceptual Evaluation will be given and the two evaluations will be compared as a basis for discussion. *This work was partially funded by the NSF and by The Fund for the Improvement of Postsecondary Education (FIPSE, US Department of Education).

P459: Teacher Quality Enhancement: Lessons Learned from the Force Concept Inventory
Nancy Grim Hunter (Chicago State University, USA)

The Teacher Quality Enhancement Project was founded to develop and sustain professional development opportunities for higher education faculty at the community college and university level in order to promote systemic reform in teacher preparation. This paper will explore the lessons learned when the Force Concept Inventory was used to explore best practices issues between teacher preparation candidates and traditional physics majors.

P460: A Classification Scheme for Categorizing Concept Inventories
Rebecca Lindell (Southern Illinois University Edwardsville, USA)

Since the development of the Force Concept Inventory (FCI), there has been a heightened interest in developing other concept inventories to assess students' understanding of a phenomena. As more and more of these instruments are created, it must be made self-evident to test users that not all tests are created equal. We claim that there are three non-overlapping types of concept inventories and that the Science education research communities have an obligation, through peer review, to label any concept inventory as one of these three types of tests: (1) Local Tests, (2) Efficacy Tests, and (3) Diagnostic Instruments. We propose these distinctions based on differences in their development methodology. In this talk we will present evidence for this new classification scheme, as well as provide an analysis of the FCI.

P461: Investigations into student learning of thermodynamics
David Meltzer (University of Washington, United States)

Recent research into student learning of thermodynamics has helped to identify certain common learning difficulties faced by most students in introductory courses. These difficulties are related to basic concepts prominent in both physics and chemistry courses, such as energy, heat, work, entropy, and the laws of thermodynamics. I will discuss some of this research, along with pedagogical strategies that are being developed to address students' learning difficulties. I will emphasize the ways in which our findings are relevant to instruction in college chemistry courses.

P462: Investigating Upper-Division Student Understanding of Thermal Physics

John Thompson (University of Maine, United States), Brandon Bucy (University of Maine, United States), Donald Mountcastle (University of Maine, United States)

In research on the teaching and learning of upper-level (junior-senior) thermal and statistical physics, we are probing student understanding of topics taught in physics and chemistry at the introductory level (e.g., work, heat, the first and second laws of thermodynamics, entropy) as well as in more advanced courses (e.g., thermodynamic potentials, the Maxwell relations, chemical potential). Many of our preliminary findings are consistent with prior work at the introductory

level (1,2), however we find some differences for 2nd law topics. Our research also deals with student functional understanding of mathematical concepts applied in the context of thermal and statistical physics (e.g., path integrals, partial differentiation, probability). We present data from written responses and individual interviews from physics and physical chemistry students. Finally, we discuss the development of instructional materials to address specific difficulties found in our research. 1. M.E. Loverude, C.H. Kautz, and P.R.L. Heron, Am. J. Phys. 70, 137 (2002). 2. D.E. Meltzer, Am. J. Phys. 72, 1432 (2004). Supported in part by NSF grant PHY-0406764.

9:00 AM - 12:00 PM STEW 218CD

S22: POGIL: Process-Oriented Guided Inquiry Learning - Session 3 of 4

Rick Moog (Franklin and Marshall College, USA)

POGIL is a student-centered instructional paradigm that combines a group learning approach with specially designed guided inquiry activities. The goal is to not only enhance student mastery of course content, but also to develop important learning process skills such as communication, problem solving, and critical thinking. This symposium will include presentations dealing with the implementation and evaluation of this approach across a wide array of disciplines and institutional types and levels.

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|-------|------------------|--|
| 9:00 | Katie Amaral | P463: Transitioning POGIL from Large to Small Classes |
| 9:20 | Hae-Won Kim | P464: POGIL in a Learning Community at Penn State Abington College |
| 9:40 | Maryann M. Jones | P465: Trials and Tribulations of Introducing a Modified POGIL Introductory Chemistry Lab Program at a Large State University |
| 10:00 | James Wheeler | P466: Critical Thinking in the Laboratory |
| 10:20 | | break |
| 10:30 | Cheryl Coolidge | P467: Using Spreadsheets for Inquiry Based Learning |
| 10:50 | Steve Wright | P468: Blending A Data-Driven Approach with POGIL: An Attempt to Infuse Critical Thinking Into the Chemistry Classroom. |
| 11:10 | David Reichgott | P469: POGIL Implementation: Diversity, Classroom Tactics and Heresies |
| 11:30 | | discussion |

P463: Transitioning POGIL from Large to Small Classes

Katie Amaral (Penn State Berks, USA)

A POGIL approach to general chemistry had been used successfully at a large southeastern university by the author. In the transition to a smaller, teaching-centered environment, unexpected difficulties were encountered. Primary among these were differences in student and instructor expectations of a collaborative process. Overcoming student resistance to a new form of collaborative learning and other issues encountered during the transition will be discussed.

P464: POGIL in a Learning Community at Penn State Abington College

Hae-Won Kim (Penn State Abington, USA)

The POGIL approach was applied to a 1st semester general chemistry course in an interdisciplinary Learning Community including a math and a 1st year seminar course. Freshmen students without math prerequisites are normally delayed by a semester or a year in taking major's chemistry. We created a one semester Learning Community to enable these students to start freshman chemistry without delay. The performance of the group was on par with those students who met the math prerequisites.

P465: Trials and Tribulations of Introducing a Modified POGIL Introductory Chemistry Lab Program at a Large State University

Maryann M. Jones (University of Maryland, USA)

In the Fall of 2005, as part of a newly structured introductory general/organic chemistry course sequence, the Introductory General Chemistry lab program was rewritten to incorporate modified elements of the POGIL approach. The new curriculum was taught in 39 sections of up to 24 students each, most in a conventionally arranged laboratory setting, by 24 different teaching assistants, six of whom were non-native English speakers. Difficulties with the collaborative approach itself were found to be related to the limitations of both the physical setting and cultural and attitudinal resistance of teaching assistants to the "guide" role of the lab instructor, as well as language-related communication problems. In addition, the wording of Team Discussion and follow-through questions posed in the exercises were identified as sufficiently ambiguous to further complicate the communication needed to foster student-developed concept mastery. To address these difficulties two changes were made for the Spring 2006 semester. A pilot TA-mentoring program was put in place to assist TAs' comfort level with the POGIL approach by modeling appropriate POGIL student-instructor interactions and identifying ways to engage students in the process. In addition, discussion and application questions for at least two of the experiments were restructured to more directly address the concepts involved. Preliminary results of these modifications will be reported.

P466: Critical Thinking in the Laboratory

James Wheeler (Rockhurst University, USA)

The POGIL approach as part of the lecture material in first year college chemistry course successfully promotes serious critical thought and effort on the part of the students, in a way that most of them have never experienced before. The published material is not directly aimed at laboratory experiments. I have written material for two experiments (2 lab periods each). I use the POGIL material as the laboratory preparation. The material is centered around the laboratory directions.

P467: Using Spreadsheets for Inquiry Based Learning

Cheryl Coolidge (Colby-Sawyer College, USA)

The use of a spreadsheet module can enhance the power of an inquiry based activity. A spreadsheet module based on a POGIL activity introducing the concepts of chemical equilibrium was created following the guidelines of the NSF grant "Spreadsheets across the Curriculum". This module provides opportunity for students to make and test predictions, allowing them to solidify and enhance their conceptual understanding of equilibrium and its relationship to kinetics. Preliminary results and student responses to the use of this module will be presented in this paper.

P468: Blending A Data-Driven Approach with POGIL: An Attempt to Infuse Critical

Thinking Into the Chemistry Classroom.

Steve Wright (University of Wisconsin-Stevens Point, USA)

In an attempt to help students develop their habits of critical thinking, a data-driven approach, in which students are first presented with data and then asked to construct understanding of chemical concepts, has become the predominant strategy in my classroom. Inspired by a POGIL workshop, I now try to combine the data-driven approach with guided inquiry. I've begun to write student worksheets that, I hope, will help students expand their understanding of chemistry, while developing habits of critical analysis. In parallel with these worksheets, I'm attempting to create a student support manual that reinforces the processes used during class. I intend to present an example or two of the worksheets, accompanying support materials and talk briefly about past efforts, successes and failures.

P469: POGIL Implementation: Diversity, Classroom Tactics and Heresies

David Reichgott (Cascadia Community College, USA)

Come prepared to share your experiences with implementing POGIL in the classroom. The author will present experiences with implementing POGIL over a six-year period among diverse students at community colleges, and some heretical methods that have had great success at this level. Implementation tactics include adaptation to diverse learning styles, students of diverse background preparation, non-native speakers, students of non-Western societies, and implementation using an interlaced POGIL / lecture format.

9:00 AM - 12:00 PM STEW 214B

S47: Polling Systems in College Chemistry Classes - Session 1 of 2

William Donovan (The University of Akron, USA)

This symposium will include papers discussing the use of polling systems (aka "clickers") in college chemistry classes. Presenters will present results regarding the effects of the polling systems on student attitudes and learning, as well as to share best practices in the use of the systems.

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|-------|---------------------|--|
| 9:00 | | introduction |
| 9:05 | William Donovan | P470: ConcepTest implementation in first-year chemistry courses using a polling system |
| 9:25 | Barbara Gaddis | P471: The three Cs of learning: Conceptualizing, collaborating, and clicking |
| 9:45 | Wayne Wesolowski | P472: Darth Clicker or Luke Responder? The two sides of classroom personal polling devices |
| 10:05 | | break |
| 10:10 | Keith Walters | P473: Using polling systems in general chemistry: Do you get it yet? |
| 10:30 | Daniel Lewicki | P474: The effect of a personal response system on student achievement in general chemistry and science methods |
| 10:50 | Margaret Asirvatham | P475: CRS: Teaching students how to learn using a formative assessment tool |
| 11:10 | | break |
| 11:15 | Nihal Kaissieh | P476: The effect of using tutorials and clickers on students' understanding |

in general chemistry

11:35 Suzanne Ruder P477: Classroom polling devices as a means of student engagement
11:55 discussion

P470: ConcepTest implementation in first-year chemistry courses using a polling system

William Donovan (The University of Akron, USA)

We have implemented conceptests in freshman chemistry classes including the mainstream general chemistry and the GOBC course serving nursing majors. We have experienced increased student engagement and involvement in lecture and improved attendance and attitudes. This paper will discuss the implementation and our findings pertaining to attendance, student attitudes, and student learning.

P471: The three Cs of learning: Conceptualizing, collaborating, and clicking

Barbara Gaddis (UCCS, USA), Margaret Asirvatham (University of Colorado-Boulder, U.S.A), Larry Augenstein (University of Colorado at Colorado Springs, USA), Allen Schoffstall (University of Colorado at Colorado Springs, USA)

Electronic Response Systems (clickers) have been widely incorporated into chemistry and other classrooms to provide the interactivity and timely feedback that can be otherwise difficult in large lecture classrooms. Surveys of our students show that students like using the clickers, come to class more regularly, and rate classes that use clickers as being more interesting. But clickers can also be used for just-in-time learning, to foster collaboration, to administer tests, and to measure deeper conceptual understanding. In this presentation, we will explore the traditional and non-traditional ways that clickers are being used in the University of Colorado system. We will also present examples of conceptual questions from the database and discuss a longitudinal study of clicker use on student satisfaction and learning.

P472: Darth Clicker or Luke Responder? The two sides of classroom personal polling devices

Wayne Wesolowski (University of Arizona, USA)

Both RF (radio frequency) and IR (infrared) personal response devices were used for polling during three semesters. Classes ranged from over 300 in General Chemistry to Physical Chemistry to groups of visitors at the University of Arizona. The pros and cons are discussed for registration, distribution, lecture use vs. discussion groups, time management, student enthusiasm, information acquisition vs. improved learning, a learner-centered educational asset vs. a “gadgetphile nerd’s toy.” Two of the author’s General Chemistry large lecture classes are compared--one with responders and one without.

P473: Using polling systems in general chemistry: Do you get it yet?

Keith Walters (Northern Kentucky University, USA)

This paper summarizes the experiences of the author with classroom polling/clicker systems in the Northern Kentucky University general chemistry courses. The experience has greatly enhanced the educational experience of the author's lecture sections, as detailed by student feedback. Usage of the system, sample questions, alternative mechanisms, and incorporation into the course grade will be addressed.

P474: The effect of a personal response system on student achievement in general chemistry and science methods

Daniel Lewicki (The Sage Colleges, USA)

The purpose of this study was to investigate the effect of an interactive, electronic personal response system (PRS) on achievement and attitudes of students enrolled in General Chemistry and a Science Methods course for pre-service teachers. Sets of topic-specific questions were used to test knowledge, comprehension, analysis, application, synthesis and judgment prior to, during, or at the conclusion of a presentation. Students were asked to answer individually or discuss their answers with a “lecture” partner and to submit the answers using the PRS. Immediate feedback was provided to both instructor and students. Results of the effect of the feedback program on student achievement and attitudes will be discussed.

P475: CRS: Teaching students how to learn using a formative assessment tool

Margaret Asirvatham (University of Colorado-Boulder, U.S.A)

Classroom response systems (CRS) have been used in large first-semester general chemistry classes for three years. The real-time feedback has been beneficial in designing questions to provoke discussion, to facilitate learning, to address visualization skills, and to encourage students to take advantage of the rich graphics in current freshmen textbooks. In this presentation, we will examine some of the challenges in teaching freshman chemistry and the rewards of using a formative assessment tool.

P476: The effect of using tutorials and clickers on students' understanding in general chemistry

Nihal Kaissieh (ISU, USA)

This Study examined the effect of using tutorials in general chemistry recitations; comparing the use of tutorials to the end of chapter problems, to determine whether using tutorials improved students' performance on quizzes and exams, as well as their chemistry conceptual understanding. The subjects for this study were students enrolled in general chemistry courses at two universities. Students at the beginning of the course took the California Diagnostic Exam to set basis of comparison among the students. The recitation sections were randomly divided into A, B and C groups. Prior to the first exam, students in group A were administered tutorials, students in group B used clickers, while students in group C did comparable homework exercises. Prior to the next exam, students in group C were administered tutorials while students in group A did comparable homework problems. Students' performance from each group was compared by studying questions (both conceptual and algorithmic) on quizzes, hour exams and the final exam.

P477: Classroom polling devices as a means of student engagement

Suzanne Ruder (Virginia Commonwealth Univ., USA)

Classroom polling devices have been used effectively in chemistry classes ranging from 50-300 students at Virginia Commonwealth University. Use of the classroom polling devices was found to enhance student engagement and increase attendance throughout the semester. Additionally, in-class group work with large lecture classes could be more easily managed using the devices. In a typical 50-minute lecture period, approximately 3-4 questions were presented. Introduction of a concept was followed by a question that required use of the concept just covered. Immediate feedback was available to both the student and the instructor on student comprehension of the topic under discussion. Lectures could thus easily be adjusted based on responses to the questions posed. Students using the devices were more actively involved in learning the material and were overall very positive in response to using the devices. Details on the use and assessment of the classroom

polling devices will be presented.

9:00 AM - 12:00 PM STEW 306

S4: Research in Chemical Education - Session 6 of 6

Diane Nutbrown (University of Wisconsin - Madison, USA), **Christopher Bauer** (Univ. of New Hampshire, USA)

This symposium, sponsored by the CHED Committee on Chemical Education Research, is a forum for research conducted on the teaching and learning of chemistry at any level. Presentations will address: 1) the motivation for the research and the theoretical bases in which it is grounded, 2) the methods used to gather and interpret data, and 3) the findings and their significance interpreted in light of theory and method. Authors are being strongly encouraged to bring copies of an extended abstract to share with the audience.

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|-------|---------------------|--|
| 9:00 | Randall Robinson | P478: Research faculty's view of undergraduate researchers |
| 9:20 | Jason Steward | P479: Am I a scientist? REU students' understanding of science and scientists |
| 9:40 | Guy Ashkenazi | P480: Personal epistemology and student resistance to interactive lecture demonstrations |
| 10:00 | | break |
| 10:10 | Shanna Daly | P481: Attitude-affecting components in the general chemistry laboratory and their relationship to informal environment characteristics |
| 10:30 | Hannah Sevian | P482: An instrument for evaluating how effectively scientists explain their research |
| 10:50 | George Bodner | P483: Purdue's Energy Center educational research program |
| 11:10 | | break |
| 11:20 | Daniel Domin | P484: Cultural understanding and disenfranchisement among chemistry majors |
| 11:40 | Gregory Durland | P485: Caucasian men in chemistry: Where are they and why did they go there |

P478: Research faculty's view of undergraduate researchers

Randall Robinson (Arizona State University, USA), Janet Bond-Robinson (Arizona State University, USA), Amanda Cunow (Arizona State University, USA)

Research Faculty's View of Undergraduate Researchers In developing a program for first and second year students in undergraduate research we have identified factors affecting the inclusion of this group by research advisors. We have investigated what research directors believe is possible for these relatively inexperienced students in the research lab. A questionnaire was prepared and taken to the faculty in the chemistry department and chemistry related departments at a "Research 1" university. The semi-scripted interviews were recorded. While detailing their experience with undergraduates the faculty members were questioned concerning what they believed is necessary for a younger student to have an optimal experience and for the PI and the PI's group to achieve a maximum benefit. A careful review of the responses facilitated our proposal of a program, which

will place interested and motivated first and second year students into research groups and follow their professional and personal development through the remainder of their undergraduate research careers. The results from our questionnaire will be presented. How the results dictated the design of our program will also be discussed.

P479: Am I a scientist? REU students' understanding of science and scientists

Jason Steward (Purdue University, USA), *Gabriela Weaver* (Purdue University, USA)

Research experiences for undergraduates (REU) programs are used to provide students with first-hand experiences of how scientists, especially those in the academic setting, operate within research labs on a day-to-day basis. Students are quickly immersed into the process of research, working closely with graduate and post-doctoral students. Those selected from a pool of applicants presumably possess the highest potential for success in graduate school based on their performance as undergraduates. As these students continue their careers from students to practitioners, how do they view scientists and science at this early stage? What role do they think they play within science? This talk will describe the views of participants who took part in a summer-long Chemical Biology REU program.

P480: Personal epistemology and student resistance to interactive lecture demonstrations

Guy Ashkenazi (Hebrew University of Jerusalem, Israel), *Rachel Zimrot* (The Hebrew University of Jerusalem, Israel)

Many student-centered instruction initiatives encounter resistance by students, who prefer traditional lecture format. This paper relates students' attitudes towards a constructivist teaching method to their personal epistemology. A qualitative study was conducted on a sample of students who participated in an Interactive Lecture Demonstration enhanced general chemistry course. The sample consisted of 15 students, all of which explicitly expressed an interest in understanding the course material. However, personal interviews revealed different implicit definitions of what 'knowing' and 'understanding' means to them. We identified three distinct types of personal epistemologies, and then correlated each epistemology with attitudes towards constructivist elements in the teaching method - disequilibrium, interactive engagement and context-dependent assertions (rather than absolute "truths"). This led us to introduce minor changes to the teaching method, which resulted in a pronounced shift in students' attitude towards the teaching method.

P481: Attitude-affecting components in the general chemistry laboratory and their relationship to informal environment characteristics

Shanna Daly (Purdue University, USA), *George Bodner* (Purdue University, US)

Research on the topic of student attitudes in the general chemistry laboratory has explored the effect on student attitudes of specific components of the laboratory experience, but none have provided students with the open-ended opportunity to discuss their attitudes and the factors that influence those attitudes. The NSTA and other literature sources categorize science laboratories as informal learning experiences. Student attitudes about the chemistry laboratory were therefore compared with student attitudes about another informal science learning environment—the science museum, in hopes of shedding additional light on the situation. This presentation will include a discussion of the phenomenographical categories generated, encompassing student-said attitude-affecting components in the undergraduate chemistry laboratory, and compare those categories with characteristics of informal learning experiences and undergraduate student responses to a science museum visit.

P482: An instrument for evaluating how effectively scientists explain their research

Hannah Sevian (University of Massachusetts Boston, USA)

We present a rubric we developed for assessing the quality of scientific explanations by science graduate students. The rubric was developed from a study that explored science graduate students' abilities to explain their own research to an audience of non-scientists. We find that scientists are more effective at explaining science when they have some training in pedagogy. Improved explanations of science by scientists, some of whom become professors, would lead to better teaching of science at the university level. This would, in turn, improve retention of qualified and diverse scientists. Our rubric is useful as an instrument to help evaluate scientific explanations because it distinguishes between the content knowledge and pedagogical knowledge of scientists, as well as a scientist's ability to integrate the two in the service of a clear and coherent explanation of his or her research. It is also generally useful in evaluating, or self-evaluating, science explanations by science professors and researchers, graduate students preparing to be scientists, science teachers and pre-service teachers, as well as students who are explaining science as part of learning.

P483: Purdue's Energy Center educational research program

George Bodner (Purdue University, US), **Shanna Daly** (Purdue University, USA)

The Energy Center recently established at Purdue University consists of multidisciplinary teams investigating such topics as clean coal, hydrogen energy systems, and the future of nuclear energy. The problems investigated by those at the Energy Center rely on expertise from a variety of fields, including chemistry, engineering, physics, biology, economics, and political science. The public does and will play a major role in the successful societal integration of discoveries made at the Energy Center, and public misconceptions that already exist in the energy arena hinder this integration. One of the broad objectives of the Energy Center is to address these misconceptions and effectively educate the public on advances in the energy industry, supporting the transition from fossil fuels to bio, solar, wind, and nuclear energy sources. This presentation will discuss some aspects of Energy Center educational research, specifically focusing on chemistry and engineering education components.

P484: Cultural understanding and disenfranchisement among chemistry majors

Daniel Domin (Tennessee State University, USA)

A qualitative investigation was undertaken to explore students' and faculty's perceptions of the quality of chemistry programs at historically black colleges and universities. The methodology included surveying and interviewing both faculty and students at four different institutions. Across all four institutions, 187 lower-division undergraduate students completed surveys assessing their learning styles, attitude and efficacy with respect to chemistry and non-cognitive factors including self-concept, leadership ability, and self-appraisal. Upper-division students (n = 16) and faculty (n = 10) completed surveys that assessed their perception of the strengths and weaknesses associated with their respective chemistry programs. Semi-structured interviews were conducted with both upper-division undergraduates (n = 10) and faculty (n = 6). Analysis of upper-division undergraduate surveys and transcripts from interviews indicate that although the majority of chemistry majors are overall satisfied with the education and preparation they are receiving, there exists a fraction of students who have become disenfranchised with their educational experience. The data from this study suggest that a key contributor to this feeling of disenfranchisement is the

inability of these students to develop a conceptual understanding of the cultural dynamics within their chemistry program.

P485: Caucasian men in chemistry: Where are they and why did they go there

Gregory Durland (Purdue University, United States), George Bodner (Purdue University, US)
According to the 2002 NSF compilation of data on new Ph.D. graduates, the number of chemistry graduates continued its decrease for the fourth year in a row. The most dramatic change has been the plunge in the number of Caucasian male U.S. citizens earning chemistry Ph.D. degrees. In 1970 more than 1,500 Caucasian men earned their Ph.D. degrees in chemistry, while in 2002 only 636 reached this mark. This sharp decline and the fact that I myself am a Caucasian male working toward a Ph.D. in chemistry, has sparked my interest in the following research questions: 1) Why is there a decline in Caucasian male Ph.D. graduates in chemistry? 2) What can we, as educators, do to curtail this decline? In this presentation, I will discuss a research design to explore these questions and a review of the literature related to this topic.

9:00 AM - 12:00 PM STEW 214A

S48: Service-Learning in Chemistry - Session 1 of 2

Susan Suthaimer (Green Mountain College, USA)

The pedagogy of service-learning links the classroom to the community using a service component embedded within the course. Presenters will share examples of exemplary service-learning projects in chemistry, information on finding and working with community partners, ways to encourage chemistry faculty participation, and similar topics related to service-learning in chemistry.

| | | |
|-------|------------------|---|
| 9:00 | | introduction |
| 9:05 | Michael Thompson | P486: Using service-learning to facilitate K-12 outreach: A way to engage, develop, and teach K-12 science and engineering students |
| 9:25 | Melissa Strait | P487: Out of the lab and into the field: Using a real-world site for instrumental analysis |
| 9:45 | Jay Brown | P488: Lead testing in area grade schools: An example of service-learning |
| 10:05 | Tamera Jahnke | P489: Service-learning in chemistry : Minors only? |
| 10:25 | | break |
| 10:35 | Susan Suthaimer | P490: Simplifying strategies for service-learning |
| 10:55 | Bryan May | P491: Environmental water studies: Connecting students to the community |
| 11:15 | Maria Pacheco | P492: Service-learning in general chemistry : A collaborative effort |
| 11:35 | | discussion |

P486: Using service-learning to facilitate K-12 outreach: A way to engage, develop, and teach K-12 science and engineering students

Michael Thompson (Purdue University, USA)

Chemistry and engineering educators face many challenges in designing first year programs and outreach programs for K-12 students. First-year chemistry/science and engineering students need real experiences to allow them to gain an appreciation for chemistry/science and learn to address large and open-ended problems. Pre-college students need opportunities to learn about and even

experience chemistry/science and engineering. Students also need programs that address recruitment and retention. In 2003 the Department of Chemistry and Engineering Education at Purdue University began a partnership to address both the needs of pre-college and first-year engineering students. First-year chemistry/science and engineering students in a multi-cultural learning communities partner with an outreach program, Science Bound, which works with junior and senior high school students from a large urban school system. This partnership uses a service-learning model to engage the first-year university students with the high school students that is meaningful for both groups. 120 students from chemistry/science and engineering over 200 junior and senior high students, from 8 urban schools have participated in this program. This paper will focus on the chemistry/science aspect of the K-12 outreach program and the experiences of both the first-year college and high school students. Both qualitative and quantitative assessments of will be reported and have shown initial success.

P487: Out of the lab and into the field: Using a real-world site for instrumental analysis

Melissa Strait (Alma College, United States)

Instrumental Analysis at Alma College is the course in which chemistry majors do disciplinary-oriented writing as required by the college. In a desire to integrate the lab experiments as well as connect the lab to the real world, a service-learning project was added. A local gun club had asked if the college had anyone interested in evaluating lead contamination at their site. This has formed the core around which the project in the instrumental analysis lab revolves. We spend several weeks learning to measure lead using a variety of instrumentation, and writing lab reports that evaluate the operation of the instrument and how well it performs in the analysis of lead. At the same time the students are writing a proposal to an “funding agency” to solve a problem associated with lead at the gun club. Now in its third year, the students have done a surface survey, shallow coring and an analysis of the fish in the lake on the property. The results have been presented at a “conference” to an audience consisting of interested members from the gun club. The results have also been used by the gun club as a guide in their recent remediation of the trap and skeet area. The students get to see a the direct consequences of their analysis and also get to interact with a community outside the very narrow, isolated college community.

P488: Lead testing in area grade schools: An example of service-learning

Jay Brown (Southwest Minnesota State University, USA)

This presentation outlines a successful outreach program in which undergraduate research students provided a free lead testing service to area grade schools using anodic stripping voltammetry (ASV). Drinking water sample kits were mailed to participating grade school science classes. The water samples were then returned to our university for analysis by trained undergraduate research students. Training included ASV theory and practice, cleaning procedures, the standard addition method, detection limit calculations, and error propagation. A final report, all voltammograms, and an instruction sheet were then sent to the corresponding grade schools so that science classes could analyze the data for themselves. The lead-testing results were presented by our undergraduate students during Spring National Meetings of the American Chemical Society. The students were also required to provide an oral presentation at our annual Environmental Chemistry Conference. We invited all participating science class to attend the conference, tour our facilities, and see an ASV analysis first hand. Over the years, this project has grown to include approximately 30 science classes from throughout the state of Minnesota. Based upon the results, we would like to encourage similar projects at other universities.

P489: Service-learning in chemistry : Minors only?

Tamera Jahnke (Missouri State University, USA)

A service learning program was developed in 1997 at Missouri State University to offer opportunities for students. The Department of Chemistry developed and offered their first service learning course in 1998. Over the past eight years only two students out of the many who have completed the course have been chemistry majors and the others have all been chemistry minors. An analysis of student motivations will be presented including the results of a campus-wide research analysis of student motivation and participation in service learning courses. The course syllabus and a list of community partners will be shared. An analysis of the journals and reflection papers indicate that students learn an appreciation for chemistry outside the classroom and their communication skills are greatly enhanced through this experience.

P490: Simplifying strategies for service-learning

Susan Sutherland (Green Mountain College, USA)

Chemistry faculty face several impediments to using service-learning in their classrooms. These include lack of community partners who have needs relevant to chemistry classes, the need to meet expectations by community partners that exceed the scope of the course, the need to meet requirements in the chemistry curricula relating to course content, and concerns about extra time required by faculty to prepare for such innovative classes. Such concerns can be addressed by using strategies that simplify the implementation of service-learning projects. Projects need not be long or complex, may utilize non-traditional community partners and topics, and may take very little class time. This presentation will look examples that utilize these and other innovative strategies for implementing service-learning in chemistry courses.

P491: Environmental water studies: Connecting students to the community

Bryan May (Central Carolina Technical College, US)

First semester general chemistry students study environmental water samples from the community. Student teams first develop their own measurement protocols. The teams then select water systems in the community to study. Data is collected over the course of the semester and the overall water quality is determined. When teams identify poor water quality parameters they are expected to devise methods to further study and then explain their findings. Teams present their findings to their class and to appropriate stakeholders from the community.

P492: Service-learning in general chemistry : A collaborative effort

Maria Pacheco (Buffalo State College, USA)

Students in the second half of the general chemistry sequence were involved in the soil analysis of various community gardens in Buffalo, NY. The project was a collaboration between Buffalo State's Volunteer and Service Learning Center, Buffalo's West Side Coalition and the Geography and Planning Department. The data obtained will be used in the generation of a socio-economic map of the city's West Side. This paper will present the logistics of the project as well the impact on the students' attitudes towards service learning and chemistry.

9:00 AM - 12:00 PM STEW 322

S49: Teaching Students About Copyright and Plagiarism - Session 1 of 1

Bartow Culp (Purdue University, USA), *Leah Solla* (Cornell University, USA)

All undergraduate chemistry majors have writing assignments in their classes and many are doing research. They should learn now about copyright and plagiarism and why they are important. In their education and work, how do they respectfully interact with copyrighted materials, especially internet resources? When is it okay to cite a work and when is permission to use required? How is their own work protected as intellectual property? This symposium will cover copyright basics in the academic community and provide examples of how to incorporate awareness and understanding of these issues into the chemistry curriculum.

9:00 Donna Ferullo P493: Copyright reality in academe
9:40 Eric Slater P494: Copyright 101
10:20 break
10:30 Marina Koether P495: Chemistry career seminar
10:55 Bozena Widanski P496: Using collaborative efforts to teach students about plagiarism
11:20 Jennifer Sharkey P497: Cyberplagiarism: the ruse of a new era or an old issue in fancy packaging?

P493: Copyright reality in academe

Donna Ferullo (Purdue University, USA)

This session will cover copyright basics including fair use and other exemptions. Identification of copyright issues frequently encountered in academe and the classroom as well as application of the copyright law will be addressed.

P494: Copyright 101

Eric Slater (American Chemical Society, USA)

This session will feature a general discussion of basic United States Copyright Law, including, but not limited to, such topics as subject matter of copyright, exclusive rights of copyright, and duration of copyright. Additionally, some time will be devoted to the application of copyright law to all media, including the Internet, as well as to how the permissions process works.

P495: Chemistry career seminar

Marina Koether (Kennesaw State University, USA)

Students entering the Professional ACS Certified Track are required to take a one credit Freshman course on Careers in Chemistry. Within this course, skills in Word and Excel are developed. Speakers from a variety of careers in Chemistry are invited speakers. However, one particular aspect of the course involves paraphrasing and identifying plagiarism. One 100 minute lecture is devoted to a discussion of plagiarism. Two assignments are given, one from a textbook and one from Chemical and Engineering News. A discussion of this lecture and results will be reported.

P496: Using collaborative efforts to teach students about plagiarism

Bozena Widanski (University of Cincinnati Clermont, USA), Debra Courtright-Nash (Ferris State University, U.S.A.)

For more than three years Chemistry and English professors have been collaborating to teach our undergraduate students about writing scientific articles and peer-reviewing. Throughout most of our collaboration we have assumed that our students had adequate knowledge about plagiarism

while doing research, writing papers, and peer-reviewing. The recent project that included on-line training and a subsequent quiz on plagiarism provided us with more insight on students' perceptions. In our presentation we will provide an example from our recent project, discuss results from that study, and propose different ways to increase the awareness of plagiarism among undergraduate students.

P497: Cyberplagiarism: the ruse of a new era or an old issue in fancy packaging?

Jennifer Sharkey (Purdue University, USA)

With more and more information available online, are students really stealing more than ever before? Some claim cyberplagiarism, typically defined as the copying and pasting of electronic information, is on the rise; others suggest it isn't. This presentation will delve into the issues of cyberplagiarism and discuss what educators and librarians can do to detect, deter, and avoid it.

9:00 AM - 12:00 PM STEW 314

S50: Technology and Organic Chemistry - Session 1 of 1

Kyle Strode (Carroll College, USA), **Willy Hunter** (Illinois State University, USA)

This symposium of general interest to the Chemical Education community will focus primarily on the use of technology in teaching chemistry and on organic chemistry.

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| 9:00 | | introduction |
| 9:05 | Kyle Strode | P498: Programming the TI Voyage 200 calculator to enhance learning in chemical equilibrium |
| 9:25 | Dennis Mitchell | P499: Undergraduate laboratory research by community college students: Episode 2 |
| 9:45 | Robert Kerber | P500: Testing using A1c for illustration of chemical principles in medicine |
| 10:05 | Connie Pitman | P501: Problem-based learning in the organic chemistry laboratory: Interfacing biology and chemistry projects in the organic chemistry laboratory |
| 10:25 | | break |
| 10:35 | Martin Ondrus | P502: Multimedia DVD final project in instrumental analysis |
| 10:55 | Natasha Obrecht | P503: OrChem: Tutorial tool with quizzing, assignment and extra help capabilities |
| 11:15 | Sian Thornton | P504: Integrating green chemistry into the organic laboratory curriculum |
| 11:40 | David Baker | P505: Microwave Experiments for the Organic Chemistry Laboratory |

P498: Programming the TI Voyage 200 calculator to enhance learning in chemical equilibrium

Kyle Strode (Carroll College, USA)

In advanced chemistry courses that deal with chemical equilibrium, students and teachers often work with equilibrium systems that involve difficult polynomial expressions, multi-step approaches and iterative solutions. These equilibrium systems illustrate important concepts, and they provide a unique opportunity to develop advanced problem-solving skills in chemistry. The

drawbacks are that involved equilibrium problems usually take a long time to solve by hand, they present myriad opportunities for trivial errors, and if errors are present, they are difficult to evaluate. Programmable calculators like the TI Voyage 200 offer an approach to solving equilibrium systems that enhances the understanding of the underlying chemistry of chemical equilibrium, and introduces the calculators' programming capabilities. In this talk I will explain how the TI Voyage 200 calculator can be programmed to solve several types of problems in chemical equilibrium. I will also discuss how simple programming exercises can be integrated into lecture, class projects and exams.

P499: Undergraduate laboratory research by community college students: Episode 2

Dennis Mitchell (Los Angeles City College, USA)

At the previous BCCE, a report was given on research where Los Angeles City College collaborated on a project of Donald Deardorff from Occidental College. This collaboration has continued, with Derek Ross from Los Angeles City College as the student participant. Several changes have taken place in the project. The syntheses now focus on enantiomerically pure compounds of pharmaceutical interest and, most importantly, some of the research is now being carried out at Los Angeles City College. This talk will present the current results including synthetic approaches, spectroscopic analyses, benefits to the student participant(s), and the general utility of research at the community college level, its advantages, successes, and difficulties.

P500: Testing using A1c for illustration of chemical principles in medicine

Robert Kerber (Stony Brook University, USA)

Some 20 million diabetics in the USA provide blood samples for the A1c test to determine a 60-day average value of their blood glucose concentration. The test is rooted in chemical kinetics and can be used to illustrate kinetic principles. It is a model for non-enzymatic biological reactions which are responsible for the devastating effects of excess glucose concentrations resulting from diabetes. Many of the reactions provide examples useful in second-semester organic chemistry. These examples can be used to motivate health-science oriented students in chemistry courses.

P501: Problem-based learning in the organic chemistry laboratory: Interfacing biology and chemistry projects in the organic chemistry laboratory

Connie Pitman (University of Colorado, USA), Larry Augenstein (University of Colorado at Colorado Springs, USA), Barbara Gaddis (UCCS, USA), Allen Schoffstall (University of Colorado at Colorado Springs, USA)

Doing multistep projects in the organic laboratory that have a biological focus has increased students' interest and increased the numbers of dual majors. Students work in collaborative development teams to synthesize products of biological or commercial significance, such as color-specific dyes, sunscreens, scents, antibiotics, and other products. Success is measured not only by the typical outcomes of yield and purity, but also by the effectiveness of the products. Students present both formal oral and written reports. Course assessment shows that projects have improved student motivation and interest.

P502: Multimedia DVD final project in instrumental analysis

Martin Ondrus (University of Wisconsin-Stout, United States)

For the past 3 years, students in Instrumental Analysis at UW-Stout have been expected to prepare (in groups of two or three) a 15-minute video presentation to become part of a digital video disk

(DVD) shared with all members of the class. This activity has replaced the traditional final exam. The purpose of the presentation has been to summarize instrument theory and operation and to demonstrate an experiment performed with a specific instrument. Projects were graded on criteria including: • Instrument theory • Description of components, controls, software, etc. • Proper startup, setup, operation, shutdown • Demonstration of an analysis with the instrument • Spoken narration, written captions, or music background where appropriate • Logical sequence from introduction and instrument theory through final concluding clip or statement. • Creativity • Overall professional quality of the presentation The video presentation was put together with iMovie, iPhoto, PowerPoint, and iDVD on Apple computers using video and digital photos from cameras, camcorders, and student laptops. Once a project was in final or near-final form, it was moved to a computer with DVD burner and imported into an Instrumental Analysis iDVD project. With class sizes ranging from 14 to 21 students, it has been possible to record all class projects on a single two-hour DVD covering all instruments used in the course and playable on any computer or television DVD player. Sample DVDs will be available as handouts.

P503: OrChem: Tutorial tool with quizzing, assignment and extra help capabilities

Natasha Obrecht (Siborg Systems Inc., Canada), Michael Obrecht (Siborg Systems Inc., Canada)

The variety of software available to modern day teachers includes software programs are used to quiz students on a regular basis, to review exam material, as a tutorial for lagging students and as extra work for advanced students. Unfortunately each of these functions usually requires a separate program. An instructor is then forced to decide what exactly they would like to use their software for and be limited by that choice for the term or year (until money is allotted for new software). OrChem is innovative software that integrates all of the features listed above. OrChem's innovative approach allows it to be used for tutorials, quizzes, assignment, and practice work (studying). In addition instructors can use it for mark organization and students can use it as an interactive periodic table as well as a list of common constants. OrChem allows students to work through questions in depth, showing them their mistakes, giving them hints, explaining answers and steering students in the right direction.

P504: Integrating green chemistry into the organic laboratory curriculum

Sian Thornton (Western Washington University, USA), **George S. Kriz** (Western Washington University, USA)

The green chemistry organic laboratory course developed in this research focuses on maintaining the essential techniques learned in an organic laboratory, but integrating green chemistry principles into each experiment. The experiments are designed to reinforce concepts learned in class and familiarize the students with organic laboratory equipment while practicing environmentally friendlier procedures. The designed curriculum includes greener experiments teaching essential laboratory methods such as distillation or thin-layer chromatography. It includes many types of reactions with which the organic chemist should be familiar, including the Friedel-Crafts reaction, Michael-aldol condensation, Diels-Alder reaction, and Wittig reaction. Through this curriculum, a wide variety of green procedures are demonstrated, including the preparation of an ionic liquid, reactions using a microwave oven or sonicator, and extraction with liquid CO₂. The laboratory course is currently being implemented to test the experiments and validity of instructional methods.

P505: Microwave Experiments for the Organic Chemistry Laboratory

David Baker (Delta College, USA)

A series of microscale experiments using microwave technology have been developed for use in the organic chemistry laboratory courses. Five very proficient and interesting experiments using microwaves have been developed. These experimental procedures will be described. These experiments are designed to expose the students to new developments and perspectives in microwave synthesis and combinatorial chemistry. They are intended to expand the student's knowledge of multiple syntheses.

10:15 AM - 12:00 PM STEW 206

S61: Survivor Skills for 1st to 5th year Chemistry Teachers - Session 1 of 2

Esther Freeman (Retired; Tabb High School, USA)

National research data claims that one out of every five novice teachers leaves the teaching profession after only three years and 50% leave in the first five years. Often, these teachers are frustrated and feel overwhelmed because they are held to the same accountability standards as veteran teachers. One of the major reasons cited for leaving is the lack of support and guidance. In this symposium, veteran teachers will offer themselves as role models for novice teachers or other educators seeking to improve and fine tune their classroom instruction and management skills. These veteran teachers will share a full range of resources such as great lesson plans, teaching strategies, activities, projects, or demonstrations that can help prevent novice teachers from having to "reinvent the wheel."

10:15 introduction

10:20 Esther Freeman P506: Building VSEPR models using Spice Drops

10:50 Bette Bridges P507: 20 Questions or how to survive stoichiometry

11:20 Debbie Herrington P508: "Don't mistake my kindness for a weakness": Surviving your first years and keeping your sanity!

11:50 discussion

P506: Building VSEPR models using Spice Drops

Esther Freeman (Retired; Tabb High School, USA)

If you cannot afford a classroom set of models to teach electron dot structures (VSEPR Models), you can easily build structures of common chemicals with the proper bond angles using spice drops and toothpicks. These models can even be used to teach extended octets.

P507: 20 Questions or how to survive stoichiometry

Bette Bridges (Bridgewater-Raynham Regional High School, USA)

A great way of introducing stoichiometry and building up to doing word problems. Your students will never struggle again!

P508: "Don't mistake my kindness for a weakness": Surviving your first years and keeping your sanity!

Debbie Herrington (Grand Valley State University, USA)

Being passionate about your teaching and sincerely wanting your students to succeed are important attributes of chemical educators that students will quickly recognize and be drawn to. However, some students believe that this concern translates into teachers tying themselves into knots to

accommodate them. Though many of us would like to accommodate our students, trying to individually accommodate 100-150 students or more can send you over the edge. As a new teacher, trying to maintain the balance between student rapport and classroom control is often a difficult and sometimes daunting task. This talk will discuss practical techniques and tactics I have picked up as a high school teacher and a university faculty member that have helped me to maintain a good rapport with my students and my sanity. These techniques include: setting guidelines that benefit you and your students, helping students take responsibility for their learning, demonstrating concern for individual students while still being fair to all, and resolving student conflicts. Although I did learn some of these tactics and techniques the hard way, I have also benefited from the experience of a number of colleagues. Thus, my talk will also highlight the importance of mentoring in surviving your first years as a new teacher.

Workshops

Wednesday, August 2 morning

W31: Customizing a Demo for Your Classroom

9:00 AM - 12:00 PM WTHR 104

James Maynard (UW Madison, U.S.)

The flame test demo will be presented in three sizes, for use in three different classroom settings, using variations of a theme

Capacity: 15 Fee: 5-10\$

W32: Introduction to POGIL: Process Oriented Guided Inquiry Learning

9:00 AM - 12:00 PM STEW 320

Rick Moog (Franklin and Marshall College, USA)

POGIL is a student-centered discovery-based teaching strategy designed to simultaneously develop content knowledge and key process skills such as critical thinking and teamwork. This introductory workshop will use an active team-learning mode to introduce the basics of implementing POGIL. Participants will experience the approach from a student perspective through work on POGIL activities. Expert facilitators will model a handful of effective classroom techniques. Evidence for the effectiveness of this approach will also be discussed. Those interested in learning about POGIL in greater depth may also register for one of the Advanced POGIL Workshops offered in subsequent timeslots (see schedule).

Capacity: 60 Fee: none

W33: Teaching Chemistry with Models and Simulations; Section 2

9:00 AM - 12:00 PM SC 231

Dr. Jurgen Schnitker (Wavefunction, Inc., USA)

By invoking the tremendous power of three-dimensional visualization, molecular modeling fosters an understanding of chemical concepts that is intuitive and thorough. Attend this hands-on workshop and learn how to add this new dimension to your lecture demonstrations as well as to your laboratory and homework assignments. Two suites of software will be featured: Odyssey, a new chemistry learning tool that allows for realistic simulation of molecular motion, and Spartan, Wavefunction's industry-leading molecular modeling application that is used in teaching and

research laboratories worldwide. A variety of examples from the standard curriculum for General, Organic, and Physical Chemistry will be given--from the gas laws to chemical reactivity, from bond polarity to basic thermodynamics. Find out for yourself why molecular modeling is uniquely effective in engaging students!

Capacity: 0 Fee:

W34: Vernier Hands-on Chemistry with Computers; Section 2

9:00 AM - 12:00 PM BRWN 2125

Dan Holmquist (Vernier Software & Technology, USA)

This hands-on workshop will allow participants to collect and analyze chemistry data using Vernier LabPro with computers running Logger Pro software. Data will be collected using sensors such as Temperature, Pressure, pH, Conductivity, and Colorimeters. A variety of experiments from the popular Vernier lab manuals Chemistry with Computers and Advanced Chemistry with Vernier will be offered.

Capacity: 40 Fee: \$0

W35: Dazzling Density Demos, Activities, and Labs: A Workshop Honoring the Spirit of Babu George

9:45 AM - 12:30 PM BRWN 2124

Brian Rohrig (Jonathan Alder High School, USA)

This workshop will present material at the high school level, but is easily adaptable to younger or older grade levels. An inquiry approach will be stressed with each activity presented. Participants will perform a number of short demos, labs, and activities designed to give students concrete experiences that will enhance their conceptual understanding of density, as well as its interconnectedness with other aspects of chemistry, such as buoyancy, pressure, energy, and gas laws. Each participant will receive a bound manual of all activities presented. A few of the highlights include: • Great convection experiments that illustrate density • Dazzling dry ice experiments • Determining the density of a person • Making your own submarine • Floating and sinking bowling balls • Density in the movies • Making a mini lava lamp • . . . and much more!

Capacity: 0 Fee:

Wednesday, August 2 afternoon

Plenary Speakers

Wednesday, August 2 afternoon

7:00 PM - 8:30 PM

L10: Creative demo tales from two continents

Robert Becker (Kirkwood High School, USA)

A pretty experiment is in itself often more valuable than twenty formulae extracted from our minds." Albert Einstein (1879-1955) The word 'pretty' in Einstein's quotation unites aesthetics with modern neurobiological research, which has proven that lasting learning is closely linked with emotions. As a rule, students remember most the beautiful or dangerous experiments. Many

colleagues decided to become chemists after being awed by spectacular experiments around age 10-14. In Europe, new regulations for storing and disposing of chemicals, smaller teaching material budgets, and a greater emphasis on general education have reduced chemistry teachers' time and material resources for chemical education. Costs, as well as preparation and clean-up time and effort, must be in proportion to the impact/success of the learning experience. Simple, green, timesaving experiments with the ability to demonstrate the big ideas of chemistry can be "pretty" and effective. European chemistry teachers are not alone in the desire for timesaving hands-on activities. Such timesaving experiments offer the opportunity for more time to discuss and reinforce chemical concepts. Newly designed and innovative teacher-friendly experiments using self-made, microscale, and everyday materials will be demonstrated in a time-saving fashion. Even potentially hazardous and dangerous reactions can be performed using small amounts of chemicals, enlarged with modern digital equipment for a big audience if needed.

7:00 PM - 8:30 PM

L11: TIMESAVING EXPERIMENTS CAN BE PRETTY

Viktor Obendrauf (University of Graz, Austria)

"A pretty experiment is in itself often more valuable than twenty formulae extracted from our minds." Albert Einstein (1879-1955) The word 'pretty' in Einstein's quotation unites aesthetics with modern neurobiological research, which has proven that lasting learning is closely linked with emotions. As a rule, students remember most the beautiful or dangerous experiments. Many colleagues decided to become chemists after being awed by spectacular experiments around age 10-14. In Europe, new regulations for storing and disposing of chemicals, smaller teaching material budgets, and a greater emphasis on general education have reduced chemistry teachers' time and material resources for chemical education. Costs, as well as preparation and clean-up time and effort, must be in proportion to the impact/success of the learning experience. Simple, green, timesaving experiments with the ability to demonstrate the big ideas of chemistry can be "pretty" and effective. European chemistry teachers are not alone in the desire for timesaving hands-on activities. Such timesaving experiments offer the opportunity for more time to discuss and reinforce chemical concepts. Newly designed and innovative teacher-friendly experiments using self-made, microscale, and everyday materials will be demonstrated in a time-saving fashion. Even potentially hazardous and dangerous reactions can be performed using small amounts of chemicals, enlarged with modern digital equipment for a big audience if needed.

Poster sessions

Wednesday, August 2 afternoon

12:30 PM - 1:30 PM E Lounge 2nd floor Union

Session 5 of 5: 2nd Floor Union

Ann Cutler (University of Indianapolis, USA)

Poster presentations provide a unique venue for sharing ideas, learning about creative endeavors from colleagues, and highly personal one-on-one interactions. As such, the 19th BCCE will continue the long standing tradition of holding several poster sessions during the meeting.

| | |
|-----------------------|---|
| Laura Eisen | T81: "Science of terrorism": An interdisciplinary course for non-majors |
| Marguerite S. Crowell | T82: Chemistry Week at the Pakistani Teachers Institute at Plymouth State University |
| Donald Estes | T83: DNA Melt |
| Kurt Birdwhistell | T84: Green alternative for the acylation of ferrocene lab experiment |
| Sushmita Chowdhury | T85: Greener alternative to qualitative analysis of cations without H ₂ S and other sulphur containing compounds |
| John Galiotos | T86: Gulf Coast Technology Articulation Partnership |
| Joanne Wittbrodt | T87: How does a candle work? |
| Andrew Cherkas | T88: Marshmallow chronicles |
| Penny Snetsinger | T89: Modeling competitive adsorption in physical chemistry lab |
| Lon Porter | T90: Nanoscience-fiction resources for the chemistry classroom: Read, watch, and play on! |
| Cheryl Frech | T91: National Chemistry Week projects for teams |
| Paul Endres | T92: Polyacetylene: Synthesis and characterization |
| Martin Maresch | T93: Practical efficient utilization of microglassware in Grignard reactions |
| David Smith | T94: Purple genie: The reaction of turpentine and iodine |
| Donald Storer | T95: Soil analysis and archaeology: A final project to introduce first-year chemistry students to research |
| Indu Sidhwani | T96: Some green experiments for undergraduate inorganic chemistry curriculum |
| Stephanie Gould | T97: Student designed activity to experimentally calculate the value of the ideal gas constant: A green alternative to the traditional experiment |
| Lois Zook-Gerdau | T98: Use of digital simulation software in analytical chemistry to teach electrochemistry |
| Jeffrey Lacy | T99: Using Mathcad to visualize the probability densities of the relativistic hydrogen atom |
| Susan Ensel | T100: Using NMR spectroscopy to 'discover' organic chemistry |
| Mary Turner | T101: Welcome to the nanoworld: Introducing concepts of size and nanofabrication in the liberal arts curriculum |

T81: "Science of terrorism": An interdisciplinary course for non-majors

Laura Eisen (The George Washington University, USA)

Non-science majors often complain that introductory science courses are too abstract, and are not relevant to their interests. If we want these students to become scientifically literate, we need to develop courses that present science in a context that will interest them. The George Washington University attracts a large number of undergraduates who plan to major in political science or international affairs. In an effort to offer a science course that would appeal to these students, I developed "The Science of Terrorism", an interdisciplinary first year seminar that fulfills a laboratory science requirement. The course uses case studies, media reports, and popular literature to provide a context for learning about important ideas in chemistry, biology, and physics. Thus, a news article about dirty bombs and nuclear terrorism introduces the atomic nature of matter,

nuclear reactions, and mass-energy equivalence. The Oklahoma City bombing serves as the framework for discussing molecules, bonds, and chemical reactions. Reading about the anthrax letters and the threat of a smallpox attack leads to an exploration of the structure and function of DNA and the genetic code. The growing resistance to the anti-viral and antibacterial agents that would be a major part of our response to a bio-terror attack points to the importance of evolution and natural selection. The laboratory includes simple problem-solving activities (such as the identification of a mystery white powder), and also provides the students with a chance to use some of the methods of modern biotechnology that are described in the readings.

T82: Chemistry Week at the Pakistani Teachers Institute at Plymouth State University

Marguerite S. Crowell (Plymouth State University, USA)

The Pakistani Teachers Institute is an intensive summer program held at Plymouth State University for educators and administrators from Pakistan. One aspect of the program provides the participants with strategies to incorporate chemistry into their secondary science curriculum. The goal is to enhance their subject knowledge and pedagogical skills, and present alternative approaches to teaching science and math in a manner which addresses their particular needs. Limited resources in some Pakistani schools require innovative applications of various teaching methods. Development of a chemical hygiene plan for the laboratory as well as standards for high school chemistry is examined. Fieldwork integrates environmental aspects of the subject and helps draw inferences and integration with other sciences. The outcome was very positive. Teachers implemented new material into their curriculum and promoted good mentoring practices in their school. The active learning and science as inquiry approach was used to develop projects and labs in their home institutions. Despite the devastation after the 2005 earthquake, the Pakistani teachers remain committed to effective teaching in accordance with the national curriculum.

T83: DNA Melt

Donald Estes (Yeshiva University, USA), *Nomi Ben-Zvi* (Yeshiva University, USA), *Lea Blau* (Yeshiva University, USA)

A new module, the DNA Melt, has been developed for the Physical Chemistry On-Line (PCOL) Consortium. PCOL is a multi-university, multi-faculty effort to carry out physical chemistry projects on-line. One goal is to allow students to work collaboratively from remote sites. In this module, a short DNA duplex is denatured by heating. The transition from double-stranded to single-stranded DNA is monitored by UV spectroscopy. The dominant forces of interaction are determined in the helical structure by varying the base sequence and/or base composition. The effect of solvent composition, including ionic strength, on the melting temperature is also investigated. The dependence of the melting temperature on strand concentration is analyzed to yield thermodynamic data (ΔG , ΔH , ΔS). The experimental thermodynamic data are compared to those predicted from the nearest-neighbor model. The structural dependence of DNA melting is important for several molecular biology techniques including the polymerase chain reaction in which primers are attached to the melted target strands to make additional copies of DNA of complementary structure.

T84: Green alternative for the acylation of ferrocene lab experiment

Kurt Birdwhistell (Loyola University, United States), *D. Andrew Knight* (Loyola University New Orleans, USA)

The Freidel Crafts acylation of ferrocene is a common experiment used in either undergraduate

organic or inorganic labs. A standard procedure uses phosphoric acid to form the acylium ion electrophile from acetic anhydride. The phosphoric acid is then neutralized and disposed at the end of the experiment. We will discuss our use of Nafion, a polymeric sulfonic acid as a replacement for phosphoric acid in this experiment. Nafion can be recovered, regenerated and reused for this reaction. The relative yields of acetylferrocene and conditions for use of Nafion will be presented in this presentation.

T85: Greener alternative to qualitative analysis of cations without H₂S and other sulphur containing compounds

Sushmita Chowdhury (Gargi College, India), **Indu Sidhwani** (Gargi College, India)

Qualitative Inorganic analysis using classical technique is in the curriculum of high school, undergraduates and postgraduates classes of India and other South Asian countries. One of the most widely used reagents in these practicals is H₂S. Though H₂S has great pedagogical importance, its toxicity cannot be ignored. It has harmful effects on students, teachers and laboratory staff and inhalation of H₂S in some cases kills faster than HCN. Greening of this analysis is the only remedy. We, at Gargi College, have been able to develop an alternate method of analysis which totally eliminates use of H₂S and other sulphur compounds. This Green analysis is much quicker having simple and fewer steps and number of groups have also been reduced to four. Cations are separated on the basis of common chemical properties and also use spot tests at the undergraduate level. Heating time has also been reduced. The students are familiarized with different types of equilibria, namely, reversible, solubility and complexation. They are also exposed to sensitivity and selectivity of the reagents. It is an attempt to introduce Green Chemistry at the grassroots level.

T86: Gulf Coast Technology Articulation Partnership

John Galitos (Houston Community College, USA)

The Gulf Coast Technology articulation partnership was developed by Houston Community College-NE (HCC-NE) Science Technology division and McNeese State University (MSU) Department of Engineering Technology. This is the first of its kind NSF funded initiative in the Gulf Coast region where graduating students with an AAS degree in Science Technology related programs can continue with their studies at MSU towards a BS in Engineering Technology. The GCTAP platform of articulations has been adapted by area universities such as the University of Houston College of Technology and Prairie View A&M University Department of Chemical engineering to generate similar articulation agreements with other AAS programs. Thirty six students from HCC-NE have been enrolled in this partnership program with MSU all with scholarships from GCTAP.

T87: How does a candle work?

Joanne Wittbrodt (Wayne County Community College District,)

How does a candle work? This demonstration encourages students to question their understanding of common objects and events, utilizes the scientific method, and emphasizes the difference between a physical change and a chemical change. The only supplies needed are a wax taper candle, matches, a non-flammable tray to catch melted wax, a container of water to completely extinguish used matches and, as a standard safety precaution, a fire extinguisher. Students are given five minutes to write "a description of a candle and how it works." The instructor then leads a group discussion, performing small experiments throughout. The following questions are

addressed: What is burning, the wick or the wax? Are the changes that occur chemical or physical? What states of matter are involved? A sample script is given as a guideline, however, each actual demonstration will be different based on student responses. Prior to the demonstration, most students think they know exactly how a candle works. After the demonstration, most students are amazed by how much they learned and by how many questions can be asked about a candle.

T88: Marshmallow chronicles

Andrew Cherkas (Stouffville DSS, Canada)

Marshmallows are used to illustrate principles of chemical change, molecular structure, Boyle's Law, particle theory, Types of reactions, balancing chemical equations.

T89: Modeling competitive adsorption in physical chemistry lab

Penny Snetsinger (Sacred Heart University, US)

The study of the adsorption of a substance onto activated charcoal and the modeling of this adsorption using common isotherms is a typical physical chemistry experiment. However, the importance of this method and its application to the "real world" problems of water and wastewater treatment are typically not mentioned. The competitive adsorption experiment described here bridges the gap between an isolated lab investigating adsorption onto activated carbon and applied environmental work. The goal of this experiment was to examine and model the relative competitive effect of the adsorption of two organic compounds. The single component isotherms were studied and evaluated using a GC/MS instrument. In the second phase of the experiment, students monitored the adsorption with both components present. Finally, students then applied and tested the ideal adsorbed solution theory (IAST) as a model of the adsorption. From this, they were able to present a picture of competitive adsorption and evaluate its implications for environmental work.

T90: Nanoscience-fiction resources for the chemistry classroom: Read, watch, and play on!

Lon Porter (Wabash College, USA)

Nanotechnology appears to be everywhere these days! Browse the newspaper, surf the web, or look to recent works of science fiction. The manipulation of matter on the nanometer scale has been termed nanotechnology, an exploding field still in its infancy. Nanotechnology provides an excellent way of learning to look at the amazing opportunities that arise when various fields of science intermingle. This poster will present a range of nanoscience-based fiction resources for the chemistry classroom. A sampling of full-length novels, short stories, television programs, full-length motion pictures, and video games will be discussed. If you thought Michael Crichton's *Prey* was the only choice for nanotechnology, you've got a lot to see!

T91: National Chemistry Week projects for teams

Cheryl Frech (University of Central Oklahoma, United States)

The ACS National Chemistry Week celebration each year falls in October. Students and faculty alike can use a fun break from the routine at this point. Several NCW project ideas are described that are suitable for teams at any level. Each student receives an individual assignment that is linked to the assignments of the others on his or her team. After some initial research, students are able to discover the common thread in their assignments. The team is assigned to make a presentation in class. Step aside and watch the students learn on their own and work together!

T92: Polyacetylene: Synthesis and characterization

Paul Endres (Bowling Green State University, USA)

Polyacetylene is the prototype of the conductive organic polymer and it has rich educational potential. The polymer forms when acetylene gas comes into contact with a liquid catalyst. We have students synthesize PA as thin films (in approximately two hours) and characterize the material using conventional methods. The catalyst and polymer are oxygen and water vapor sensitive, so students must utilize inert atmosphere conditions (glove box or inexpensive syringe methods.) When prepared at dry ice temperatures, the polymer is mainly cis-PA; it isomerizes on gentle heating to trans-PA. The fully deuterated films are easily prepared utilizing calcium carbide and small amounts of deuterium oxide. These films and their isomerization are easily characterized by Infrared spectroscopy. Very thin films can also be prepared and these show bright colors (cis is red, trans is blue.) The visible spectra and molecular computations (SPARTAN) are used by students to explore aspects of semiconductors and bandgap theory. The film can be electrically doped by simple room temperature exposure to iodine vapor, producing a material with high electrical conductivity.

T93: Practical efficient utilization of microglassware in Grignard reactions

Martin Maresch (Lock Haven University of PA, US)

During microscale organic reactions, students are often challenged with a practical and efficient method for delivering reagents. Crudely calibrated Pasteur pipets or microsyringes tend to lead to erratic reagent addition by students, and subsequent low yields in critical reactions. In the absence of a separatory funnel, students can utilize the microscale chromatography column with its stopcock to perform dropwise addition of solutions. As part of microscale kits which receive little usage, the microscale chromatography columns can provide controlled delivery to many reaction mixtures, such as the oxidation of cyclohexanol or the reagent addition of Grignard reactions.

T94: Purple genie: The reaction of turpentine and iodine

David Smith (Doane College, United States)

The reaction of turpentine and iodine is spectacular, producing a large cloud of purple smoke. The reaction is very exothermic, perhaps due to the relief of ringstrain associated with opening the four-membered ring in alpha-pinene. By using GC/Mass Spec, GC, and HPLC, it was found that the products formed are not those proposed in the literature.

T95: Soil analysis and archaeology: A final project to introduce first-year chemistry students to research

Donald Storer (Southern State Community College, USA)

Chemical analyses of ancient anthrosols used by archaeologists studying the Maya in Mesoamerica have demonstrated the explanatory value of these investigative techniques and illustrated the problems that challenge interpretive capabilities. For example, soil phosphorus levels can be used to locate areas in which food was prepared or consumed which allows the archaeologists to learn more about the daily life of the Maya. Soil analysis in the context of archaeological excavations was used in a final project in general chemistry as an introduction to research. Soil samples taken at a roadside rest area were dried, ground, and sieved and the soil phosphorus extracted using the Mehlich 3 soil extractant. The extractable phosphorus was determined spectrophotometrically and the results of this simulation were interpreted similarly to an archaeological excavation site.

T96: Some green experiments for undergraduate inorganic chemistry curriculum

Indu Sidhwani (Gargi College, India)

Greening of chemistry practicals is the answer to most existing problems. Students at all levels can benefit from introduction to green chemistry as they start to think critically about the hazards posed by different chemicals used and also enhance their interest in chemistry as a discipline. Some experiments have been carried out and proposed for restructuring of curriculum for undergraduates. These experiments also have applications in various fields. Some of these experiments are- Analysis of water for DO, alkalinity and hardness to know whether water is suitable for municipal or industrial use. Titrations can also be carried out spectrophotometrically; removal of toxicity of heavy metals from soil and water using aqueous biphasic systems; preparation of nanoparticles as there is a great deal of interest in preparation and application of nanosized materials; extraction of colour from eucalyptus bark using supercritical carbon dioxide as a solvent. SCFE applicability also helps in getting rid of natural tannins and polyphenols with main colourant; preparation of coordination compounds as luminescent materials used for OLED. We are in a process of designing many more experiments and the work is in progress.

T97: Student designed activity to experimentally calculate the value of the ideal gas constant: A green alternative to the traditional experiment

Stephanie Gould (University of California, Los Angeles, USA)

A greener alternative to the traditional high school experiment that uses the reaction between hydrochloric acid and magnesium turnings to determine a value for the ideal gas constant (R) has been developed. Generally laboratory lessons designed on the principles of green chemistry use benign reagents and produce less waste, which is ideal for high school classrooms with limited supplies and resources. In this lesson, the reaction between vinegar and baking soda is exploited. Students are presented with several common materials and instructed to design their own experimental procedure to capture the CO_2 released during the reaction. Through the teachers' guide, instructions are provided in a step-by-step manner for teachers to easily guide this inquiry lesson. Finally students are guided through a series of questions to determine R , consider sources of error in their design and suggest improvements. This paper will discuss the development and details of the laboratory along with several experimental procedures that were designed.

T98: Use of digital simulation software in analytical chemistry to teach electrochemistry

Lois Zook-Gerdau (Muskingum College, USA)

Electrochemistry is central to many chemical processes and products. Voltammetry, an electrochemical diagnostic tool, can be used to study both the thermodynamics and kinetics of chemical reactions, as well as mass transport and material properties. While voltammetry is an extremely useful technique, the electrochemical response is often affected by a variety of dynamic factors. This makes voltammetry difficult to teach effectively using standard textbooks and literature articles. Currently Muskingum College teaches voltammetry techniques such as potential step voltammetry, cyclic voltammetry, and rotating disk voltammetry in the junior/senior level Analytical chemistry course. First students are taught the basics of voltammetry through a structured laboratory assignment. Second, students are allowed to vary parameters using simulation software. This method provides freedom for exploration of many different ideas using the modeling program without necessitating multiple time-intensive experiments. Students could quickly test a variety of parameters and based on the simulation results develop the current relationship of a cyclic voltammogram for a Nernstian electrochemical reaction. Overall, the

combination of simulations and experimental verification lead to a better understanding of electrochemical phenomena than either method alone can provide.

T99: Using Mathcad to visualize the probability densities of the relativistic hydrogen atom

Jeffrey Lacy (Shippensburg University, USA)

We have previously shown that Mathcad can be used to illustrate the 2s radial and one of the 2p angular probability densities of the relativistic hydrogen atom. Our current work continues with visualization of all of the 2p and 3d angular probability densities.

T100: Using NMR spectroscopy to 'discover' organic chemistry

Susan Ensel (Hood College, USA)

Organic chemistry labs typically take students through a series of well-planned steps, allowing for little thought or creativity. Discovery-based, guided inquiry pedagogy removes the cookbook and forces the student to examine and discover the underlying chemical principles. The general chemistry course at Hood College has been inspiring students for years with this methodology and we will now present organic chemistry lab experiments that have been designed in this manner. The new labs presented on this poster take advantage of our NSF-funded Anasazi 60 MHz NMR spectrometer to determine product identity. One experiment utilizes DEPT spectroscopy to help uncover Markovnikov's Rule while another experiment incorporates ¹³C NMR spectroscopy to investigate substituent directing abilities in EAS reactions.

T101: Welcome to the nanoworld: Introducing concepts of size and nanofabrication in the liberal arts curriculum

Mary Turner (Maryville College, USA)

Nanotechnology has been described as the fabrication and manipulation of matter with nanometer scale dimensions. This exploding field is discussed in everything from textbooks to popular magazines to web blogs. But what is a nanometer? Few students outside of science, math, and engineering fields can explain the term. Most have little understanding of the relative size of objects having dimensions smaller than one millimeter, much less how to manipulate them. Two activities that have been developed to aid students in this understanding will be described. The first activity, "Come On Down", is based on powers of ten and has the students order objects according to their longest dimension using a "Price is Right" game show approach. In the second, students use Play-doh® to illustrate the differences in technique and applicability of "top-down" and "bottom-up" nanofabrication. These activities were designed for liberal arts courses in chemistry, but are appropriate for anyone seeking to enhance their students' knowledge of microscale and nanoscale objects.

Demonstration sessions

Wednesday, August 2 afternoon

1:15 PM - 4:50 PM WTHR 200

Session 2 of 2

Kenneth Lyle (Duke University, USA)

In the hands of a skilled educator, chemical demonstrations can be an effective instructional

strategy that helps students learn and understand the chemical concepts. The emphasis of this symposium is on the pedagogical use of chemical demonstrations to foster student learning. Presenters will share demonstrations that have proven to be an effective instructional tool and how these demonstrations are used in their classrooms to promote learning of the concepts. Presenters will also provide a teacher's guide for each demonstration that includes 1) the chemical concepts addressed; 2) a brief description of how the demonstration addresses these concepts; 3) a guide to preparing and performing the demonstration, including safety and disposal issues; and 4) a description of how the demonstration is used in the classroom to foster learning and understanding of the concepts. Once completed, the teacher's guide will be posted on the BCCE Web site.

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|-------------------------------------|--|
| 1:15 | introduction |
| 1:20 Bassam Z. Shakhashiri | D15: Chemical demonstrations: Purposes, effectiveness, and when not to do them |
| 1:45 Raymond Dudek | D16: Using a liquid prism to demonstrate index of refraction |
| 1:55 Susan Hershberger | D17: Using LEDs to demonstrate properties of light |
| 2:10 Edward Senkbeil | D18: Fireproof balloon |
| 2:20 Doctor DeMento (Jerry DeMenna) | D19: Nutritional label LIES! |
| 2:35 Mike Briggs | D20: Macro-level demonstration of equilibrium |
| 2:50 Brian Rohrig | D21: Light bulb demos with a forensic twist |
| 3:05 Kathryn Wagner | D22: Like dissolves like |
| 3:15 | break |
| 3:30 Bette Bridges | D23: Instant slush |
| 3:45 Jason Hofstein | D24: Approximating the adiabatic expansion of a gas |
| 4:00 James Maynard | D25: Scaling a flashy demo |

D15: Chemical demonstrations: Purposes, effectiveness, and when not to do them

Bassam Z. Shakhashiri (UW-Madison,)

[Bassam Z. Shakhashiri, James Maynard, Rod Schreiner, and Michael Boll]

Chemistry demonstrations can be used as principal vehicles for communicating chemical concepts and phenomena to a variety of audiences. In this talk we will discuss the fundamental purposes for doing chemical demonstrations in classroom and other settings. The pedagogical values of planning lectures and discussion sessions on the basis of chemical demonstrations will be discussed. We shall also discuss strategies for enhancing the effectiveness of demonstrations in different settings.

D16: Using a liquid prism to demonstrate index of refraction

Raymond Dudek (Wittenberg, United States)

The use of two parallel lasers shined onto a plastic prism filled with liquid media having varying indexes of refraction, which effectively demonstrates how the beam paths are altered by the different media. The use of different lasers at different wavelengths can also demonstrate the wavelength dependence of index of refraction. By making simple measurements the index of refraction for any media can be calculated.

D17: Using LEDs to demonstrate properties of light

Susan Hershberger (Miami University, USA), Lynn Hogue (Miami University, USA), Mickey Sarquis (Miami University, USA)

Whether you are: introducing quantized energy levels for the first time, or covering properties of light, quantized energy, photoelectric effect, line spectra and introducing the Bohr model of hydrogen, or presenting different types of spectroscopy and distinguishing between fluorescence and phosphorescence: focus your student's attention using colored LEDs to illuminate properties of emitted light. Most dramatically, shining colored LEDs on a phosphorescent material allows the relative energy of colored light to be experienced. Shining red light on a phosphorescent (ZnS-Cu doped) plastic sheet causes no phosphorescent glow. Green light on the same phosphorescent sheet causes a faint and short lived phosphorescent glow. Blue light causes the brightest and longest lived yellow-green phosphorescent glow. The order of light energy is blue>green>red. The light emitted is of lower energy than the excitation energy: blue, green-blue > yellow-green (Stokes Law). The difference between phosphorescence and fluorescence can also be demonstrated with fluorescent materials such as fluorescent markers, or chlorophyll extracted from spinach or other green leaves in isopropyl alcohol. The fluorescence is observed only with the blue LED, and the glow, (yellow-green, marker) (or red, chlorophyll) is observed only while the LED is shining on the fluorescent material. The addition of red, green and blue light to give white light can also be observed in the mixed light on a white background.

D18: Fireproof balloon

Edward Senkbeil (Salisbury University, USA)

"The Fireproof Balloon" is a safe and simple inquiry-based demonstration that challenges the audience to explain why student-filled balloons pop over a lit candle, while the instructor-filled balloon does not. The placement of 25 mL of water in the instructor's balloon prior to filling allows the heat to be absorbed from the candle flame and prevent the balloon from breaking. The concept of specific heat can be explained and compared when using this demonstration.

D19: Nutritional label LIES!

Doctor DeMento (Jerry DeMenna) (Sacred Heart University, US)

Using the selective "Fingerprinting" capability of Infra-Red (IR) Spectroscopy... we can quickly test most FOODS for their Fat, Carbohydrate and Protein content... and often find mistakes (otherwise known as QC "discrepancies"). Trans-Fat Falsehoods, Low-Card "Non-Bread", Faux Meat and Anti-Cheese will be shown for the FAKES that they are! Be afraid... be very afraid!!

D20: Macro-level demonstration of equilibrium

Mike Briggs (IUP, USA)

Demonstrations of chemical concepts can scaffold student learning by focusing attention on the details of a demonstration in order to assure a domain acceptable mental model is constructed. Equilibrium is often a difficult concept for students to grasp and a properly designed and delivered demonstration can help students understand the dynamic nature of chemical equilibrium processes. The dynamic operation at the heart of equilibrium is a necessary constituent of a robust mental model of the concept. I will show how one can use a desktop sized demonstration of chemical equilibrium to facilitate the construction of a mental model having five constituents.

D21: Light bulb demos with a forensic twist

Brian Rohrig (Jonathan Alder High School, USA)

Three short related demos dealing with the light bulb will be presented. The first will involve heating a bulb and then immersing it in cold water, breaking the bulb. When turned on, it will then burn for only about a second before burning out. This teaches the non-reactivity of noble gases and combustion of the W filament when exposed to oxygen. The presence of tungsten oxide on the filament is used by forensic scientists to determine if a bulb was on or off during an accident. The second will involve repeating the above procedure, except this time immersing in liquid nitrogen, where it will burn brightly. This demonstrates non-reactivity of nitrogen. The third involves heating a bulb until it pops, resulting in a small hole in the bulb where the gases escaped. This method is used by arson investigators to determine the direction fire originated. The blown out portion of the bulb points toward the direction the fire originated. This demo also demonstrates how the pressure of gases increase as they are heated in a confined space, as well as how glass can become soft and weak upon heating. Throughout, the amazing chemistry of the light bulb will be discussed.

D22: Like dissolves like

Kathryn Wagner (Princeton University, USA)

With very slight changes in the presentation, this colorful demonstration of molecular interactions can be used to illustrate many concepts at many levels: pure substances and mixtures; types of mixtures; solubility and extraction; polar/non-polar bonds; hydrophilic/hydrophobic interactions; phases and surfaces; density; and chemical reaction.

D23: Instant slush

Bette Bridges (Bridgewater-Raynham Regional High School, USA)

INSTANT SLUSH Let an unopened glass bottle of soda (seltzer) water cool completely surrounded by an ice/salt or ice/acetone bath until thermal equilibrium (about 20 minutes) is reached. Carefully, lift the bottle partially out of the bath, break the seal to open the bottle. Slowly continue to lift the bottle out of the bath. Watch.

D24: Approximating the adiabatic expansion of a gas

Jason Hofstein (Siena College, USA)

In an attempt to approximate the effect of an adiabatic expansion in a laboratory setting, an apparatus is assembled and filled with a gas. The system is rapidly exposed to atmospheric pressure, and then allowed to recover. By measuring and recording the pressure throughout this process using a low-cost Vernier pressure sensor, the resulting expansion can be discussed thermodynamically, and the ratio of heat capacities for the gas in question can be calculated.

D25: Scaling a flashy demo

James Maynard (UW Madison, U.S.)

Chemical demonstrations must be made appropriate for both the students and for the classroom. This presentation will demonstrate the concept of flame emission and absorption spectroscopy for a small, medium, and large classroom setting, to combine maximum effect with maximum safety.

Symposia sessions

Wednesday, August 2 afternoon

1:15 PM - 5:00 PM STEW 202

S43: Chemistry Across Borders - Session 2 of 2

Lucy Eubanks (Clemson University , USA), **Carmen Gauthier** (Florida Southern College , USA)

This symposium will explore the practice of chemistry education in other parts of the world.

Speakers will give examples of successful collaborations and then discuss current projects and future directions. This is an opportunity to expand horizons and learn from other educators' experiences.

| | | |
|------|----------------|--|
| 1:15 | | introduction |
| 1:20 | Zafra Lerman | P509: Chemical education in the Middle East: a bridge to peace |
| 1:40 | Andoni Garritz | P510: Impact of the Journal "Educacion Quimica" on Ibero-America |
| 2:00 | Lynn Hogue | P511: Korea and Ohio—A Special Connection |
| 2:20 | William Deese | P512: Chemical Concepts and Connections (C3) for Teacher Leaders |
| 2:40 | | break |
| 2:50 | Fang Huang | P513: Researchers' understanding of NOSI in China and America |
| 3:10 | Nak Han Jang | P514: Structural Analysis of Conceptual Hierarchy on Chemical Bonding for Korean College Students Using Knowledge State Analysis |
| 4:00 | | discussion |

P509: Chemical education in the Middle East: a bridge to peace

Zafra Lerman (Columbia College Chicago, USA)

Nobel laureate Yuan T. Lee from Taiwan said to Middle East chemists who gathered together in Malta for a conference, "Borders are only lines on a map. Nature does not recognize borders."

With this motto, scientists from 12 Middle East countries (including Israel, Palestine, Jordan, Egypt and Iran, just to name a few) started working on a unified science curriculum for the Middle East.

P510: Impact of the Journal "Educacion Quimica" on Ibero-America

Andoni Garritz (UNAM, MEXICO)

This paper describes an International Multilanguage Journal and its Importance in Updating Chemistry Teaching. Between 1966 and 1974 the Journal "Revista Iberoamericana de Educación Química" was edited by the Mexican Chemical Society. In the nineties "Educación Química" was born in Mexico, edited since then by the author. Now, a majority of papers are written by non-Mexican authors, so it is an International Journal already. Up today, more than 260 papers have this characteristic, and are signed by authors mainly from Argentina, Spain, USA, Israel, Cuba, Chile and Brasil. The policies of the journal are that we have a Mexican Editorial Council (1988)

and an International Editorial Council (1994)]: Plurality; Four languages (English, Spanish, French and Portuguese); Strict referee judgment; Minimization of translations and maximization of original papers.

P511: Korea and Ohio—A Special Connection

Lynn Hogue (Miami University, USA), Mickey Sarquis (Miami University, USA)

A special educational and cultural program for Korean science teachers was developed by the Center for Chemistry Education at Miami University, Ohio, with funding from the Seoul Ministry of Education. Specially selected Korean science teachers received training in science content, pedagogy, and inquiry-based lessons. This three-week program also included immersion in US culture and visits to historical and recreational sites. Details of this program and what we learned along the way will be discussed.

P512: Chemical Concepts and Connections (C3) for Teacher Leaders

William Deese (Louisiana Tech University, USA)

C3 is a 3-year professional development program funded by the NSF. It is held in northern Louisiana on the campus of Louisiana Tech University. Approximately 150 physical science and chemistry teachers from Louisiana, Texas, and Arkansas attend the program. Components of the program include an intensive 2-week institute each summer and academic year follow-up through workshops, newsletters, classroom visits, and electronic learning community. The program integrates history of science, chemical content, teaching through inquiry, and leadership skills. The project is team taught by university faculty and an experienced K-12 teacher.

P513: Researchers' understanding of NOSI in China and America

Fang Huang (Malinson Institute for Science Education, USA)

This paper focuses on researchers' understanding of the Nature of Scientific Inquiry (NOSI) in America and China. Common places and differences in these two countries will be explored. In addition, researcher's view of teaching approach in order to implement scientific inquiry will be studied.

P514: Structural Analysis of Conceptual Hierarchy on Chemical Bonding for Korean College Students Using Knowledge State Analysis

Nak Han Jang (Kongju National University of Education, KOREA)

Chemical bonding concepts is regarded as a difficult topic for students to understand because it involves both the abstract concept as well as the understanding of many other chemistry concepts. Thus, there is great potential for the formation of many misconceptions. In order to be efficient teaching should understand the current level of learners through diagnostic evaluation. This study was examined for conceptual hierarchy on chemical bonding by incorporating the using knowledge state analysis. Knowledge state analysis is a method where by a distinguished collection of knowledge uses the theory of knowledge space. The theory of knowledge space is very advantageous when analyzing knowledge in strong hierarchies like mathematics and science. It helps teaching plan through methodically analyzing a hierarchy viewpoint for students' knowledge structure. The theory can also enhance objective validity as well as support a considerable amount of data fast by using the computer. In the result, student understanding can be improved through individualistic feedback. In this study, an evaluation was developed with measurement of students' concept for chemical bonding, which is unattainable from the existing evaluation

method. The instrument was administered to Korean college freshman students, and the result of student evaluation was analyzed using the theory of knowledge space. Following this, a revised diagnostic evaluation was constructed for facilitating individual learning of Korean college freshman students.

1:15 PM - 5:10 PM STEW 218AB

S51: Designing Effective Molecular Animations - Session 1 of 1

Loretta Jones (University of Northern Colorado, USA)

This symposium will focus on the development of design principles for effective molecular animations. Developers of animations and those who have done research on animations will present their findings about what works and what doesn't as well as how best to use animations in the chemistry classroom at all levels.

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|------------------------------------|---|
| 1:15 | introduction |
| 1:20 Michael Sanger | P515: What have we learned from a decade of research on computer animations in chemistry? |
| 1:40 Barbara Tversky | P516: Cognitive aspects of animation design |
| 2:00 Resa Kelly | P517: Exploring how animations of NaCl dissolution affect students' ability to explain a precipitation reaction |
| 2:20 Rebecca Dalton | P518: Comparison of expert and novice interpretations of a redox animation |
| 2:40 Jerry Honts | P519: Representing time and space in animations of molecular machines |
| 3:00 | break |
| 3:10 Sevil Akaygun | P520: Research-based design of a molecular animation of physical equilibrium |
| 3:40 Jacqueline Hilsenbeck-Fajardo | P521: Effect of molecular visualization on novice biochemistry students |
| 4:00 David Falvo | P522: Influence of interactive, self-explaining environments |
| 4:20 Catherine Milne | P523: Using cognitive load theory to develop animations and simulations: The road partly traveled |
| 4:40 | panel discussion |

P515: What have we learned from a decade of research on computer animations in chemistry?

Michael Sanger (Middle Tennessee State University, USA)

This paper will describe the results of a decade's worth of chemical education research performed by the author on the use of computer animations to teach chemical processes at the molecular level. I will discuss specific examples of animations that have been shown to improve students' conceptual understanding of chemistry, general trends from these studies, and specific issues such as when animations actually detract from student learning and difficulties encountered when assessing students' conceptual understanding.

P516: Cognitive aspects of animation design

Barbara Tversky (Teachers College Columbia, USA)

Graphics can rapidly communicate concrete and abstract information, if well-designed. Principles for effective design can come from studying people's mental models of the concepts to be conveyed. Animations are rapid sequences of graphics so they seem ideal for conveying change over time. Nevertheless, animations have drawbacks: they are often too complex; people think about change over time as discrete stages; animations typically show rather than explain. Our hope is to design animations that will take into account these cognitive limitations. I will describe experimental approaches to developing cognitive design principles for effective animations.

P517: Exploring how animations of NaCl dissolution affect students' ability to explain a precipitation reaction

Resa Kelly (San Jose State University, United States)

Many studies (Kelly, Phelps and Sanger, 2004; Sanger, Phelps and Feinhold, 2000; Wu, Krajcik, and Soloway, 2001; Burke, Greenbowe and Windschitl, 1998; and Williamson and Abraham, 1995) have suggested that students who receive instruction including computer animations or visualizations of chemical processes at the molecular level are better able to answer conceptual questions about particulate phenomena. In this study, eighteen college students enrolled in general chemistry participated in three research sessions. First, they were individually shown two popular textbook animations of salt dissolution after each performed an activity of the same event. Second, after one week the same subjects were asked to interpret a precipitation reaction at the molecular level. Third, a debriefing session and semi-structured interview were held. An analysis of the data from the first session showed that students incorporated some of the microscopic structural and functional features from the animations into their explanations, and many were able to connect how the microscopic process of dissolution related to the macroscopic disappearance of the salt. Although students' drawn explanations displayed many features seen in the salt dissolution animations, their verbal explanations sometimes indicated that they drew these features without full comprehension of their meaning. In a study of the transfer of learning, it was found that most students did not see a relation between the sodium chloride solution made when dissolving the salt and the sodium chloride solution used in a precipitation reaction.

P518: Comparison of expert and novice interpretations of a redox animation

Rebecca Dalton (University of Western Sydney, AUSTRALIA), Roy Tasker (University of Western Sydney, AUSTRALIA)

The first stage of this study was to examine similarities and differences in the ways novices (university undergraduates) and experts (chemistry academics) perceive and interpret a complex animation that depicts the chemical processes involved in a redox reaction at the molecular level. Then, by comparing and contrasting particular 'key features' identified by novices and experts, we have devised strategies for improving animations (or the way they are used) to assist novices to perceive the key features and interpret them like an expert. The research methodology involved a number of one-to-one, semi-structured interviews, each lasting approximately one hour. During interviews participants were required to express their initial concepts about a redox reaction, verbally, and in storyboard form. They were then shown a VisChem animation designed to portray facets of this reaction at a molecular level. Prior to viewing the animation, they were introduced to the visual symbolism used. During and after viewing the animation, participants were encouraged to discuss their understanding and opinions of the animation. Interviews were videotaped in order to record verbal and non-verbal (e.g., gestures) communication about the animations, together with

storyboard diagrams and comments.

P519: Representing time and space in animations of molecular machines

Jerry Honts (Drake University, United States), Amber Heck (Drake University, United States)

Our understanding of the cell has advanced to the place where we see it as a collection of interacting molecular machines. Detailed information about the structure, function, and regulation of these molecular machines has made its way into molecular life sciences textbooks during the last decade. Students are now challenged to learn not only understand *what* these machines do in the cell, but *how* they function in terms of molecular structure and mechanism. We have chosen to use the sarcoplasmic calcium pump (Ca^{2+} ATPase) as a target for the development of animations that explore the pedagogical effectiveness of various representations of the temporal and spatial aspects of the cyclic function of this ion-pumping molecular machine.

P520: Research-based design of a molecular animation of physical equilibrium

Sevil Akaygun (University of Northern Colorado, USA), Loretta Jones (University of Northern Colorado, USA)

What do beginning chemistry students imagine when they visualize the equilibrium between liquid and vapor or that in a saturated solution? Diagrams and verbal molecular-level visualizations of vapor-liquid equilibrium and saturated solutions were generated by beginning chemistry students and by chemistry instructors. Instructors who wrote verbal descriptions focused on different aspects of the molecular processes than instructors who drew diagrams. Student diagrams and writings differed from those of the instructors in that they were less complete and contained many misconceptions as well as interesting insights. The data were analyzed and the findings used to design the storyboard for an animation of the molecular processes that take place in an equilibrium situation and to develop guidelines for presenting these concepts to beginning students.

P521: Effect of molecular visualization on novice biochemistry students

Jacqueline Hilsenbeck-Fajardo (Univ Northern Colorado, United States), **Jerry P. Suits** (Univ Northern Colorado, United States)

The purpose of this study was to investigate how traditional lecture instruction combined with molecular visualization tools affect student development of protein structure and function relationships. The students were enrolled in an undergraduate “fundamentals of biochemistry” course designed for allied health majors. Quantitative analysis of the pretest and posttest results ($N \sim 100$) revealed that most students had acquired very little understanding of amino acids, peptides, protein structures or enzyme structure-function relationships. Qualitative semi-structured interviews ($N = 6$) showed that although students became familiar with key terms and concepts, they did not develop an accurate “picture” or conceptual framework to which they could apply their newly-acquired knowledge. The students who were interviewed then viewed selected on-line animations of protein structure and enzyme catalysis. Most were very engaged with the selected animations. We plan to present these findings as well as the findings from a subsequent quantitative study where students viewed animations. This research was supported by NSF ROLE Grant Award #0440103.

P522: Influence of interactive, self-explaining environments

David Falvo (University of Northern Colorado, USA)

Today, more than ever before, students and adults are using computers at home, work, and school

(Newburger, 2001). The use of educational technology for science learning has much potential. Studies by Sanger, Phelps, and Fienhold (2000), Burke, Greenbowe and Winschitl (1998), Sanger and Greenbowe (1997), and Williamson and Abraham (1995) have suggested that students who receive instruction including computer animations of chemical processes at the molecular level are better able to answer conceptual questions about particulate phenomena. Little research has focused on what aspects of the animations have helped students to change their mental models of chemistry concepts. Traditionally, print based materials have been the most widely used method to deliver this type of instruction, however computer animations are quickly gaining popularity throughout the curriculum (Reiser & Dempsey, 2002). While research on multimedia design is abundant (Mayer, 2001), little is known about the effectiveness of various elements in animated computer simulations and according to Chandler and Sweller, "...instructional design based on visual elegance, common sense, and convenience are inadequate (1991, p. 294)." Additionally, much research about self-explaining environments shows the effectiveness of that technique, but not in the context of simulations about molecular chemistry (Chi, 2005). The purpose of this study is to investigate the impact that pacing and learner control combinations, in self-explaining environments in molecular animations, have on the retention and transfer of software instruction.

P523: Using cognitive load theory to develop animations and simulations: The road partly traveled

Catherine Milne (NYU, USA), Juan Barrientos (New York University, USA), Bruce Homer (New York University, United States), Trace Jordan (New York University, U.S.A.), Slava Kalyuga (New York University, USA), Reneta Lansiquot (New York University, United States), Jan Plass (New York University, USA)

This presentation describes the work of a collaborative research team consisting of multimedia experts, content experts, cognitive psychologists, and science educators. We are using current research in cognitive science and multimedia learning to design and evaluate computer simulations/animations for chemistry education. Our experience has indicated that the visual representations introduced into high school science are frequently designed for experts rather than novices, making it difficult for students to make sense of such diagrams, animations, and simulations, not because of difficult content, but because of the difficulty of processing the representations. Our interest is in working in urban contexts with high school students who may have had very variable science educational experiences prior to commencing their study of chemistry, and to study how visual materials can be designed so that students find them more comprehensible. The first subject areas for which we developed animations/simulations are gas laws and chemical equilibrium. We will illustrate how cognitive theories of information processing (e.g., cognitive load theory), principles of multimedia design (e.g., symbolic versus iconic representation), related issues in chemistry education (e.g. levels of representation), and our partnership with high school chemistry teachers have informed our development of our current animations/simulations.

1:15 PM - 4:50 PM STEW 214C

S34: Different Methods of Using Learning Theory in Teaching Organic Chemistry - Session 2 of 2: New Skill Building Activities and Laboratory Exercises

Barbara Murray (University of Redlands, USA)

This symposium will cover new teaching methods in organic chemistry, such as POGIL, PBL, and

PLTL. The audience will be able to compare all methods presented and will be better able to judge which one might work in his/her own classroom.

| | |
|--------------------------|---|
| 1:15 | introduction |
| 1:20 Dell Jensen | P524: Beyond library basics: Building skills for reading scientific literature |
| 1:40 Jean-Claude Bradley | P525: Organic chemistry games: EduFrag and Wheel of Orgo |
| 2:00 Daryle Fish | P526: Integration of problem based learning in Organic II: Synthesis and spectroscopy of common pharmaceuticals |
| 2:20 Brenda Harmon | P527: Student-centered approach to teaching the organic laboratory: Learning to think like a chemist |
| 2:40 Dell Jensen | P528: Integration of synthesis and spectroscopy using 9-hydroxyphenyleneone |
| 3:00 | break |
| 3:10 Owen Priest | P529: Collaborative organic chemistry laboratory exercise: Mosher amides |
| 3:30 Martin Jones | P530: Discovery based group projects in the organic laboratory |
| 3:50 Benjamin Reynolds | P531: Research-based synthetic experiences in organic chemistry |
| 4:10 Layne Morsch | P532: Original research in sophomore organic chemistry laboratory |
| 4:30 | discussion |

P524: Beyond library basics: Building skills for reading scientific literature

Dell Jensen (Augustana College, USA), *Connie Ghinazzi* (Augustana College, US), *Richard M. Narske* (Augustana College, USA)

With the growing availability of electronic databases, online journal publications, and open access publishing there is unprecedented access to research materials. These materials are increasingly integrated into undergraduate research and science curriculum with the assumption that students are more computer savvy than previous generations. The question remains, "Do students REALLY know how to use research materials?" Building from basic information literacy skills, we have implemented a series of assignments in the organic chemistry lecture to introduce students to reading and interpreting scientific literature. These assignments include classification of publications, purpose of the title and abstract, surveying literature using research topics, and summarizing research in an annotated bibliography. These information literacy skills specific to scientific literature provide a solid foundation for advanced literature searches in upper level courses and undergraduate research.

P525: Organic chemistry games: EduFrag and Wheel of Orgo

Jean-Claude Bradley (Drexel University, USA)

The implementation of two gaming strategies to catalyze the learning of organic chemistry will be demonstrated. The first game, "Wheel of Orgo", involves play in a face-to-face classroom context. Students take turns drawing reactions on a tablet PC to complete a multi-step synthesis. In the second game, "OrgoFrag", students explore a map within a First Person Shooter (FPS) environment (Unreal Tournament). The rooms are decorated with organic chemistry concepts and reactions on the walls and doors. Knowledge of the material allows for safe navigation through the

map. The game can be played either alone as a maze or against bots and other players in Death Match mode. See <http://edufrag.wikispaces.com/orgofrag> for more information.

P526: Integration of problem based learning in Organic II: Synthesis and spectroscopy of common pharmaceuticals

Daryle Fish (Saint Vincent College, USA)

There are a number of common pharmaceuticals on the market today that can serve as target compounds for sophomore organic students. Students are given problem sets that require them to develop synthetic routes to these compounds and to use NMR techniques to identify compounds such as Albuterol, Atenolol, Ibuprofen, and Prozac. These problem sets are developed to reinforce the learning that takes place throughout the year and to develop higher order thinking skills.

P527: Student-centered approach to teaching the organic laboratory: Learning to think like a chemist

Brenda Harmon (Oxford College of Emory University, USA)

This talk will describe a student-centered first semester organic laboratory course where students are presented with the challenge on the first day of lab of coming up with their own procedure for isolating pure caffeine from coffee beans. Throughout the course of the semester, the students learn the concepts of separation, purification, and identification in the context of smaller assignments (all of which employ some form of situated learning) but are consistently reminded that they will have to combine all of the techniques they learn at the end of the semester to isolate caffeine. Students are required to work in pairs and extended groups (4-6 students) before and during all of the laboratory sessions. During the final two weeks of lab, the students design and implement their own methods to isolate, purify, and identify the caffeine as a "lab practical". Student attitudes and reflective responses over four years of implementing this student-centered approach will be presented.

P528: Integration of synthesis and spectroscopy using 9-hydroxyphenalenone

Dell Jensen (Augustana College, USA)

9-Hydroxyphenalenone is a planar multicyclic alpha-keto enol, which is synthesized from a Friedel-Crafts acylation followed by acid catalyzed cyclization in a one-pot reaction during a lab period. Due to tautomerization of the alpha-keto enol, this compound demonstrates C_{2v} symmetry on the NMR timescale with three separate spin systems. The ¹H and ¹³C assignments can be made using standard 1D and 2D NMR techniques and data collection can be reduced to less than thirty minutes using optimized parameters. This integrated experiment demonstrates the utility of NMR characterization beyond the typical ¹H and ¹³C spectra.

P529: Collaborative organic chemistry laboratory exercise: Mosher amides

Owen Priest (Northwestern University, United States)

At Northwestern, we have created a laboratory project that allows students to use many of the tools they learn in organic chemistry while requiring them to learn to work as part of a team. The synthesis and analysis of Mosher amides allow students to explore their understanding of concepts such as enantiomers, diastereomers, chirality, NMR spectroscopy, magnetic anisotropy, shielding, and deshielding. In order for students to successfully complete the project they must work in teams of at least two. Each team is given an amine of unknown chirality, and each half of the team derivatizes a sample of the amine with either the R or S-Mosher's acid chloride. The resulting

diastereomeric, Mosher amides are easy to prepare, purify, and characterize by $^1\text{H-NMR}$ spectroscopy to determine the absolute stereochemistry of the starting amine. Examples of this laboratory project will be presented as well as an assessment of its effectiveness.

P530: Discovery based group projects in the organic laboratory

Martin Jones (Adams State College, USA)

For five years, students in our organic chemistry lab have conducted group project experiments to explore dehydration and electrophilic aromatic substitution (EAS) reactions. Both sets of experiments involve the use of molecular modeling to predict product distribution and the confirmation of the predictions by analysis of the actual products obtained using instrumental techniques (capillary GC, H- and C-NMR). Students work in groups of four, with each student doing an individual reaction. This permits the group to compare two different sets of conditions with replication of each set and provides more information for the writing of a formal laboratory report. Because of the advance use of computer-based molecular modeling for predictive purposes, one might question whether these group projects truly are “discovery” experiments or “verification” experiments. Regardless of the semantics, students do indeed discover, in these projects, that Zaitsev’s rule is followed for dehydration of alkenes and also that specific substituents have specific directing influences in EAS reactions.

P531: Research-based synthetic experiences in organic chemistry

Benjamin Reynolds (University of Michigan, USA), Amy Gottfried (University of Michigan, USA)

Incorporating authentic laboratory activities into the undergraduate chemistry classroom is important for helping students develop realistic conceptions about the scientific process. At the University of Michigan, we have been developing a research-based lab project in second-semester organic chemistry that familiarizes students with the synthetic process and chemical literature. We have focused on balancing the desire to have students participate in full-fledged, open-ended inquiry projects with the practical limitations of our current classroom structures. This presentation will examine the challenges of this laboratory design and describe the results of a comparative study of students in our traditional lab courses with those participating in the research-based lab course.

P532: Original research in sophomore organic chemistry laboratory

Layne Morsch (DePaul University, USA)

In order to provide organic chemistry students with a more representative view of working as a scientist, a project was developed to provide research experience during the third quarter of a year-long organic chemistry sequence. To better understand students’ perceptions about performing research during a laboratory course, anonymous questionnaires were completed prior to the laboratory research and at the completion of the course in several lab sections that were engaging in research. The students were asked questions soliciting their impressions and evaluations of this alternative laboratory approach in a systematic and comprehensive manner. Students from three sections of a standard laboratory course were also asked to answer the same questions to have direct comparison data.

1:15 PM - 4:50 PM STEW 302

S35: First Year College Chemistry - Session 2 of 3

Cecilia Collado (Universidad de Concepcion, CHILE), **Matthew Fisher** (Saint Vincent College , USA)

Entry level college chemistry courses, whether for science majors or nonmajors, present unique challenges for instructors. This symposium will focus on several aspects of these challenges posed by first-year chemistry courses. Topics to be considered will include teaching strategies, curriculum questions especially as they relate to issues of globalization and harmonizing disparate needs and interests, and assessment of student learning.

| | | |
|------|------------------|---|
| 1:15 | | introduction |
| 1:20 | Gabriela Weaver | P533: Authentic research experiences for the undergraduate chemistry curriculum |
| 1:40 | Anil Banerjee | P534: Student learning and retention in a first year college chemistry course |
| 2:00 | Shawn Kellie | P535: Factors affecting the success of freshman chemistry students at a rural 2Y Community College |
| 2:20 | George Armstrong | P536: Pre-chemistry course designed to increase success of students in General Chemistry I |
| 2:40 | Gregory Gellene | P537: An evaluation of placement tests and remedial courses in the chemistry curriculum |
| 3:00 | | break |
| 3:10 | Patricia Morales | P538: Problem based learning (PBL) in general chemistry for engineering: Some steps forward and some steps back |
| 3:30 | Thomas Jose | P539: Pyramid testing as a catalyst for change in a non-majors chemistry course |
| 3:50 | Roy Jensen | P540: Pedagogical continuity. Minimizing learning barriers |
| 4:10 | Siegbert Schmid | P541: Bridging the gap : Preparing students for first year chemistry |
| 4:30 | Manuel Martinez | P542: Integration of multiple methods of teaching in a general chemistry course: An effective mode of instruction |

P533: Authentic research experiences for the undergraduate chemistry curriculum

Gabriela Weaver (Purdue University, USA), William Fornes (Purdue University, United States), Fred Lytle (Purdue University, USA), Robert Morris (Ball State University, USA), Cianán Russell (Purdue University, United States), Pratibha Varma-Nelson (Northeastern Illinois University, US), Donald Wink (UIC,)

Research experiences can often be inspiring and life-changing for young college students. It is possible that research experiences are pivotal in making decisions about college majors and careers. We are beginning to implement research as part of the regular curriculum for first and second year students in chemistry. In this presentation, I will discuss the structure of the Center for Authentic Science Practice in Education (CASPiE) project and describe our initial steps towards providing research experiences to early undergraduates as part of their regular curriculum. The center utilizes authentic research projects, a remote-access network of chemical instruments, the peer-led team learning (PLTL) model, and the first-year laboratory course for giving students a research experience. Results of the first two years of the program will be described.

P534: Student learning and retention in a first year college chemistry course

Anil Banerjee (Columbus State University, USA)

This study involving 110 students enrolled in a first semester introductory chemistry course in fall 2005 aims at improving student learning of basic concepts and problem solving, and also their retention in the class. This first college course in chemistry is taken by students as a core course. The majority of students in this course is nursing, and exercise science majors. The entry level chemistry knowledge varies widely. The instructional strategies include small peer-group tutorial sessions, home work on problem solving, and study guides to supplement the lecture classes. The first test on three units was given after four weeks of instruction and showed about 30 % students failing. Students struggled with writing chemical formula and balancing chemical equations. These concepts and stoichiometry were again introduced after teaching the units on atomic structure, periodic table and electron configuration. The students felt more comfortable with this strategy. The second test after eight weeks showed some improvements with less than 15% students failing and about one-fourth of the class improving grades by 20%. Similar trend is found after the third test in mid November. The number of students dropping the course is below 6 %. The emerging trend indicates that student learning and retention could be improved through sustainable efforts and learning materials. The data on student achievements and retention in the semester course will be presented along with the effect of the interventional strategies.

P535: Factors affecting the success of freshman chemistry students at a rural 2Y Community College

Shawn Kellie (Elizabethtown Community & Technical College, USA)

Anyone who has spent time talking to students knows that a student's success or failure in college chemistry deals with more than just their academic background. At Elizabethtown Community and Technical College, in an attempt to understand the reasons for students' success, a detailed study was conducted during the 2005-2006 school year. National test scores for each student were collected prior to their enrollment in a chemistry class in the form of ACT or Compass scores. The students' scores in prior math classes were also collected. Students were questioned on a variety of topics including their academic background, course expectations, employment status and lifestyle. Among the specific items examined were the number of hours a student worked, the living arrangements of students and the student's motivation for taking chemistry. These results of the student surveys were analyzed with respect to their outcome in the course and their score on an ACS final exam. Students in both General College Chemistry and non-science major chemistry courses were evaluated.

P536: Pre-chemistry course designed to increase success of students in General Chemistry I

George Armstrong (Tougaloo College, USA), **George H Armstrong** (Tougaloo College, USA), *Alfredlene Armstrong* (Tougaloo College, USA), *Demetria White* (Tougaloo College, USA)

Tougaloo College, a HBCU institution, has a history of significant numbers of its science majors going to graduate school and completing degrees in the health profession. Tougaloo accepts students with a wide range of readiness for undergraduate school. Historically, the success, obtaining a grade C or higher, in General Chemistry I has been as low as 30%. Students are identified to take General Chemistry I, if math test scores place them in College Algebra I or in a higher math. Students that do not place in College Algebra I take a pre-college algebra math course. They are eligible to take General Chemistry I when they are eligible to take College Algebra I. CHE 104 Chemical Problem Solving is designed for students who initially do not

qualify to take General Chemistry I. The course consists of: basic math, including the metric system, taught by a math instructor; developing study skills and content strategies taught by a reading teacher; and selected topics in General Chemistry taught by a chemistry instructor, using the POGIL (Process Oriented Guided Inquiry Learning) method with in-class experiments when appropriate. Preliminary results showed that students who have taken this course do better in General Chemistry I than historically seen, with approximately 70% passing with grade C or higher. The ACS Toledo Exam (undergraduate placement test) showed significant gains in content knowledge by students taking CHE 104 Chemical Problem Solving.

P537: An evaluation of placement tests and remedial courses in the chemistry curriculum

Gregory Gellene (Texas Tech University, USA)

The performance of unremediated-underprepared, remediated-underprepared, and prepared students in a first fundamental university level chemistry course is compared over a six year period involving almost 6000 students. The average final percentage scores of these three groups of students are statistically indistinguishable suggesting no special benefit is gained by the successful completion of the remedial course. Furthermore, because about 75% of incoming students are deemed in need of remediation by virtue of their performance on a placement examination, and about 40% these students who successfully complete the remedial course do not continue in the program, the net result of the placement/remediation program is that fewer students successfully complete the first fundamental chemistry course required for most science, engineering, and pre-medical field/health care academic majors and programs. Follow-up studies involving student exit surveys and direct comparisons of various placement examinations indicate that the uncovered deficiencies resulted from limitations of the placement exam rather than from the remedial course. Current work in developing an improved placement exam will be discussed.

P538: Problem based learning (PBL) in general chemistry for engineering: Some steps forward and some steps back

Patricia Morales (Pontifical Catholic University of Peru, Peru)

The need for adequate methodology and teaching strategies for significant learning achievements has been widely described in literature. Our university's Strategic Plan 2000-2010 includes an expressed statement for the reformulation of methodologies applied, refocusing them towards a student centered curriculum, along with proper skills & abilities as major goals, for a more reflexive and autonomous student with better knowledge of environmental issues, processes and new technological tendencies. In 2001, Cooperative Learning was incorporated to the new Chemistry 1 course, with PBL experience in Organic and Biological Chemistry units. Initial results encouraged us to go on, one step forward, reformulating Chemistry 2 including PBL in all the topics and units. Assessment of two years of implementation and applications of PBL showed that succeeding students are much larger in number, with better learning skills achieved, according to higher grades obtained. This can be understood as a genuine interest for discovering the relevance and relationship between the course and future professional demands. However, when we moved on to step three, spreading the application by making the transfer process to a wider group of professors, we obtained lower levels of teachers' motivation and engagement, consequently, forcing a great loss of student's interest in many areas. Which is then, the real problem to deal with? Is it only related to the methodology applied? Is it due to our "misconception" on the "right way" to teach chemistry?

P539: Pyramid testing as a catalyst for change in a non-majors chemistry course

Thomas Jose (Blinn College, USA)

Pyramid testing is a novel student-centered method of assessment that awards students credit not only for individual achievement, but for group work as well. This two-part testing procedure has been used extensively in our CHEM 1405 Introductory Chemistry course for liberal arts and non-science majors. This presentation outlines the steps taken to more formally evaluate our use of pyramid testing. Achievements on pre- and post- content knowledge exams will be compared. Patterns of individual and group success on semester exams will be clarified. Students' attitudes and instructors' reactions to this approach were also considered. Early experiences with pyramid testing have guided decisions to modify the course focus. The hope is that these changes result in a course better suited for the terminal chemistry student.

P540: Pedagogical continuity. Minimizing learning barriers

Roy Jensen (Grant MacEwan College, Canada)

Historically, there has been a disconnection between high school and post-secondary science education. Based on classroom observations and students input, this presentation explores several current teaching practices that introduce artificial barriers to student's learning and suggests teaching strategies that may simultaneously improve student's learning and understanding. Concepts explored include scientific syntax, significant figures, dimensionality, equilibria, and activities.

P541: Bridging the gap : Preparing students for first year chemistry

Siegbert Schmid (The University of Sydney, Australia), *Adrian George* (University of Sydney, AUSTRALIA), *Justin Read* (The University of Sydney, Australia), *David Youl* (The University of Sydney, Australia)

Helping first year students, who have little or no prior knowledge of chemistry, to successfully complete first year tertiary studies represents a major challenge for chemistry educators. One way to ensure that all students are well equipped with the necessary skills and knowledge to complete a unit of study is to encourage those with a weak background in chemistry to participate in a bridging course. This presentation will discuss the chemistry bridging course at the University of Sydney as a model for bridging course design. Substantial empirical data concerning the efficacy of this bridging course, collected using a mixture of qualitative and quantitative methods, will be presented. These data allow the linkage between students' academic performance and their prior understanding of chemistry to be probed, and allow examination of the impact of the bridging course on the development of understanding. This presentation will also discuss the effect of both academic and non-academic factors related to the bridging course on exam performance at the end of the semester.

P542: Integration of multiple methods of teaching in a general chemistry course: An effective mode of instruction

Manuel Martinez (Universidad de Santiago, Chile), *Emilio Balocchi* (Universidad de Santiago, Chile)

Nowadays, a particular emphasis on how a shift can be made from someone who teaches to someone who tries to facilitate learning is taking place (Bodner et al, 1997). A classroom environment in which students are active participants in the learning process through the integration of multiple methods of teaching is something that ought to deserve our attention. We

need to try different strategies of instruction. The use of a cooperative learning environment in the classroom is widely known (Bowen, 2000). It has been chosen as a teaching strategy for its proven effectiveness as a teaching tool as well as a catalytic mean that promotes learning to learn. The use of concept maps has also been used to illustrate relationships among ideas and as advance organizers and there is evidence of its effectiveness for education (Francisco et al, 2002). The authors of this paper, have decided to actively involve students in a course that combines the principles of instructional design (Morrison, 2001) with cooperative learning techniques, where students work in teams, actively involved, and the use of concept maps in a general chemistry course, for students majoring in biochemistry. We developed instructional materials to be used in ionic equilibrium, electrochemistry and molecular geometry. Examples of the activities done from 2003, assessment results on tests and students opinions will be presented.

1:15 PM - 5:10 PM STEW 322

S52: Graduate TA Training and Beyond - Session 1 of 1

Lynne O'Connell (Boston College, USA)

Those who are responsible for training graduate students to be Teaching Assistants encounter many challenges. Beyond preparing these novice instructors for their first teaching assignment, there is also an opportunity to provide them with professional development and support for their career goals. Presenters will share information with others about their training and support programs for graduate student TAs. Examples of topics that will be included are: orientation programs for new graduate students who will teach laboratory or discussion sessions; seminar series that inform TAs about teaching methods and pedagogy; Preparing Future Faculty programs; support programs for international teaching assistants; and assessment of training programs.

| | | |
|------|-------------------------|---|
| 1:15 | | introduction |
| 1:20 | Gautam Bhattacharyya | P543: Graduate Teaching Assistants: Standing on the bridge between teaching and learning |
| 1:40 | Elizabeth Sprague | P544: Chemistry teaching seminar: Interactive approach preparing chemistry graduate students for their teaching assignment. |
| 2:00 | Steven Brown | P545: Selling TAs on learner centered education |
| 2:20 | Nilhan Gunasekera | P546: Resource development for graduate TA training in inclusive teaching |
| 3:00 | | break |
| 3:10 | Lynne O'Connell | P547: Undergraduate Guide program for international Teaching Assistants |
| 3:30 | Cynthia Fuhrmann | P548: Establishing a Preparing Future Faculty program at a research-focused health sciences university |
| 3:55 | Brian Huesgen | P549: Synthesizing a better Teaching Assistant: UMSL program review, TA reflections, and proposed improvements to training |
| 4:15 | James Rudd | P550: Development of constructivist teaching views in science and mathematics graduate students |
| 4:35 | | discussion |

P543: Graduate Teaching Assistants: Standing on the bridge between teaching and learning

Gautam Bhattacharyya (University of Oregon, USA), **Deborah Exton** (University of Oregon,

USA)

Excited to pursue their degrees and further their own career aspirations, students arrive in graduate school having given little thought to their roles as teachers. In addition, many fail to realize that earning and owning a Ph.D. means that they will be expected to teach in many settings, whether in academia or industry. How does a TA training program go about helping graduate students view the world through a teacher's eyes and prepare them for lifelong teaching and learning? How do we emphasize the importance of teaching in an environment that prioritizes research? In this seminar, we will attempt to address these questions as we discuss TA training at the University of Oregon.

P544: Chemistry teaching seminar: Interactive approach preparing chemistry graduate students for their teaching assignment.

Elizabeth Sprague (Rensselaer Polytechnic Institute, USA)

Since the mid 1990's the Chemistry and Chemical Biology Department at Rensselaer Polytechnic Institute has offered a Chemistry Teaching Seminar to its first year graduate teaching assistants. The seminar is a required 1 credit course for all of its graduate students that are assigned to teach. The seminar is informal and relaxed to create an atmosphere of ease that enables students to ask questions about responsibilities, expectations, and to raise any issues that may be of concern. The seminar course is not simply a lecture format course; topics are designed and presented with the expectation that the graduate students will provide their ideas and past experiences from the undergraduate education. With guidance from the course supervisor, specific objectives are accomplished. Some of the topics discussed are lab safety, job responsibilities, efficient and fair grading practices, academic dishonesty, ethical issues, lecture organization, presentation skills and individual presentations. The seminar has evolved over recent years to include interactive mini-workshops. The Archer Center for Student Leadership at Rensselaer has worked with the seminar group each year to promote leadership practices that develop teamwork and integrity in professional and personal development. The graduate students are an integral component to the success of the teaching seminar course. Specific examples of the topics will be presented as well as student evaluations of the course.

P545: Selling TAs on learner centered education

Steven Brown (University of Arizona, USA)

All new teaching assistants at the University of Arizona are required to participate in a seven day training course prior to the start of teaching and to take our one-credit "college teaching" seminar course. Many topics are discussed in these courses including laboratory safety, policies and procedures, teaching methodologies and grading. One major focus is the creation of an effective learner-centered learning environment. In this presentation the program will be described. Data showing the effectiveness with which teaching assistants are able to implement learner-centered methods will be presented. The impressions of teaching assistants will be discussed.

P546: Resource development for graduate TA training in inclusive teaching

Nilhan Gunasekera (UW-Rock County, USA), *Judith Burstyn* (University of Wisconsin, USA), *Alberto Cabrera* (University of Wisconsin, USA), *Katherine Friedrich* (University of Wisconsin,), *Sherrill Sellers* (University of Wisconsin-Madison, USA)

Training of future STEM educators often begins in graduate school. Thus adequate training of graduate Teaching Assistants (TAs) is critical not only for teaching the undergraduate courses at

the graduate institution, but also for the future success of STEM educators. As the U.S. college student population experiences major changes in demographics in the coming decades and the number of students pursuing certain STEM degrees declines, the need to create welcoming and inclusive STEM classrooms will only increase. To meet this challenge the Center for the Integration of Research Teaching and Learning at UW-Madison has created resources for faculty development under the auspices of a grant from the National Science Foundation. This short presentation will introduce you to a couple of these resources that have been created with the new graduate TAs and faculty members in mind, and explore their use in the training of Graduate Teaching Assistants.

P547: Undergraduate Guide program for international Teaching Assistants

Lynne O'Connell (Boston College, USA), Suzanne Barrett (Boston College, USA), Michael Panichas (Boston College, USA)

A new support program for international Teaching Assistants (ITAs) has been implemented in our department. Senior chemistry and biochemistry majors are hired to serve as guides for the ITAs. Each Undergraduate Guide (UG) is partnered with an ITA and attends the ITA's lab period each week, assisting the instructor when communication problems arise. In addition, the UG meets with the ITA each week to discuss events that occurred in the laboratory and to answer questions about English language, slang expressions and American culture. Feedback about the program was gathered from the ITAs, UGs and the students of the ITAs via focus groups and surveys.

P548: Establishing a Preparing Future Faculty program at a research-focused health sciences university

Cynthia Fuhrmann (University of California, San Francisco, USA)

In the summer of 2004, Preparing Future Faculty (PFF) was launched as a volunteer, student-driven initiative at the University of California San Francisco (UCSF), a doctoral-granting research institution that specializes in the health and basic life sciences. The pilot PFF program (www.ucsf.edu/pff) was a 12-week "Summer Series" consisting of weekly seminars, lectures, workshops, and panel discussions designed to aid graduate students and postdoctoral scholars in developing their teaching skills, building awareness for academic careers, and acquiring tools to competitively approach the academic job search process. Evaluation and survey data were collected and analyzed to determine the effectiveness of the Summer Series, participants' perceptions of academic careers and teaching, and changes in perceptions upon participation in our program. We will present recommendations for implementing similar programs at other universities, and discuss our ideas for expanding the Summer Series to provide graduate/professional students and postdoctoral scholars with in-depth pedagogical training and mentored experience in teaching.

P549: Synthesizing a better Teaching Assistant: UMSL program review, TA reflections, and proposed improvements to training

Brian Huesgen (University of Missouri-St. Louis, US), Hal Harris (University of Missouri-St. Louis, US)

At the University of Missouri-St. Louis, our graduate teaching assistants are responsible for leading workshop sessions (a modified PLTL scheme). Few of them have had any teaching experience or training prior to their time here. Within the first few weeks of their arrival they are thrust into the roles of discussion leader, laboratory expert, grader, proctor, and researcher; and are

expected to succeed in each role. To help the new graduate students cope with these responsibilities the University has established a short training program, but the "real" training comes on the job. We have surveyed our current and recent teaching assistants, to better learn which parts of the pre-service and on-the-job experiences are most important and useful to them, and what other preparation could make them more effective. By combining this with research on successful existing TA training programs elsewhere, we hope to better tailor our training program to the needs of our graduate students, and provide them with the skills that will make them better educators.

P550: Development of constructivist teaching views in science and mathematics graduate students

James Rudd (California State University, Los Angeles, USA), R. Dean Gerdeman (National Science Foundation, USA)

We have studied how the NSF GK-12 program at UCLA has impacted science and mathematics graduate students' views of teaching and learning. The graduate students collaborated with first-year secondary teachers to design and teach inquiry-based science and math lessons in urban Los Angeles schools. We assessed the pedagogical views of the graduate students prior to their entry into the program and again at the end of the program year. The results indicate changes in beliefs regarding the process of knowledge development and the engagement of learners in that process. Graduate students showed more understanding of and more value for specific intellectual and motivational support mechanisms in agreement with constructivist-based teaching of science and mathematics.

1:15 PM - 5:10 PM STEW 214A

S53: Long-Running Public Outreach Activities - Session 1 of 1

Stephanie Myers (Augusta State University, USA)

Come learn about successful long-running public outreach programs and find out answers to questions such as: What works? What doesn't? How to sustain while allowing growth and/or transformation to meet changing needs? Why folk are still continuing their efforts inspire of the challenges and barriers that arise?

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| 1:15 | break |
| 1:20 Al Hazari | P551: University of TN, Knoxville K-12 science and engineering outreach program |
| 1:40 Dave Finster | P552: Crime scene analysis by the Mills Lawn sixth grade class |
| 2:00 Matthew Nance | P553: Terrific science: reaching kids, parents, families, and more |
| 2:20 Stephanie Myers | P554: Wow! That's chemistry? show for sixth graders |
| 2:40 Rashmi Venkateswaran | P555: Mini courses for kids to celebration of science for teens |
| 3:00 | break |
| 3:10 Bassam Z. Shakhashiri | P556: Science is fun! |
| 3:30 Gina Barrier | P557: NC State University's science house outreach programs |
| 4:10 Susan Olesik | P558: Wonders of our world, W.O.W. |

4:30 Julie OBrien

P559: Nurturing a sustained science outreach program

4:50 Marisa Burgener

P560: National chemistry week, and beyond!

P551: University of TN, Knoxville K-12 science and engineering outreach program

Al Hazari (University of Tennessee, USA)

An exciting outreach program to area K-12 schools and to the East Tennessee community started in 1991. It showcases science and engineering concepts through a variety of hands-on demonstrations and experiments to students and teachers and to the general public. Some of the community activities include visits to after-school programs, doing "senior science" at assisted-living facilities, working with boys/girls scouts and holding summer science camps. Program information as well as a listing of our supporters can be found on the web at www.chem.utk.edu/outreach.

P552: Crime scene analysis by the Mills Lawn sixth grade class

Dave Finster (Wittenberg University, USA)

This presentation describes an annual four-day "crime scene investigation" carried out on site by the sixth grade classes at a local grade school. Each year a new crime is invented and the students perform a series of forensics tests to solve the crime. A sub-group of students travels to Wittenberg University to perform IR and GC analysis. Community members are suspects and the event culminates with an interrogation by the local police chief. The presentation will briefly describe the forensic tests and the local circumstances that allow this event to work smoothly each year.

P553: Terrific science: reaching kids, parents, families, and more

Matthew Nance (Miami University (Ohio), USA), Lynn Hogue (Miami University, USA), Mickey Sarquis (Miami University, USA)

It's not always easy to share your love of science with a sometimes science-phobic public. By helping others see the extraordinary science involved in ordinary life, the Center for Chemistry Education has a long-standing tradition of offering enriching experiences to communities near and far. We would like to share some of the secrets to our success in the past and present. Tips on organizing and planning outreach initiatives and events will be shared and sample activities will be demonstrated.

P554: Wow! That's chemistry? show for sixth graders

Stephanie Myers (Augusta State University, USA), Donna Hobbs (Augusta State University, USA)

For ten years, Augusta State University has presented a live chemistry show at the schools theater for area sixth graders. Typically, we have two shows with a audience of about 700 for each. The show involves all of the chemistry faculty and most of the chemistry majors. With all this practice, we have developed many ways to make sure the show involves a large number of our students, yet runs smoothly with minimal time and financial investment.

P555: Mini courses for kids to celebration of science for teens

Rashmi Venkateswaran (University of Ottawa, Canada)

At the University of Ottawa, our Mini Enrichment program has been in place since 1981. Since its inception, the program has invited over 50,000 students from the Grade 8 to Grade 12 level to come to the University of Ottawa for a one week intensive course in one of over 80 programs

offered in both English and French. Of these programs, the chemistry mini-enrichment course, focusing on students in grades 8 and 9, is one of the most popular and most quickly filled. Over the last 5 years, we have also instituted a program called a Celebration of Science in which over 1000 Grade 11/12 students, both English and French, come to the University to do hands-on, university-level experiments in seven subjects spread over the different sciences. Once again, chemistry is one of the most popular programs and we usually accommodate 250-360 of the 1000 students. I will share some of the things that make these programs so successful and why we think it is important to continue with such outreach programs. I will also mention some of the other popular scientific outreach programs offered by the Faculty of Science at the University of Ottawa.

P556: Science is fun!

Bassam Z. Shakhshiri (UW-Madison,)

We will describe and discuss our Science Is Fun activities and how they can be adapted by others. These include presentations at shopping malls, school gymnasias, the State Capitol, exposition centers, and other locations.

P557: NC State University's science house outreach programs

Gina Barrier (NC State University, US)

Established in 1991, The Science House is an educational outreach program of NC State University with satellite offices across North Carolina. The Science House collaborates with K-12 teachers and students to promote hands-on inquiry-based learning activities in science and mathematics. This session will provide an overview of Science House programs concentrating on an equipment loan program in which computers, graphing calculators, and experimental probes are rotated among rural schools across North Carolina. This session will also highlight a multi-site environmental testing program that has emerged from the equipment loan and serves to bring communities together through student research.

P558: Wonders of our world, W.O.W.

Susan Olesik (The Ohio State University, USA)

The Wonders of Our World, W.O.W. program is a science outreach program for grades K-5. W.O.W. allows local area scientists to contribute strongly to the elementary science education in their community. The W.O.W. program celebrated its seventh year of operation this year. Well over 10,000 students have been served to date by approximately 400 volunteers per year. The goals of W.O.W. include: 1) enhancing the science literacy of elementary school teachers and students, 2) supplementing established elementary science education curricula, 3) increasing the science material that elementary school teachers are comfortable presenting to their students, 4) increasing the involvement of local scientists, parents and undergraduate science students in important community projects, and 5) generating a model that can be used by scientists across the United States to assist science programs in other elementary schools. W.O.W. continues to be a highly successful program. Data collected to date show major gains in the student performance as well as teacher/student enthusiasm for science. Details of the program will be provided in this presentation.

P559: Nurturing a sustained science outreach program

Julie OBrien (Eli Lilly and Company, US)

Maintaining enthusiasm and motivation for a young outreach program can sometimes be challenging. Changes in a volunteer base, financial strains, and other stressors cause many

outreach programs that experienced initial success to disband. Reflections of experiences from 15 years of science outreach program coordination will be presented. Tips and advice for maintaining a sustained outreach program will be provided.

P560: National chemistry week, and beyond!

Marisa Burgener (American Chemical Society, USA)

The American Chemical Society's National Chemistry Week (NCW) program will be celebrating its 20th anniversary in 2007. We will discuss the past, present and future of NCW, ways to incorporate it in the high school and undergraduate classroom, and engaging the public. Chemists Celebrate Earth Day, a newer program, was created to coincide with an already long-running celebration, Earth Day. Learn about the possibilities for this outreach activity as well as tips, techniques and the resources that exist for public outreach.

1:15 PM - 5:10 PM STEW 310

S46: Physics Education Research for Chemistry Instructors: Facing Joint Challenges and Practical Concerns - Session 2 of 2

David Meltzer (University of Washington, United States), **Tom Greenbowe** (Iowa State University, USA)

Chemistry educators and physics educators are concerned with many of the same issues about teaching and learning science. Physics education researchers have carried out systematic discipline-based studies of student learning. These studies incorporate a theory base, a careful collection and analysis of data, and interpretation of results that can be generalized. These investigations have revealed a wide gap between the objectives of most physics instructors engaged in traditional forms of instruction and the actual level of conceptual understanding attained by the majority of their students. This symposium provides an opportunity for physics education researchers to share the advances that have been made in their field with chemistry educators.

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| 1:15 | | introduction |
| 1:20 | Chandralekha Singh | P561: Improving student understanding of quantum mechanics |
| 1:50 | Michael Loverude | P562: Research on student understanding of matter and energy in college physical science courses |
| 2:20 | Robert Beichner | P563: Student-Centered Activities for Large Enrollment Undergraduate Programs |
| 3:00 | | break |
| 3:10 | Catherine Crouch | P564: Classroom Demonstrations: Learning Tools or Entertainment? |
| 3:40 | Arthur Friedel | P565: Adapting Education Research Tasks to Promote Robust Learning |
| 4:00 | Charles Henderson | P566: "Build it and they will come", and other myths about science education reform |
| 4:30 | | discussion |

P561: Improving student understanding of quantum mechanics

Chandralekha Singh (University of Pittsburgh, USA)

We are investigating the difficulties that students have in learning quantum mechanics and designing quantum interactive learning tutorials (QuILTs). Our investigation includes interviews with individual students and the development and administration of free-response and multiple-choice tests. The preliminary results from the QuILTs are promising. *Supported by NSF PHY-0244708 and DUE-0126439

P562: Research on student understanding of matter and energy in college physical science courses

Michael Loverude (Cal State University Fullerton, United States)

The nature of matter and energy are ideas of common concern to chemistry and physics. In this talk, we examine student conceptual understanding of matter and energy in several specific physical contexts familiar to instructors in both disciplines. In particular, we will illustrate examples of common conceptual and reasoning difficulties. Students in the study have been drawn from a variety of courses, including a lecture course for non-science majors, a lab-based inquiry-oriented course for pre-service teachers, and lecture and lab courses for science and engineering majors. We will show sample student responses given in individual student interviews as well as on written questions posed on course quizzes and examinations and discuss implications for instruction as well as future research.

P563: Student-Centered Activities for Large Enrollment Undergraduate Programs

Robert Beichner (North Carolina State Univ., United States)

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? The Student-Centered Activities for Large Enrollment Undergraduate Programs (SCALE-UP) Project has addressed these concerns. Because of their inclusion in the leading introductory physics textbook, project materials are used by more than 1/3 of all science, math, and engineering majors nationwide. The room design and pedagogy are being adopted at leading institutions across the country. Physics, chemistry, and biology classes are currently in operation, with mathematics, engineering, and oceanography adaptations in progress. This talk describes the pedagogy and some of the research that went into its design and implementation.

P564: Classroom Demonstrations: Learning Tools or Entertainment?

Catherine Crouch (Swarthmore College, USA)

Classroom science demonstrations are intended to serve two important purposes: to increase students' interest in the material being covered and to improve students' understanding of the underlying scientific concepts. Student end-of-semester evaluations typically praise demonstrations as one of the most interesting parts of a course, suggesting that demonstrations accomplish the first objective. What about the second? Do demonstrations effectively help students learn the underlying concepts? We examined whether the mode of presentation of demonstrations affects their effectiveness as teaching tools. Two results are noteworthy: first, we find that students who simply observe a demonstration and hear an explanation of it, without activities that engage them actively with the demonstration, show no greater understanding of the demonstrations at the end of the semester than did students who did not see the demonstration at all. Second, students who predict the outcome of the demonstration before seeing it show a much higher rate of understanding of the demonstration than the students who simply observed the demonstration

P565: Adapting Education Research Tasks to Promote Robust Learning

Arthur Friedel (IPFW, USA), David Maloney (Indiana University Purdue University Fort Wayne,)

Physics and chemistry education researchers have un-covered numerous obstacles to learning in the students' everyday conceptions. Physics educators have found that research tasks often make good curricular and assessment materials. We will show how the same process can be applied in chemistry to produce task sets that focus on problematic issues. These task sets get students to process the ideas in multiple ways, thus promoting more robust learning. Examples of chemistry task sets and results of using them will be presented.

P566: “Build it and they will come”, and other myths about science education reform

Charles Henderson (Western Michigan University, USA), Melissa Dancy (University of North Carolina at Charlotte, USA)

Reform-minded science educators have focused much energy developing high quality curricular materials with the expectation that science instructors will recognize the superiority of these materials and adopt them. Adoption is assumed to be an unproblematic process and the expectation is that the number of faculty using these materials will naturally expand, eventually leading to a critical mass of instructors teaching in a fundamentally new way. Unfortunately, current and historical evidence does not indicate promise for this approach to reform. This talk will focus on the importance of understanding college science instructors and the contexts within which they work when planning instructional reforms. Specific examples will be given from several empirical studies of college physics faculty.

1:15 PM - 4:50 PM STEW 218CD

S22: POGIL: Process-Oriented Guided Inquiry Learning - Session 4 of 4

Rick Moog (Franklin and Marshall College, USA)

POGIL is a student-centered instructional paradigm that combines a group learning approach with specially designed guided inquiry activities. The goal is to not only enhance student mastery of course content, but also to develop important learning process skills such as communication, problem solving, and critical thinking. This symposium will include presentations dealing with the implementation and evaluation of this approach across a wide array of disciplines and institutional types and levels.

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|------|--------------------|--|
| 1:15 | Linette Watkins | P567: POGIL in the Biochemistry classroom |
| 1:35 | Colleen Conway | P568: POGIL Activities in an Organic and Biochemistry Course |
| 1:55 | Lafayette Eaton | P569: The Effect of Process Oriented Guided Inquiry Learning on Student Achievement in a One Semester General, Organic, and Biochemistry Course. |
| 2:15 | Andrea Martin | P570: Development of Guided Inquiry Experiments for a One-Semester General, Organic, and Biochemistry Lab for Nursing Majors |
| 2:35 | | break |
| 2:45 | Jeffrey Paradis | P571: Data Driven Learning as the Basis for Guided Inquiry |
| 3:05 | Robin Lasey | P572: Non-majors can do inquiry too! |

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| 3:25 | Edward Baum | P573: Process-Oriented Guided Inquiry into the Scientific Method |
| 3:45 | William Wallace | P574: How Do You POGIL? |
| 4:05 | | discussion |

P567: POGIL in the Biochemistry classroom

Linette Watkins (Texas State Univ-San Marcos, USA)

During the 2004/2005 academic year, POGIL exercises were introduced into the junior level Principles of Biochemistry lecture and senior level Metabolism lecture at Texas State University—San Marcos. Exercises were developed for each class, exploring concepts traditionally challenging for students. This presentation will discuss the activity development and modification, student and faculty attitudes toward the change, and student performance in subsequent classes and standardized tests.

P568: POGIL Activities in an Organic and Biochemistry Course

Colleen Conway (Mount Mary College, USA)

Mount Mary College is a small urban women's college with both traditional age students and nontraditional aged students. The students in the one semester organic and biochemistry course are in the health sciences and have had one semester of general chemistry. The presentation will discuss the use of POGIL activities and comparisons of the grade distributions of POGIL and non-POGIL classes.

P569: The Effect of Process Oriented Guided Inquiry Learning on Student Achievement in a One Semester General, Organic, and Biochemistry Course.

Lafayette Eaton (St John Fisher College, United States)

The effects of process oriented guided inquiry learning (POGIL), a student centered cooperative learning strategy, on achievement in an introductory college chemistry course will be examined. Students in the treatment groups (n = 42 & n = 51) who experienced the student centered cooperative learning will be compared to students in the control group (n = 36) who experienced traditional lecture. The differences between exam scores in the control group and those in each treatment group will be evaluate using a one way analysis of variance. Initial results indicate that students in the treatment groups show an increase in achievement, however, it remains to be determined if this increase is statistically significant.

P570: Development of Guided Inquiry Experiments for a One-Semester General, Organic, and Biochemistry Lab for Nursing Majors

Andrea Martin (Widener University, USA)

After attending an NSF workshop on developing POGIL laboratory exercises during the summer of 2005 at Washington College, I undertook a major overhaul of our one-semester chemistry lab for nursing majors “on the fly.” This presentation will discuss the reasons for the change, the difficulties encountered in changing an entire semester at once, examples of the new labs compared to the previous ones, and the results of student evaluations. In addition, as we are currently in the second iteration of the new system, I will discuss how the experiments have been modified as a result of feedback from students and instructors.

P571: Data Driven Learning as the Basis for Guided Inquiry

Jeffrey Paradis (CA State U-Sacramento, USA)

The process-oriented guided inquiry (POGIL) approach has been used to develop a series of chemistry activities currently used to prepare pre-service K-8 teachers at California State University Sacramento. With these activities, learning is directly based on the guided interpretation of experimental data and student observations. The author will discuss the philosophy used to develop the materials, share examples of activities (which deal topics such as phase changes, nomenclature, ionic and covalent bonding, solutions, chemical reactions and acids/bases) and present assessment results. A collection of these activities was published by Benjamin Cummings in spring 2006.

P572: Non-majors can do inquiry too!

Robin Lasey (Arkansas Tech University, USA)

Some say non-majors are not capable of the level of thought needed for inquiry activities. My experience shows otherwise. Lesson ideas for a non-majors course will be presented along with the author's experience implementing the new materials and student feedback. Lesson ideas include unit conversions, ions, ionic bonding, and others.

P573: Process-Oriented Guided Inquiry into the Scientific Method

Edward Baum (Grand valley State University,)

General chemistry courses and textbooks usually begin with an introduction to scientific method. The presentations usually proceed by defining terms such as "hypothesis" and "theory" but often leave students with little conceptual understanding of what the scientific method is and how it works. An entertaining POGIL approach that does provide a firm conceptual understanding of the method is presented here using the format of the "Wheel of Fortune" TV game or the "Hangman" game. Students construct their own concept of how science is done and explore the sometimes subtle nuances of scientific research.

P574: How Do You POGIL?

William Wallace (Barton College, US)

Barton College has recently has recently decided to implement engaged learning in all aspects of the college experience. As we all know, POGIL is one of the best examples of active learning. One of the advantages of POGIL is that there is no set way to do it. Some of my experiences of the last three years using POGIL in general and organic chemistry will be discussed.

1:15 PM - 4:50 PM STEW 214B

S54: Remote Access to Advanced Instrumentation - Session 1 of 1

Fred Lytle (Purdue University, USA)

Most modern "research grade" instruments are typically both easier to use and give more readily interpretable data than older, less powerful, and/or "teaching" models. However, such advanced instruments are typically much more expensive to both purchase and maintain and are typically beyond the budgets of most universities and/or not available for teaching. One approach to dealing with this combination of factors is the use of remotely operated instruments by consortia of institutions. While a familiar concept in some research settings, this technology has now matured to the point that it is "ready for prime time" in teaching. This session will feature talks on the practical aspects of establishing and operating such instruments (e.g. budgets, security, teaching

materials) both in general terms and applied to a range of specific topics as telescopes synchrotrons and single lab experiments.

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|------|----------------|---|
| 1:30 | | introduction |
| 1:35 | Devon Cancilla | P575: Building the infrastructure for the use of remote instrumentation within the curriculum |
| 2:00 | Simon Albon | P576: Remote instrumentation: Impacts on student learning and teaching practice |
| 2:25 | Allen Hunter | P577: The STaRBURSTT - CyberInstrumentation Consortium - cyberenabled instrumentation access |
| 2:50 | | break |
| 3:00 | John Huffman | P578: Remote access to crytallography instruments and data |
| 3:25 | Debora Steffen | P579: Working toward unattended student access to remote instrumentation |
| 3:50 | | discussion |

P575: Building the infrastructure for the use of remote instrumentation within the curriculum

Devon Cancilla (WWU, USA)

Within the last ten years, interest has grown in the use of remote instrumentation as a mechanism to provide greater access to instrumentation within the undergraduate curriculum. The NSF Cyberinfrastructure initiative has described the potential for the use of remote instrumentation as well as the need to “..exploit advances in networking, web-based tools and other facets of Cyberinfrastructure to facilitate broader access to the requested instrumentation.” In fact, the rapid advancement of Internet-based technologies has made it possible to use instrumentation almost anywhere in the world. However, remote access to instrumentation constitutes only one of the steps necessary for instruments to be used more widely and effectively throughout the curriculum. Access to instrumentation must also be accompanied by access to the on-line laboratory, instructional, and training materials developed with the tools available to the on-line teaching and instructional design community. The integration of remote instrumentation with well designed supporting materials will create a dynamic web-based learning environment that provides both synchronous and asynchronous opportunities to incorporate instrumentation into the curriculum. To accomplish this, the infrastructure necessary to support and promote the development and use of remote instrumentation within and between institutions needs to develop. This paper describes the conceptual framework for the development of this infrastructure as well as the types of on-line tools available to effectively incorporate remote instrumentation into the curriculum.

P576: Remote instrumentation: Impacts on student learning and teaching practice

Simon Albon (UBC, Canada)

The Baccalaureate of Science in Pharmacy (B.Sc.Pharm) program at the University of British Columbia (UBC) includes a compulsory lecture-laboratory course in pharmaceutical analysis (PA; enrollment: 137). Through a two-year collaboration with Western Washington University's Integrated Laboratory Network (ILN), remote instrumentation and video-conferencing have become central teaching tools in both the lecture and laboratory components of the PA course.

These new teaching tools have provided the catalyst for expanding the scope of the PA course, developing a new generation of lecture and laboratory learning activities, creating collaborative teaching methods and improving student's perceptions of science and research and the importance of PA in their training as pharmacists. Using assessment data collected to date, this session will discuss an emerging body of evidence on how these new methods are changing the way PA is taught at UBC and the degree to which they have impacted student learning.

P577: The STaRBURSTT - CyberInstrumentation Consortium - cyberenabled instrumentation access

Allen Hunter (Youngstown State University, USA)

The STaRBURSTT-CIC (i.e., Science Teaching and Research Brings Undergraduate Research Strengths Through Technology - CyberInstrumentation Consortium) is a national consortia of made up primarily of Predominantly Undergraduate Institutions, Historically Black Colleges and Universities, and Hispanic Serving Institutions having strong interests in X-ray diffraction. Five core instrumentation hubs at California State University Fullerton, Central Connecticut State University, Illinois State University, South East Missouri, and Youngstown State University are remotely accessible to our 50+ PUI collaborators to support our members including community colleges such as East Los Angeles College and Harold Washington College. Continuing advances in hardware and software are making it increasing easy to both collect and process data from modern scientific instruments. Undergraduates and other novices are therefore increasingly able to successfully use these tools in their coursework and research. Unfortunately, no Predominantly Undergraduate Institution has the resources to purchase and maintain any but a selected sample of the instrumentation that they would like to have access to. Remote access over the WEB via instrumentation consortia offer a potentially effective solution. The advantages and disadvantages to such a remote access approach will be discussed along with practical recommendations about how to implement such remote access instrumentation consortia.

P578: Remote access to crystallography instruments and data

John Huffman (Indiana University, USA)

Collaboration technologies have matured dramatically in the past few years to the point that they are no longer used only for eye-catching demonstrations, but are becoming an integral part of both research and teaching programs. As part of the NSF Common Instrument Middleware Initiative (CIMA), the Indiana University Molecular Structure Center (IUMSC) has been developing the techniques and technologies that allow remote collaborations and access to crystallographic instrumentation and data. Currently being deployed in several major university laboratories and synchrotron sites, the CIMA Crystallography Portal will provide access not only to a variety of research grade instruments with differing capabilities that no single laboratory can justify. The system has already been used to provide virtual crystallography experiments to undergraduate classes in several predominately undergraduate institutions in Indiana. The CIMA Crystallography Portal provides access to the data using Web Services so that the remote user can observe and process the data as it is collected. Various videoconferencing techniques and other software have been developed that allow the remote user to have a "same as being there" experience from preliminary microscopic examination of the sample to final viewing of the molecular structure. Indiana University has made an institutional commitment to provide open access to the data for both research and instructional purposes. We will describe the current status of the portal and the data and software that are available to users.

P579: Working toward unattended student access to remote instrumentation

Debora Steffen (Purdue University, USA), Fred Lytle (Purdue University, USA), Gabriela Weaver (Purdue University, USA), Phil Wyss (Purdue University, USA)

The Center for Authentic Science Practice in Education (CASPiE) is a consortium of schools introducing a research experience into regular curriculum freshman and sophomore undergraduate laboratories. As part of this effort a laboratory has been created with research-quality instrumentation equipped with autosamplers to facilitate high sample throughput. Instruments will be remotely accessed by students to collect their own data. Because of the anticipated high numbers of students, remote control will occur outside normal laboratory hours. The ultimate goal of this effort is to allow student access while instruments are unattended (nights and weekends). This presentation will focus on the challenges associated with restriction of student user rights and protection of sensitive instrument components.

1:15 PM - 5:10 PM STEW 306

S55: Research in Chemical Education: Theoretical Frameworks - Session 1 of 2

MaryKay Orgill (UNLV, USA)

The type of data a chemist collects in an experiment is influenced by his or her choice of instrumentation. For qualitative research studies, a theoretical framework plays a role analogous to the role of the instrument. A theoretical framework is a system of ideas, aims, goals, theories and assumptions about knowledge. It tells us how research should be carried out and how research should be reported, influencing what kind of qualitative experiments can be carried out and the type of data that result from these experiments. During this symposium, different theoretical frameworks will be discussed in the context of chemistry education research. The focus of this symposium is on the theoretical underpinnings of individual frameworks and their application to designing qualitative research, not on specific research results.

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| 1:15 | introduction |
| 1:20 George Bodner | P580: An Introduction to the Discussion of Theoretical Perspectives |
| 1:40 Robert Ferguson | P581: Constructivism as a research lens |
| 2:00 Joe Shane | P582: Hermeneutics and Narrative: Complementary Theoretical Frameworks |
| 2:20 Kirsten Casey | P583: Phenomenology and Science Education Research |
| 2:40 | break |
| 2:50 MaryKay Orgill | P584: Phenomenographic Research in Chemical Education |
| 3:10 Provi Mayo | P585: The Use of Critical Theory in Chemical Education |
| 3:30 Dawn Del Carlo | P586: Symbolic Interactionism |
| 3:50 Gautam Bhattacharyya | P587: Bringing Culture to Theory |

P580: An Introduction to the Discussion of Theoretical Perspectives

George Bodner (Purdue University, US)

It has been almost 25 years since a graduate student in the Department of Chemistry at Purdue asked whether she could do an M.S. thesis with me. I checked with the Head of the Department,

who assured me that I was a member of the graduate faculty, and could therefore chair a thesis committee. That thesis – “A Study of the Relationship Between Spatial Ability, Field Dependence-Independence, and Achievement in Chemistry” – has been followed by more than 50 others. This talk will examine some of what my students have taught me during this 25-year time span as an introduction to the discussion of theoretical frameworks or perspectives in this symposium.

P581: Constructivism as a research lens

Robert Ferguson (Cleveland State University, United States)

Constructivism is a theory of learning. It describes how a learner incorporates knowledge into existing mental frameworks, structures or schemas. This paper describes the use of constructivism as a theoretical model in science education. As a theoretical framework, researchers have employed constructivism to investigate how students meaning making (Southernland), how students understand concepts (Ferguson, 2003, Piquette, 2004, Johnson, 2000, 2002), and alternative conception (Calik, 2005). Other researchers have used Constructivism to explore conceptual change and situated cognition.

P582: Hermeneutics and Narrative: Complementary Theoretical Frameworks

Joe Shane (Shippensburg University, USA)

Hermeneutics, the art of understanding, is commonly used in qualitative research to define the researcher as the voice of the participants. The overall goal of a hermeneutic inquiry is to present the findings in a fair, comprehensive, and historically grounded manner. Narrative analysis complements hermeneutics by having the researcher present the findings in the form of a story woven together by plots. In this presentation, I will discuss the connections between the two theoretical frameworks and outline examples from our own work in science and chemistry education.

P583: Phenomenology and Science Education Research

Kirsten Casey (Anne Arundel Community College, USA)

Phenomenology is a well established research tradition in many disciplines that stems from the work of philosophers such as Husserl, Heidegger, and Merleau-Ponty. Phenomenology seeks to describe the "essence" of an experience. In this paper, I will discuss the philosophical and methodological foundations of this framework and the types of questions in chemistry education that might be suitable. Care will be taken to distinguish this tradition from the more recent but currently more popular framework that shares a similar sounding name (phenomenography).

P584: Phenomenographic Research in Chemical Education

MaryKay Orgill (UNLV, USA)

Phenomenography is an empirical research tradition that was designed to answer questions about thinking and learning, especially in the context of educational research. Phenomenographers seek to identify the different ways in which people experience, interpret, understand, perceive or conceptualize a phenomenon. During this presentation, I will discuss how both the “classic” and “new” phenomenography frameworks can inform chemical education research. I will present the aims, assumptions, and methods associated with phenomenography. I will also discuss limitations of the framework and examples of the use of the framework in chemical education research.

P585: The Use of Critical Theory in Chemical Education

Provi Mayo (South Dakota State University, USA)

Critical theory has inspired studies and theories in the sociology of education that try to understand suppression in education. Several critical theorists have argued that critical theory aims to provide a better understanding of present social conditions, how these conditions evolved, and how they interact with each other. In order to provide this knowledge, critical theory encompasses a multi-discipline approach that combines perspectives drawn from many fields of study, including history, philosophy, economics, politics, psychology and sociology. During this presentation I will discuss how critical theory serves as a system of ideas, aims, goals, theories and assumptions about knowledge. I will also discuss how critical theory influenced educational research should be designed, performed and reported. I will also discuss what kind of qualitative experiments can be carried out using critical theory as an instrument and the type of data that result from these experiments.

P586: Symbolic Interactionism

Dawn Del Carlo (University of Northern Iowa, USA)

Originally conceived of by Herbert Blumer, symbolic interactionism is a theoretical and methodological perspective that seeks to understand the socially constructed meaning behind human behavior and interaction. Grounded within the tenets of social psychology, it can be used as a framework to shape educational research in the sciences. A brief history of symbolic interaction's development, a description of its assumptions and methods, and its direct applicability to science education research including examples of published research will be discussed.

P587: Bringing Culture to Theory

Gautam Bhattacharyya (University of Oregon, USA)

Ethnography and ethnomethodology are two related, but distinct, theoretical frameworks. While ethnography aims to understand what constitutes the culture of a specific group of people, ethnomethodology presumes the existence of a culture and aims to elucidate how people make sense of their routine activities so that they may function in that culture. By using examples from science education research, this presentation will focus on the origins of the research paradigms, the basic theoretical features of each, and the types of research questions that are appropriate for the frameworks.

1:15 PM - 4:50 PM STEW 314

S56: Student Retention in Introductory Chemistry - Session 1 of 1

Zexia Barnes (Morehead State University, USA), **Willy Hunter** (Illinois State University, USA)

This symposium of general interest to the Chemical Education community will focus primarily on the retention of students and their individual knowledge retention in the introductory chemistry.

- 1:15 introduction
P588: Establishing a national clearinghouse for teaching and encouraging blind and low vision students in chemistry and other scientific disciplines: A web portal
- 1:20 Cary Supalo
- 1:40 Zexia Barnes P589: Chemical demonstrations as a chemistry capstone class
- 2:00 Cary Supalo P590: Independent laboratory access for the blind
- 2:20 Mark Ellison P591: Physical chemistry and evolution

| | | |
|------|------------------|---|
| 2:40 | Haim Weizman | P592: Incorporating concepts from process chemistry into the undergraduate organic laboratory |
| 3:00 | | break |
| 3:15 | Petra Van Koppen | P593: Motivating students to prepare for and actively participate in large lecture classes |
| 3:35 | Alan Pribula | P594: They've had the prerequisites--but what do they remember? |
| 3:55 | Rebecca Kruse | P595: Physical science for elementary teachers: Emphasizing students' ideas |
| 4:15 | Michelle More | P596: Terra firma: A solid foundation for pre-service elementary teachers |

P588: Establishing a national clearinghouse for teaching and encouraging blind and low vision students in chemistry and other scientific disciplines: A web portal

Cary Supalo (Pennsylvania State University, USA)

This web portal (<http://www.blindscience.org>) will serve as the first national clearinghouse of teaching techniques and tools for blind and visually impaired students in chemistry and other science classes. It is supported by three educators of blind children in science curriculum, and maintained by the National Federation of the Blind, the largest consumer organization of blind persons in the United States, utilizing its national membership of over 50,000 blind persons and its collaborators as a source of ideas. Submissions will be evaluated before being incorporated into the web portal. This clearinghouse will be the primary place for educators and parents of blind children to look for tools for teaching chemistry and other sciences to blind and visually impaired students. The development and spread of ideas by this web portal should make the sciences more accessible to blind and visually impaired students, a group currently underrepresented in the technical fields.

P589: Chemical demonstrations as a chemistry capstone class

Zexia Barnes (Morehead State University, USA), Nathan Coker (Morehead State University, USA)

I will discuss a course in which chemistry majors choose, prepare and practice demonstrations over various chemistry topics. They have exams over the actual demonstrations and background material related to the demonstrations. Next fall they will take selected demonstrations "on the road" to area high school chemistry classes.

P590: Independent laboratory access for the blind

Cary Supalo (Pennsylvania State University, USA)

ILAB: Independent Laboratory Access for the Blind This project seeks to implement a suite of talking laboratory tools and modified laboratory procedures to increase the participation of blind and visually impaired students in chemistry laboratory classes. Aided by JAWS screen reader software and Vernier Logger Pro 3.4, these tools will allow a blind student to more independently obtain observational data. Additional low cost tools have been developed in conjunction with the electronics shop of Penn State's chemistry department, and these too will enable blind students to have a more complete understanding of what is taking place during laboratory procedures. This more active involvement will increase the interest and confidence of blind and visually impaired students toward chemistry and the sciences, hopefully leading more to pursue careers in science,

technology, engineering, or mathematics careers, where their problem solving strengths will be of great value and contribution.

P591: Physical chemistry and evolution

Mark Ellison (Ursinus College, USA)

Anti-evolution arguments often cite the alleged violation of the Second Law of Thermodynamics as a "problem" with evolution. These arguments arise from a misunderstanding or misinterpretation of the Second Law. The Second Law will be clarified, and it will be shown that evolution is entirely consistent with the Second Law. Sound scientific rebuttals to commonly alleged violations of the Second Law will be provided so that teachers can confidently counter these flawed claims.

P592: Incorporating concepts from process chemistry into the undergraduate organic laboratory

Haim Weizman (UCSD, USA)

The current curriculum of organic chemistry laboratory exposes students to various laboratory techniques and a wide repertoire of reactions. While this is an essential step in educating organic chemists, modern organic chemistry also requires emphasis on efficient synthesis (for minimizing costs and reducing environmental risks). Chemical efficiency is in the heart of process chemistry, the field of chemistry that deals with the development of synthetic routes for making large quantities of compounds. We believe that incorporating concepts from process chemistry into the undergraduate laboratory is essential. Therefore we developed an advanced organic lab which emphasizes that efficient synthesis originates from understanding the fundamental physical-organic principals of reactions. The relationships between molecular structure and reactivity are explored using modern synthetic methods and advanced instrumentation. This is achieved by performing reactions on an assortment of substrates using a variety of conditions. The individual experimental results are combined into one table and the students need to analyze the effect of structure and reaction conditions on the results. The course stresses the importance of molecular design and optimized reaction conditions for the development of practical reactions. The last part of the course is devoted to multistep synthesis with an emphasis on chemical development. The target that was chosen for synthesis is Sildenafil (Viagra) precursor. The synthesis of a familiar commercial target increases student's interest and illustrates the relevance to the pharmaceutical world. The students carry out several steps according to the patented synthetic route (medicinal chemistry approach) which is then compared to the more efficient process chemistry approach.

P593: Motivating students to prepare for and actively participate in large lecture classes

Petra Van Koppen (UCSB, USA)

How can we help students be prepared to discuss concepts presented in the lecture? Many students cannot respond to material they are seeing for the first time. This talk focuses on the many ways to connect with students outside of the classroom to motivate them to prepare for lecture so they can actively participate. Simply sending emails with key concept questions and reminders about homework problems encourages students to prepare for lecture and builds professor-student rapport, increasing attendance. Providing real-world examples keeps science on the radar screen of their day-to-day life. Promoting science outreach allows students to build and share their enthusiasm with the community. Included will also be a discussion of how to help students learn effectively, how to motivate them to work hard, and how to provide them with time management

tips.

P594: They've had the prerequisites--but what do they remember?

Alan Pribula (Towson University, USA)

I asked myself the title question about ten years ago and realized that, while I suspected the answer (along the lines of "A lot less than I'd like."), I didn't know it for certain. What fraction of the material from a course is actually retained for use a semester later (when taking General Chemistry II) or 1-3 years later (when taking Inorganic Chemistry)? To help answer this question (and to encourage the students to review appropriate material), I decided to distribute a take-home "pretest" to my students in these two courses, which counts 5-10% of their overall course grade. After ten years, I'm still not totally sure I know the answer to the question, but I'm sold on giving pretests. I'll present my reasons why.

P595: Physical science for elementary teachers: Emphasizing students' ideas

Rebecca Kruse (Southeastern Louisiana University, US)

In accordance with the No Child Left Behind Act of 2002, by year 2007 all states throughout the U.S. will require that students be assessed in science content by the end of their fifth grade year. Few elementary teachers are prepared for this, especially in the physical sciences. Evidence of the need for effective physical science courses for elementary teachers comes from many directions: recent government policies and reports, new state certification requirements, and professional societies. *Physical Science for Elementary Teachers** is a 75-hour, one semester course curriculum for prospective and practicing elementary teachers. The main goals of the course are to help students 1) develop a deep understanding of physical science ideas through guided inquiry; 2) practice the scientific process and understand how knowledge is developed within a scientific community; and 3) make connections between children's learning and their own learning of physical science. The course pedagogy and activity sequence is guided by research on student learning of physical science and builds on the work of previous NSF supported projects, *Physics for Elementary Teachers*, *Constructing Physics Understanding* and *Constructing Ideas in Physical Science*.

P596: Terra firma: A solid foundation for pre-service elementary teachers

Michelle More (Weber State University, USA), Bradley Carroll (Weber State University, USA)

Teaching chemistry to pre-service elementary school teachers can be more successful if students know basic physics concepts. In this paper a chemistry class is described where basic physics is taught first to provide a solid foundation (terra firma) for the learning of introductory chemistry.

1:15 PM - 5:10 PM STEW 206

S57: Teaching to the National Science Standards: Using Technology to Implement Chemistry Standards - Session 1 of 1

Claire Baker (Brebeuf Jesuit Preparatory School, US)

Interested in learning how to use technology to assist students in acquiring the skills required by chemistry standards at the national, ACS, and state levels? The speakers in this symposium share their insights on doing this and include classroom practices, training content, hardware and software suggestions, and research results.

1:15

introduction

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|------|-------------------|--|
| 1:20 | JD Ferris-Rowe | P597: Use of technology as a tool in instruction |
| 1:55 | Timothy Benedict | P598: Hardware and software available to enhance instruction |
| 2:30 | Sharon Woodbridge | P599: Technology professional development |
| 3:05 | | break |
| 3:15 | Marla Williams | P600: Impact of using technology on student learning in the general chemistry laboratory |
| 3:35 | Phil McBride | P601: Using technology and industrial applications of chemistry to implement science standards |
| 3:55 | Romualdo Desouza | P602: Using CALM to implement chemistry standards in Indiana HS |
| 4:15 | Stacey Brydges | P603: Lighting the high school chemistry course with light bulbs and LEDs: A context for technology education (Part 2) |
| 4:35 | | discussion |

P597: Use of technology as a tool in instruction

JD Ferris-Rowe (Brebeuf Jesuit Preparatory School, USA)

An overview of the use of technology to meet educational goals, including standards.

P598: Hardware and software available to enhance instruction

Timothy Benedict (Brebeuf Jesuit Preparatory School, USA)

Hardware that is available for use as tools in the classroom.

P599: Technology professional development

Sharon Woodbridge (Brebeuf Jesuit Preparatory School, USA)

Training for use of technology in the classroom. What is available and what questions to ask to get what you need in training and inservice regarding technology.

P600: Impact of using technology on student learning in the general chemistry laboratory

Marla Williams (South Dakota State University, USA)

The use of technology is continually changing within the field of chemistry and is increasingly being incorporated into teaching laboratories under the supposition that technology makes concepts more understandable. Qualitative and quantitative methods were used to analyze the impact of technology on student learning in the laboratory. Surveys, observations, and interviews were used to collect data as students completed experiments during a first-year general chemistry laboratory. Data from an experiment involving spectroscopy is presented to identify what knowledge students construct, how students use the technology to construct knowledge, and what students perceive when using technology. It was shown there was an increase in student content knowledge as a result of completing the laboratory, yet these effects on student learning were not always positive. Students state there are benefits to using technology because it provides a visual aid and allows students to collect accurate and precise data. While students state the benefits of using technology, they also express frustration that is a result of their concerns of correctly using the technology and collecting correct data. The use of technology and its impact on students' ability to apply science

process skills to conduct investigations will be discussed.

P601: Using technology and industrial applications of chemistry to implement science standards

Phil McBride (Eastern Arizona College, USA), Mickey Sarquis (Miami University, USA)

Technology is being used in laboratory activities patterned after the industrial processes involved in copper mining to help students acquire the skills required by ACS, NSTA, and Arizona Science Standards. This presentation will highlight several laboratory activities that incorporate the use of technology, pH meters and UV-Vis spectrophotometers, with Vernier's Logger Pro software to teach students how to make observations, work in groups to collect and analyze data, and communicate their results in written and oral formats. Activities include physical and chemical properties, determination of copper concentration, and Le Chatelier's principle applied in the extraction of copper. The activities will be presented along with how the coordinating science standards are implemented.

P602: Using CALM to implement chemistry standards in Indiana HS

Romualdo Desouza (Indiana University, USA)

CALM, Computer Assisted Learning Method, is a Web-based learning environment developed and in use at Indiana University, Bloomington. With it faculty present students with questions selected from a database. Each student is presented with an individualized, algorithmically generated question on a particular topic. Question can be either on a single topic or can tie together multiple topics in successive stages. Over the past 3 years use of CALM has been extended to approximately 50 Indiana HS and is in use by 3000 HS students. Recently, questions in CALM have been tied to the Indiana standards in chemistry. We will describe how with this tool questions developed in a peer-review environment can be used to implement chemistry standards over a wide geographic region.

P603: Lighting the high school chemistry course with light bulbs and LEDs: A context for technology education (Part 2)

Stacey Brydges (Columbia University, United States), Luis Avila (Columbia University, United States), Leonard Fine (Columbia University, United States)

As innovations in illumination displace the primacy of the incandescent light bulb, we are presented with an ideal platform for integrating technology education into the chemistry classroom. And while it is often difficult to separate the achievements of technology from those of science, the concepts and designs embodied in lighting artifacts can enable the teaching and learning of both areas. We will provide examples of this integrated approach through the use of computer-based instruction (LENS software) and hands/minds-on exercises with light-emitting diodes (LEDs). Fiat lux!

1:15 PM - 5:20 PM STEW 318

S26: Web-Based Applications for Chemical Education - Session 3 of 3

Robert E Belford (University of Arkansas at Little Rock, USA)

In this symposium, developers of web-based applications will come together with chemical educators to share experiences and innovations from the perspectives of development and implementation. Presenters will cover specific web-based applications, creative solutions to web-

based issues in the context of chemical education, reports of the impact of web-based applications on pedagogy and learning, or visions of the future.

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| 1:15 | | introduction |
| 1:20 | Rudolph W Kluiber | P604: General Chemistry Laboratory PreLabs, Videos and Tutorials |
| 1:40 | Robert Toreki | P605: Promoting a Culture of Safety Through Web-Enhanced Laboratory Content |
| 2:00 | David Yaron | P606: The ChemCollective: Virtual Labs and Scenario-Based Learning for Introductory Chemistry |
| 2:20 | Steven Githens | P607: Using Sakai to Develop Integrated Software for the Undergraduate Chemistry Program |
| 2:40 | Inci Morgil | P608: Developing ICT Supported Educational Modules for Undergraduate Students |
| 3:00 | | break |
| 3:10 | Sheila Woodgate | P609: BestChoice: A Model for Interactive Teaching |
| 3:30 | John H. Penn | P610: Lessons Learned in Web Delivery of Organic Chemistry |
| 3:50 | Anita Brandolini | P611: The Keys to Chemistry: Interactive Web-Based Tutorials |
| 4:10 | Vicente Talanquer | P612: The POINT: Interactive Web-Based Resources for the Secondary School Classroom |
| 4:30 | Jon Holmes | P613: JCE Digital Library: A Pathway to WWW-based Chemistry Education Applications |
| 4:50 | | discussion |

P604: General Chemistry Laboratory PreLabs, Videos and Tutorials

Rudolph W Kluiber (Rutgers University, USA)

The classical general chemistry laboratory usually involves completing a pre-laboratory exercise before class and listening to a short explanation of the experiment at the start of the laboratory. Our experience shows that the pre-labs found in the lab manual are frequently just copied and lectures or parts of them may be missed. In the past, our students gave very low ratings to both these aspects of the Gen Chem Lab. We have replaced the lab manual based pre-lab with a web based PreLab which the students must pass before starting the experiment. The computer individualizes each PreLab so that there cannot be mindless copying. The computer also grades the PreLab and tell the student when they have passed. Videos (10-15 min) have been created to replace the lab talk. These can be downloaded from the web using wideband and viewed at any time. Both the videos and web based PreLabs are rated highly by our students. They provide a uniform, reproducible introduction to each experiment.

P605: Promoting a Culture of Safety Through Web-Enhanced Laboratory Content

Robert Toreki (Interactive Learning Paradigms Incorporated, US), Robert E Belford (University of Arkansas at Little Rock, USA)

The MSDS (Material Safety Data Sheet) HyperGlossary (MSHG) is a free on-line resource that discusses well over 500 terms typically found on MSDS's and other laboratory health & safety documents, <http://www.ilpi.com/msds/ref/> Each entry in the MSHG offers a concise definition of

the term(s), the specific relevance to MSDS's, additional information that users of all backgrounds can easily comprehend, and authoritative external links for further information. This talk will demonstrate how laboratory instructors can easily leverage the power of the MSHG to inculcate a culture of safety in their students. The MS-Demystifier component of the MSHG permits instructor and students to readily create documents in which every health & safety term is a hyperlink to the corresponding entry in the MSHG. The use of such "demystified" documents in an introductory laboratory course will be discussed and feedback from the course participants will be presented. Extension of this idea through the curriculum and to Chemical Hygiene Plans will also be discussed. Finally, the opportunity to involve students in the creation/improvement of MSHG materials in an independent study or peer-led group will be explored.

P606: The ChemCollective: Virtual Labs and Scenario-Based Learning for Introductory Chemistry

David Yaron (Carnegie Mellon, USA)

The ChemCollective digital library (<http://www.chemcollective.org>) is a collection of online activities that address two main learning challenges in introductory chemistry. The first challenge is helping students connect the algebra of the 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 lab couples the paper-and-pencil activities of the current course with activities that involve 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 their algebraic calculations. The second learning challenge is bridging chemical knowledge with the real world. Our scenario activities imbed course concepts in real world applications, while requiring only minor changes to current course structures. These materials have been used for online homework, in class experimentation, and prelabs/postlabs.

P607: Using Sakai to Develop Integrated Software for the Undergraduate Chemistry Program

Steven Githens (Northwestern University, US)

The Sakai Learning and Research Environment is an open source software project developed through collaborations between a number of universities around the world. In addition to providing tools for course management and project collaboration, it provides a powerful foundation for building new educational software. At Northwestern we are developing a number of tools for our General and Organic Chemistry programs. These include web applications for use in discovery-based labs and semantic tools for navigating course topics. Using these tools instructors have the ability to create information links between class topics, laboratory concepts, other chemistry classes, and even other disciplines. We will present an overview of the tools developed, students' reactions, and how other schools can use the Sakai platform and contribute to the Sakai project.

P608: Developing ICT Supported Educational Modules for Undergraduate Students

Inci Morgil (Hacettepe University, Turkey)

Increasing undergraduate students' understanding of our ecosystems by way of using ICT (Information and Communication Technologies) is rather important for the sustainability and future of our world. With this aim, ICT supported educational modules were developed oriented towards the preservation of the existing ecosystem in the subjects of a) global environment, b)

renewable energy, c) green house effect and d) climatic change. All of the undergraduate students that had an Internet connection could access the website. ICT supported educational modules for the preservation of the existing ecosystem are educational tools. They incorporate elements that determine students' readiness along with concept teaching, HOCS applications and student group activities (groups of three). Target questions and internet based searching regarding these questions are incorporated into student reports and presentations. At the end of the study, the effect of these modules on students' achievement was investigated.

P609: BestChoice: A Model for Interactive Teaching

Sheila Woodgate (The University of Auckland, New Zealand), David Titheridge (The University of Auckland, New Zealand)

The open-access BestChoice on-line tutorial system, designed by the authors, has been used since 2002 in New Zealand to support both first-year university students and high school students in their learning of chemistry (4000 active users in 2005). 80 modules with 2500 screen views including over 2000 pages of interactive problem-solving that features feedback for each response. The primary focus of BestChoice is interactive teaching using a programmed learning approach. We have a particular interest in developing web-based tools that allow us to mimic on screen problem-solving strategies used by subject experts. Examples of these will be presented, and as well as the variety of strategies that have been trialled for using BestChoice as part of course materials. To have a look at BestChoice, go to www.bestchoice.che.auckland.ac.nz. Register or enter guest for username and user for password. Choose the General course, then BCCE 2006.

P610: Lessons Learned in Web Delivery of Organic Chemistry

John H. Penn (West Virginia University, USA)

An experimental web-based delivery of organic chemistry was performed. The class was run side-by-side with a traditional lecture class performance. Attendance data, performance data, and a broad range of additional data will be compared in this presentation to evaluate the effectiveness of the web-based delivery of organic chemistry.

P611: The Keys to Chemistry: Interactive Web-Based Tutorials

Anita Brandolini (William Paterson University, USA)

Students today have high expectations for the quality of the web-based learning resources they use. If these materials are not engaging and even entertaining, their interest will wane quickly, rendering the resources ineffectual. A series of web-based tutorials, called the Keys to Chemistry, is being developed with the goal of strengthening key skills that are essential to success in chemistry, such as the naming of chemicals, prediction of reaction products, and stoichiometry. The format is highly modular, to allow its use by students taking different levels of chemistry, at both the university and high-school levels. Interactive and lively features, such as animations, drag-and-drop activities, jokes, and links to interesting websites are being incorporated. Such elements reinforce understanding and maintain student interest by requiring active participation and by appealing to different learning styles. For example, the current modules provide students with more feedback than a simple "right" or "wrong" response. Instead, the likely source of an incorrect answer is proposed, and hints are offered for reaching the correct solution. In the near future, additional features will be added, such as video clips, puzzles, and games, where they are appropriate to reinforce the material presented. Longer-term plans include development of similar tutorials on organic chemistry and translation of these materials to assist students for whom

English is a second language. The current version of the Keys to Chemistry can be viewed at <http://euphrates.wpunj.edu/faculty/brandolinia>.

P612: The POINT: Interactive Web-Based Resources for the Secondary School Classroom
Vicente Talanquer (University of Arizona, US), Rachel Morgan Theall (University of Arizona, USA), Marilyne Stains (University of Arizona, US)

The POINT (Photonics and Optics of Information Technology) is a web-based resource containing interdisciplinary, interactive modules and manipulatives for chemistry and physical science teachers of grades 6-12 that was developed as a central part of the educational efforts of the Science and Technology Center on Materials and Devices for Information Technology Research (STC-MDITR). Most of the modules at The POINT were designed by teachers during year-long professional development programs. The year begins during a paid four week workshop where teachers develop the activities for their modules. During this workshop, teachers meet with scientists to strengthen their knowledge in the topic area for their module, programmers to talk about their ideas for the interactive portions of their module, and science educators to enhance their pedagogical content knowledge of web-based materials. Teachers continue to meet during the school year to monitor the development of their modules and to plan the implementation the modules in their classrooms. The modules help students learn science as they explore the world of information technology and its impact on modern society. Modules and manipulatives developed for The POINT can be viewed by visiting <http://concave.stc.arizona.edu/thepoint/> (username: itq; password: itq).

P613: JCE Digital Library: A Pathway to WWW-based Chemistry Education Applications
Jon Holmes (University of Wisconsin Madison, United States)

WWW-based applications are transforming the landscape of chemistry education. At the same time, the proliferation of such materials on the WWW make it difficult to navigate this new landscape. Digital libraries hope to provide a comprehensible roadmap for finding and retrieving selected materials from the WWW. The Journal of Chemical Education Digital Library (JCE DLib) aims to identify, select, annotate, and preserve the best of the online digital learning resources in chemistry. JCE DLib provides its users various services for the retrieval (via searching and browsing), selection, and annotation of the items in its collections. A collection of the National Science Digital Library (NSDL), JCE DLib also provides a pathway to a broad, interdisciplinary array of digital resources in all areas of science, technology, engineering, and mathematics (STEM) education. Developers of suitable materials can contribute their work to the library and by providing a suitable description automatically become a part of JCE DLib and the NSDL. Itsself a WWW-based application, some of the current and developing features of JCE Digital Library will be demonstrated in this presentation.

Workshops

Wednesday, August 2 afternoon

W36: Advanced Logger Pro

1:30 PM - 4:30 PM BRWN 2125

Dan Holmquist (Vernier Software & Technology, USA)

Learn what's new in Logger Pro such as superscript, subscript, and Greek character support. Did you know you now have the option of adding a second y-axis? If you already use Vernier's Logger Pro 3 software in your labs, you will want to come to this workshop. Learn how to configure your own experiment files, insert pictures and movies, and create multiple-page documents. Have you performed the perfect calibration? Logger Pro 3 lets you save it right on your sensor so you can call it up at any time! You're sure to learn a thing or two in this interactive workshop.

Capacity: 40 Fee: \$0

W37: Advanced POGIL Workshop: Designing Activities for a POGIL Learning Environment

1:30 PM - 4:30 PM STEW 313

Rick Moog (Franklin and Marshall College, USA)

In a POGIL classroom, students are actively engaged in learning a discipline and in developing essential skills. Students work in teams to acquire information and develop understanding through guided inquiry. The activities include information in the form of a model, followed by a carefully designed series of questions. These questions compel the student to process information, to verbalize and share their perceptions and understanding, and to make inferences and conclusions, i.e., construct knowledge. This knowledge is then applied to new situations requiring higher-order thinking skills and integration with previously learned concepts. Quality activities that engage students are essential for a successful classroom environment. In this workshop, we will discuss important principles for designing POGIL activities, examine existing activities, and guide participants in developing an activity appropriate for their own interests. Participants in this workshop are expected to have attended the Introduction to POGIL workshop at this meeting, or have equivalent experience and knowledge of POGIL.

Capacity: 36 Fee: none

W38: Caveman Chemistry: Hands-On Projects in Chemical Technology

1:30 PM - 4:30 PM BRWN 2144

Kevin Dunn (Hampden-Sydney College,)

Non-science students often approach chemistry with reluctance and trepidation. This workshop will explore a strategy for engaging students through a series of 28 hands-on chemical projects. We begin in the Stone Age, making fire by friction, arrowheads, and honey wine. We make a ceramic crucible from clay, spin yarn from wool, and extract potash from wood ashes. We smelt bronze in our crucible and dye our yarn with indigo. In later projects we make paper from hay, soap from fat, mauve dye from aniline, and photographs from egg whites and salt. Along the way we learn a history of chemical technology from the Paleolithic campfire, to the crafts of antiquity, to the alchemy of the Middle Ages, to the chamber acid and soda factories of the Industrial Revolution, to the multi-national chemical giants of the twentieth century. The registration fee includes the book, Caveman Chemistry. Website: www.cavemanchemistry.com.

Capacity: 30 Fee: \$30

W39: Molecular Level Laboratory Simulations and Inquiry Activities

1:30 PM - 4:30 PM WTHR 212

John Gelder (Oklahoma State University, United States)

Participants of this workshop will learn how to use and integrate Molecular Level Laboratory Experiments (MoLEs) into the chemistry classroom at the College or High School level. MoLEs

are Java-based programs that are accessed using any web browser. They provide an interactive, molecular level view of an ideal gas, or an equilibrium reaction. The chemical kinetics of the equilibrium reaction can also be investigated. Each program includes several guided-inquiry activities for students. The MoLEs and the inquiry activities have been classroom tested at several Universities, Community Colleges and High School classrooms. Partial funding for this project was provided by the National Science Foundation.

Capacity: 0 Fee: none

Thursday, August 3 morning

Plenary Speakers

Thursday, August 3 morning

11:15 AM - 12:15 PM

L12: Chemistry Enterprise: Looking back at 2015

William Carroll (Past President of the American Chemical Society)

During 2005, the major project of my term as President of the American Chemical Society was called "Chemistry Enterprise 2015." This was a built-bottom-up vision of the state of chemistry ten years hence. Members of all fields and interests participated in a year-long dialog on our future that included nearly twenty related Presidential events at national ACS meetings. We collected everything we read, heard and said, condensed it, and published it in a report early this year (<http://www.chemistry.org/chemistryenterprise2015.html>). This presentation will discuss how the project was done, the important forces we found driving the enterprise and the way we think it will turn out. There will also be discussion of the recent growing interest on the part of industry and government in science and innovation as important future economic drivers for the United States.

Symposia sessions

Thursday, August 3 morning

8:00 AM - 11:00 AM STEW 214D

S9: Building the Community of Green Chemistry Educators - Session 3 of 3 Online tools and outreach activities:

Kathryn Parent (American Chemical Society, USA), **Julie Haack** (University of Oregon, USA)

Chemistry is a rapidly evolving discipline and societal pressures and economic incentives are demanding that chemists develop new ways to carry out vital chemical processes using environmentally benign ("green") methods. By incorporating green chemical principles into the chemistry curriculum, educators have the opportunity to transform student perceptions about the role chemistry plays in our society and to prepare future scientists, educators and policy makers to address the national need to discover and develop sustainable chemistry for the future. This

symposium focuses on community development (high school and university) of green chemistry educators by showcasing new materials, summarizing newly available electronic tools, and highlighting a diverse array of outreach activities. Educators will receive ideas and support for incorporating green chemistry throughout diverse teaching environments.

| | | |
|------|-----------------|--|
| 8:00 | | introduction |
| 8:05 | Julie Haack | P614: GEMs for chemists: Facilitating the development of greener education materials |
| 8:25 | Robert M Hanson | P615: Using the web-based Green Chemistry Assistant to enhance understanding of chemical reactions and processes |
| 8:45 | Paul Tobin | P616: Inherently safer chemistry: A new chemical class database for toxic industrial materials |
| 9:05 | Edward Brush | P617: Green Chemistry Institute Sabbatical/Fellow Program: Valuable research experiences and collaborations with the GCI |
| 9:25 | | break |
| 9:35 | Kathryn Parent | P618: Green chemistry outreach programs from the American Chemical Society |
| 9:55 | | discussion |

P614: GEMs for chemists: Facilitating the development of greener education materials

Julie Haack (University of Oregon, USA)

A key to gaining broad adoption of a greener chemistry curriculum and sustaining the development of new educational materials is to actively involve faculty from across the country in creating these materials. The opportunity to work with fellow educators who can assist in developing, testing and championing a green chemistry curriculum has been critical for the development of currently available materials. However, the demand for educational materials that teach the strategies and tools of green chemistry in parallel with other fundamental chemical concepts and techniques has exceeded the supply. This paper will describe how GEMs for Chemists, an interactive, web-based database of Greener Education Materials is facilitating a unique, community-based approach to educational materials development. The database is designed to be a comprehensive resource of educational materials including laboratory exercises, lecture materials, course syllabi and multimedia content that illustrate chemical concepts important for green chemistry. The URL for the GEMs database is <http://greenchem.uoregon.edu/gems.html>.

P615: Using the web-based Green Chemistry Assistant to enhance understanding of chemical reactions and processes

Robert M Hanson (St. Olaf College, US), Paul Campbell (St. Olaf College, USA), Marc Klingshirn (St. Olaf College, USA), Gary Spessard (St. Olaf College, United States)

The Green Chemistry Assistant (GCA), <http://fusion.stolaf.edu/gca>, is a collaborative project between St. Olaf College and the U.S. Environmental Protection Agency that allows analysis of chemical equations, reactions, and processes in terms of green chemistry, safety, and chemical hazards. Geared toward a broad range of users, the site focuses on single- or multi-step processes for which the balanced chemical equations are known. In this presentation we will describe how we have used the GCA in both general chemistry and organic chemistry to introduce students to green chemistry concepts and to get students routinely thinking about safety and chemical hazards

in the laboratory. Most significantly for the green chemistry community, we will show how ambiguity in the definition of a "chemical reaction" can lead to confusion in assigning numerical values to green chemistry measures, and how distinction among "chemical equations," "chemical reactions," and "chemical processes" leads to a more coherent understanding of green chemistry.

P616: Inherently safer chemistry: A new chemical class database for toxic industrial materials

Paul Tobin (U.S. EPA, US), Richard Williams IV (Environmental Careers Organization, USA)
Chemical emergency programs of Federal, State, and other organizations rely on various chemical lists that have been developed from specific organization criteria to include chemicals of concern to their respective programs. The Environmental Protection Agency (EPA) National Advisory Committee for the Development of Acute Exposure Guideline Levels (NAC/AEGL) (www.epa.gov/oppt/aegl) develops AEGLs for all organizations' chemicals that pose potential acute inhalation hazards upon accidental (or possibly malicious) releases to air. The AEGL chemical priority list, developed by U.S. EPA, and a database of these chemicals that has also been developed by EPA in partnership with the Research Institute of Hygiene, Toxicology and Occupational Pathology in Russia, consists of approximately 300 chemicals that can be organized according to about 50 different chemical classes. Development of a database of these chemicals by chemical class has certain advantages, including the organization of the listed chemicals in a way that can increase awareness of inherently safer chemistry opportunities by chemists, chemical hygienists and chemical engineers. The database includes links to inherently safer chemistry references for chemical classes of the toxic industrial materials. This database thus presents a wide range of information on the chemistry, toxicology, regulation and inherently safer chemistry opportunities in a user-friendly way that will result in quick appreciation by chemists and others for the basis and utility of chemical emergency programs and chemical risk management.

P617: Green Chemistry Institute Sabbatical/Fellow Program: Valuable research experiences and collaborations with the GCI

Edward Brush (Bridgewater State College, USA)
The Green Chemistry Institute provides supplemental support for professionals seeking a sabbatical or fellowship in green chemistry and/or green engineering through its Sabbatical/Fellow Program. This program was initiated in 2005, and provides up to \$50,000 in sabbatical matching support to professionals in academia, industry and government. The project proposal must focus on an area of research analysis, and/or development of an area relevant to green chemistry and engineering, that is of mutual benefit to the sabbatical fellow and the Green Chemistry Institute. This presentation will focus on my experiences as a GCI Sabbatical Fellow, conducting new research on conductive polymers in the group of Dr. John Warner at UMASS Lowell, and my collaborations with the Green Chemistry Institute. I will also discuss how to contact a sabbatical host, develop a research plan, the application process, and cost-sharing requirements.

P618: Green chemistry outreach programs from the American Chemical Society

Kathryn Parent (American Chemical Society, USA), Marisa Burgener (American Chemical Society, USA), Jennifer Young (American Chemical Society, USA)
The mission of the American Chemical Society Green Chemistry Institute (GCI) is to advance sustainability through the implementation of green chemistry and engineering principles into all aspects of the chemical enterprise. GCI actively promotes green chemistry education and focuses

on increasing the understanding and awareness of green chemistry principles, alternatives, practices, and benefits. The American Chemical Society (ACS) offers a number of outreach activities for members to share their chemistry expertise with young students and the general public. GCI works with the ACS Office of Community Activities to develop green chemistry activities for the National Chemistry Week and Chemists Celebrate Earth Day programs. GCI also coordinates with the ACS Education Division to offer “Green Chemistry Chapter” awards to student affiliates. Student awards programs administered by GCI include the ACS Environmental Division’s Kenneth G. Hancock Award, and the Joseph Breen Memorial Fellowship. Funding for faculty is available through the Joseph Breen Leadership in Green Chemistry program and the GCI Sabbatical Fellowship. GCI has offered numerous workshops on green chemistry at ACS National and Regional Meetings, as well as running a Summer School on Green Chemistry annually since 2003. This presentation will highlight the variety of outreach activities available through the American Chemical Society. This talk will also highlight the online resources available from GCI (www.greenchemistryinstitute.org) that will assist faculty in integrating green chemistry into the curriculum. Together, these resources help to engage a diversified community, promote broader adoption of a greener curriculum, and sustain the development of new educational materials.

8:00 AM - 11:00 AM STEW 218AB

S10: Computation, Modeling and Molecular Visualization across the Chemistry Curriculum - Session 4 of 4

Joseph Grabowski (University of Pittsburgh, USA), **Elisabeth Bell-Loncella** (University of Pittsburgh at Johnstown, USA)

This symposium will highlight the various ways faculty have used visualization, simulation, molecular modeling, mathematical software, and related computational methods to enhance and expand the learning experience in the undergraduate chemistry curriculum – in the classroom, in the laboratory, and in research. Papers describing specific activities for individual courses as well as department initiatives to integrate computation across the curriculum will be included.

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|-------|---------------------|---|
| 8:00 | | introduction |
| 8:05 | Eric Helms | P619: Molecular modeling and nmr of glycidol: an advanced lab with a caveat |
| 8:25 | Richard Schwenz | P620: Computational models for NMR spectra: comparison of different modelling program results with experiment |
| 8:45 | Harshavardhan Bapat | P621: Applications of diamond structure visualization software in the chemistry laboratory |
| 9:05 | Jonathan Brooks | P622: Ubiquitous quantum and forgotten gravity |
| 9:25 | | break |
| 9:35 | Joseph Grabowski | P623: Adding the third dimension to the chemistry lecture |
| 9:55 | Jo Conceicao | P624: Teaching undergraduate research at a rural university with computational chemistry |
| 10:15 | | discussion |

P619: Molecular modeling and nmr of glycidol: an advanced lab with a caveat

Eric Helms (State University of New York, College at Geneseo, USA), Nicholas Arpaia (SUNY

Geneseo, USA), Melissa Widener (SUNY Geneseo, USA)

This laboratory experience combines molecular modeling and 1-dimensional and 2-dimensional NMR spectroscopy to correctly assign the proton and carbon NMR spectra of 2,3-epoxy-1-propanol (glycidol). In the process, students learn how to read DEPT-135, HETCOR, and COSY spectra. While assigning one set of diastereotopic protons, a limitation of current computational models for predicting proton NMR is discovered. The traditional method of using dihedral angles and the Karplus relationship leads to the correct answer. While assigning the other set of diastereotopic protons, conformational modeling must be done in order to determine the multiplet width. In this instance, either the traditional method or computation leads to the same answer.

P620: Computational models for NMR spectra: comparison of different modelling program results with experiment

Richard Schwenz (Univ. of Northern Colorado, US)

Our school has recently acquired a 400 Mhz FT-NMR. We are in the process of developing several laboratory exercises involving this new instrument. A vital component of understanding the data from this instrument is the assignment of spectral features to the chemical structures within the molecule. We will use several different modeling programs capable of predicting the one-dimensional ¹H and ¹³C NMR spectra of several compounds. We will compare those simulated spectra with the experimental spectra obtained from the same compounds. The trials, errors, and difficulties with this process will be examined.

P621: Applications of diamond structure visualization software in the chemistry laboratory

Harshavardhan Bapat (University of Illinois at Springfield, USA), Keenan Dungey (University of Illinois at Springfield, USA), Wayne Gade (University of Illinois at Springfield, USA), Eric Malina (Southern Illinois Univ. Edwardsville, USA), Masangu Shabangi (Southern Illinois University Edwardsville, USA), Michael Shaw (Southern Illinois University Edwardsville, USA), Gary Trammell (University of Illinois at Springfield, USA), Eric J. Voss (Southern Illinois University Edwardsville, USA), Susan Wiediger (Southern Illinois University Edwardsville, USA)

X-ray diffraction (XRD) is an extremely powerful tool for characterizing substances, yet it has found little place in the standard undergraduate chemistry curriculum. An NSF CCLI/A&I grant has allowed the University of Illinois at Springfield and Southern Illinois University Edwardsville to purchase Rigaku/MS MiniFlex+ powder X-ray diffractometers. Both institutions are collaborating in developing activities to incorporate solid-state chemistry throughout the curriculum. The Diamond structure visualization software by Crystal Impact is a powerful tool that allows students to visualize and manipulate solid state structures. In our second semester general chemistry course, students use ICE solid-state model kits along with Diamond to build and explore numerous unit cell structures. In our senior Integrated Physical and Inorganic Chemistry laboratory course, students prepare the 1, 2, 3-superconductor and collect a powder pattern of their material. They then use Diamond to visualize the unit cell structure and to simulate the powder pattern for comparison with their experimental data. Results from these applications of Diamond will be presented.

P622: Ubiquitous quantum and forgotten gravity

Jonathan Brooks (Ivy Tech, USA)

Quantum Gravity is the name for the problem of reconciling quantum mechanics with general relativity. Both quantum gravity and the unified field are inherent in the derivation of the Rydberg

constant done by Neils Bohr. How gravity is fitted into Rydberg spectra requires a novel solution to the radial portion of Schrödinger's equation. The radii of any orbital of the periodic table are fitted by an aufbau matrix via a hill-climb PC program that also calculates their potentials. The 1-S atomic indicator, termed the principle numerical attribute. is periodic mirroring the radius.

P623: Adding the third dimension to the chemistry lecture

Joseph Grabowski (University of Pittsburgh, USA)

Computers and data projectors have dramatically impacted teaching practices across the disciplines and at all levels. This technology is often used to display images and animations that would otherwise be described only in words, or be schematized by hand drawn, icon-heavy, representations. The next use of this technology will be to transform flat two-dimensional representations of inherently three-dimensional entities, into true three-dimensional, interactive projections. This presentation will document how our Chemistry faculty have built and are using such a system in a large lecture hall, and will describe a portable system that can readily be used by faculty across the campus. All aspects of the project will be available for discussion, from the pros and cons of pseudo-3D projection vs real-3D projection to the technology needed, to experiences using the system in large to small classrooms, to the assessments so far available, to the challenges of changing software, to frustrating experiences with hardware, and even to speculation about the technology of tomorrow.

P624: Teaching undergraduate research at a rural university with computational chemistry

Jo Conceicao (Northwestern Oklahoma State University, USA), Heath Stotts (Northwestern Oklahoma State University, USA)

Participation in research is an important component of undergraduate education in the chemical sciences. The advent of high-speed personal computer and more importantly user-friendly and state-of-the-art software packages make it feasible for undergraduates to conduct research in computational chemistry. As a rural university, most of our students come from very small communities with limited exposure to chemistry. The full-blown process of research may be overwhelming and many students shy away from this experience. In order to address this issue, we have developed a course in undergraduate research using computational chemistry. Unlike traditional undergraduate research in which students are given almost free rein and independence to tackling their project, we have included a structured instruction component to these endeavors. A syllabus with well defined goals and objectives provide students with a framework of the research process. Research skills such as literature searches and experimental design are taught explicitly. Presentation skills are developed in group-meetings and students are required to prepare and present a poster at the state academy of science meeting. The structure and implementation of this curriculum, observations of successes and shortcomings as well as anecdotal feedback from discussions with students will be presented.

8:00 AM - 11:00 AM STEW 302

S35: First Year College Chemistry - Session 3 of 3

Cecilia Collado (Universidad de Concepcion, CHILE), **Matthew Fisher** (Saint Vincent College , USA)

Entry level college chemistry courses, whether for science majors or nonmajors, present unique challenges for instructors. This symposium will focus on several aspects of these challenges posed by first-year chemistry courses. Topics to be considered will include teaching strategies,

curriculum questions especially as they relate to issues of globalization and harmonizing disparate needs and interests, and assessment of student learning.

| | |
|-------------------------|---|
| 8:20 | introduction |
| 8:25 Mary Bojan | P625: Modifying the Curriculum in General Chemistry: an assessment of the Atoms First Approach. |
| 8:45 Rebecca Krystyniak | P626: Investigation of the teaching of Lewis Dot Structures in the First-Year Chemistry Course |
| 9:05 Pat Meyer | P627: How precursor key concepts for organic chemistry success are understood by general chemistry students |
| 9:25 | break |
| 9:35 Sandra Dudley | P628: Chemistry for engineers: Background and learnings |
| 9:55 Krista Young | P629: "The World We Create": An experiment in teaching chemistry to non-science majors |

P625: Modifying the Curriculum in General Chemistry: an assessment of the Atoms First Approach.

Mary Bojan (Penn State University, USA), **Ruth Bowers** (Penn State University, USA), Ralph Locklin (Penn State University, USA)

In Fall semester of 2005, we reorganized the curriculum for our first semester general Chemistry course. Although we ultimately included the same content as we had the previous year, we changed the sequence to what we call an "atoms first" approach. In this approach we started with the structure and properties of the atom, then covered structure and properties of molecules, and finally after that we talked about chemical reactions, thermodynamics and equilibria. In the traditional sequence, we started with chemical reactions and stoichiometry. In this paper, we will describe the atoms first approach and our reasons for implementing it. We will also include an assessment of the effectiveness of this approach. The results of student surveys and interviews with students will be summarized. In addition we will compare the exam scores from the semester where the new sequence was implemented to those from a previous semester where the more traditional sequence was used. The item analyses from exams is used to compare the results of individual questions on tests given in the different semesters that are similar in content but that are encountered at different times in the course. We attempt to identify "marker exam questions" that appear to be reflective of the change in topic sequence. Performance on these exam questions is compared for the two versions of the course.

P626: Investigation of the teaching of Lewis Dot Structures in the First-Year Chemistry Course

Rebecca Krystyniak (St. Cloud State University, USA)

Bonding and Lewis Dot Structures (LDS) are some of the most important topics in the Introductory Chemistry course. It has been identified at our institution that students entering subsequent chemistry courses have not mastered these topics and that often hinders their ability to succeed in these courses. This study sought to identify the current state of teaching LDS and to document student ability to draw LDS. A content analysis of current textbooks was performed, and interviews with instructors provided insight into various teaching strategies. Student surveys offered information about student ability to draw LDS as well as their perception of their

understanding of bonding. Think-aloud protocols were performed which provided in-depth information about student understanding of bonding and LDS. Implications for the teaching of LDS will also be discussed.

P627: How precursor key concepts for organic chemistry success are understood by general chemistry students

Pat Meyer (Western Michigan University, USA)

This study examines college student understanding of key concepts that will support future organic chemistry success as determined by university instructors. During four one-hour individual interviews the sixteen subjects attempted to solve general chemistry problems. A think-aloud protocol was used along with a whiteboard where the students could illustrate their ideas. The protocols for the interviews were adapted from the Covalent Structure and Bonding two-tiered multiple choice diagnostic instrument (Peterson, Treagust, & Garnett, 1989) and augmented by the Geometry and Polarity of Molecules single-tiered multiple choice instrument (Furió & Calatayud, 1996). The interviews were videotaped, transcribed, and coded for analysis to determine the subjects' understanding of key ideas. The subjects displayed misconceptions that were summarized into nine assertions about student conceptualization of chemistry. The study illuminated specific parts of the general chemistry curriculum that are particularly troublesome for students but necessary for their further achievement. This information is important; it gives the discipline of chemistry education target areas for general chemistry pedagogical improvement efforts. Furió, C., & Calatayud, M. L. (1996). Difficulties with the Geometry and Polarity of Molecules: Beyond Misconceptions. *Journal of Chemical Education*, 73 (1), 36– 41. Peterson, Raymond F., Treagust, David F., & Garnett, Patrick (1989). Development and Application of a Diagnostic Instrument to Evaluate Grade-11 and -12 Students' Concepts of Covalent Bonding and Structure Following a Course of Instruction. *Journal of Research In Science Teaching*, 26 (4), 301-314.

P628: Chemistry for engineers: Background and learnings

Sandra Dudley (Lipscomb University, USA), Bennett Hutchinson (Lipscomb University, USA)

As a result of changes in engineering accreditation standards, Lipscomb University offers a customized, one-semester chemistry course for non-chemical engineering students. This presentation includes a discussion of pertinent topics as well as textbooks and teaching methods that are suitable and effective for engineering students. The role of the chemistry section of the Fundamentals of Engineering exam, the chemistry topics used in subsequent engineering courses, and the uses of chemistry for the practicing engineer will be addressed. Plans for course modification based on feedback from engineering students in the Fall 2005 Chemistry for Engineers course will also be presented.

P629: "The World We Create": An experiment in teaching chemistry to non-science majors

Krista Young (University of Arizona, USA), Jenine Maeyer (University of Arizona, United States), Vicente Talanquer (University of Arizona, US)

This talk will focus on the design, implementation, and evaluation of "The World We Create," a novel learner-centered Tier I (freshman level) natural science (NATS) course for non-science majors being offered at the University of Arizona (U of A). The entire course is structured to engage students in interactive learning activities using the learning cycle as the main instructional model. Moreover, in every session students work in small groups of three to four people on specific hands-on and minds-on activities planned to promote mastery of course content and to

develop key thinking and process skills. “The World We Create” is also innovative in the utilization of advanced students who are training to be secondary school science teachers. These prospective science teachers, who are enrolled in the Science Teacher Preparation Program in the College of Science at the U of A, provide one-on-one support for the non-science students enrolled in the general education NATS course; they also are actively involved in the planning, delivery, and evaluation of course activities as part of their training. We have studied the effect of this innovative teaching model on student learning and attitudes towards science, and on the planning, instruction, and assessment of knowledge and skills of the prospective science teachers. In this talk, we will describe the basic structure of the course and summarize our major research findings.

8:00 AM - 11:00 AM STEW 218CD

S58: From Student to Practitioner - Session 1 of 1

Gautam Bhattacharyya (University of Oregon, USA)

Over the last several years there has been an emerging discourse in the chemical community regarding the education of future practicing chemists. This ongoing discussion stems from concern about the potential dearth of professional chemists in the future. Research in this area conducted by the chemical and science education communities will help shape the reform of professional education in chemistry. This symposium will explore the recent developments in this field and suggest improvements to graduate education in chemistry.

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|-------|----------------------|---|
| 8:00 | | introduction |
| 8:05 | Donald Wink | P630: Student data analysis as a means for understanding real science |
| 8:25 | Matthew Miller | P631: Holistic approaches to planning undergraduate research experiences |
| 8:45 | Bethany Melroe | P632: Effects of research participation on preconceptions in science |
| 9:05 | David Cartrette | P633: Outcomes of a CUR workshop: Planning for undergraduate research programs |
| 9:25 | | break |
| 9:35 | Ala Samarapungavan | P634: On becoming a chemist: The influence of authentic practice on students' models of laboratory error |
| 9:55 | Janet Bond-Robinson | P635: What has happened to a student who now is called a Ph.D. chemist? |
| 10:15 | Michael Thompson | P636: Student professional, intellectual, and ethical development: Using service-learning as a mechanism to facilitate first-year science and engineering students thinking of what it actually means to be a practitioner in their field |
| 10:35 | Gautam Bhattacharyya | P637: Mommy, where do synthetic chemists come from? |

P630: Student data analysis as a means for understanding real science

Donald Wink (UIC,), Paramjit Arora (NYU, USA), Henry Brenner (NYU,), James Canary (NYU, USA), Jeong H Hwang (University of Illinois at Chicago,), Trace Jordan (New York University, U.S.A.), Kent Kirshenbaum (NYU, USA), Johannes Schelvis (NYU, USA)

This paper will discuss the results of a multi-year project to develop instrumentation-based

extended projects in organic, inorganic, and experimental physical chemistry lab courses. In the course of this project students carried out synthetic, analytical, and physical procedures on a variety of substrates, including fullerene substrates used in multiple courses. The effect of obtaining, interpreting, and explaining authentic data significantly enhanced student understanding of the meaning of spectroscopy. The contents of the program and the results of evaluation of the program using survey and focus group methods will be shared.

P631: Holistic approaches to planning undergraduate research experiences

Matthew Miller (South Dakota State University, USA), **David Cartrette** (South Dakota State University, United States)

The purpose of this study was to assess the impact of research experiences for undergraduates via an REU site program. Analysis focused on participant nature of science (NOS) perspectives and on knowledge construction during the program. The assessment was a four phase evaluation process, with NOS and knowledge construction components functioning independently. Outcomes from the separate evaluations were merged into a meta-analysis, and was used to assess the overall REU program. Conclusions drawn from all sources of evaluative data indicate that students new to independent research would benefit from considering not only knowledge and skills gain, but also from learning about how communities of scientists work, how scientists communicate, and other legitimate forms of participation as a functioning member of a research team.

P632: Effects of research participation on preconceptions in science

Bethany Melroe (South Dakota State University, USA), **David Cartrette** (South Dakota State University, United States)

Preconceptions are ideas or beliefs that are held prior to participation in a task or subject. Research has shown that preconceptions are formed early, strongly held, and influenced by a variety of societal factors, including parental and peer influence. Even after participation in the task or subject, preconceptions persevere and often metamorphose into misconceptions, which compromise understanding and appreciation of the value of the task. This project was designed to better understand how preconceptions of scientific research develop and change after participation in undergraduate research projects. Fifteen participants were interviewed, where questions about their views of science, research, and science-technology-society (STS) were asked. Interviews were conducted throughout the participants' research experiences. Data were also gathered from Likert scale questionnaires given before and after research participation. Results of the study indicated that preconceptions of scientific research were most heavily influenced by peers and classroom experiences, and that shifts in beliefs did occur after legitimate participation in the research enterprise.

P633: Outcomes of a CUR workshop: Planning for undergraduate research programs

David Cartrette (South Dakota State University, United States), Dawn Del Carlo (University of Northern Iowa, USA), Matthew Miller (South Dakota State University, USA)

The authors of this presentation conducted a workshop at the National Council for Undergraduate Research (CUR) Meeting which focused on developing strategies for engaging students in undergraduate research projects. The workshop presented data supporting the hypothesis that research is more than just work; it is a complex learning process which requires greater planning and further study. During the workshop, participants brainstormed in group sessions to develop plans for educating undergraduate researchers and what it means to effectively participate in the

research enterprise. A summary of those findings will be presented, along with select strategies for a more holistic engagement of undergraduate researchers.

P634: On becoming a chemist: The influence of authentic practice on students' models of laboratory error

Ala Samarapungavan (Purdue University, USA)

This study investigated the ways in which beliefs about the nature of laboratory errors and strategies for dealing with laboratory errors vary as a function of an individual's chemistry expertise and chemistry research experience across the range from high-schools students, whose exposure to chemistry occurs in the classroom, to practicing research chemists. Interviews conducted with a total of 91 participants probed three key research questions: Do the participants' epistemic beliefs about the sources, nature, and meaning of laboratory errors vary as a function of chemistry expertise? Are there discipline-specific values and heuristics that help chemists identify, deal with, and interpret laboratory errors in the course of chemistry research? How does research experience influence participants' epistemic beliefs? We found that participants' beliefs about error varied significantly with chemistry expertise and with exposure to authentic research in chemistry. Differences in both the duration and the nature of participation in research had a significant effect on how participants conceptualized science and scientific research. We noted that only the practicing scientists saw productive role for empirical anomalies that arise in the course of doing research.

P635: What has happened to a student who now is called a Ph.D. chemist?

Janet Bond-Robinson (Arizona State University, USA)

A student enters graduate school. Somewhere between four and seven years later he or she becomes "certified" as a Ph.D. chemist. What has happened to graduate students in chemistry? How has their thinking changed? What changes their thinking? What have they learned? These are questions we have studied in a laboratory doing organic synthetic research. My research group has studied them for several years. This organic synthesis group at a Research I University has approximately 15 members. Our findings may provide insight as to the peculiar nature of a cognitive apprenticeship to learning as opposed to the learning done as part of a course.

P636: Student professional, intellectual, and ethical development: Using service-learning as a mechanism to facilitate first-year science and engineering students thinking of what it actually means to be a practitioner in their field

Michael Thompson (Purdue University, USA)

The transition from student to practitioner must occur for the scientist or engineer to become successful in his or her field. One of the first stages that must occur so that the student can begin a proper transition to a practitioner is that the student become mindful professionally, intellectually, and ethically of their field. This awareness most often materializes through experience and reflection on that experience. This experience must be one that the student ascertains to be a real-life example of his or her profession. Work with service-learning at Purdue University provides a glimpse of how a practicing scientist or engineer might experience their profession. We have over two years of quantitative and/or qualitative investigations with over 500 science and engineering students in service-learning. As a result it has become apparent that implementation of the service-learning pedagogy can provide this experience. We have found that science and engineering students who have participated in service-learning have a better understanding of what it means to

be a practitioner in their field. In this paper we not only discuss our quantitative and qualitative findings but do some initial discussion of a scheme that could possibly help us understand at any given time where students lie in their transition from first-year student to practitioner.

P637: Mommy, where do synthetic chemists come from?

Gautam Bhattacharyya (University of Oregon, USA)

Traditionally, Organic Divisions within Departments of Chemistry train the largest number of students in chemistry doctoral programs. Yet, very little is understood about the processes by which students evolve into practicing organic chemists. We have recently completed several studies on how individuals learn organic chemistry. Our participants ranged from students in sophomore-level organic chemistry through upper-level graduate students towards the end of their Ph.D. degrees. This presentation will discuss the epistemic development of organic chemists and suggest a type of intervention strategy aimed to help students construct practitioner knowledge in organic chemistry.

8:00 AM - 11:00 AM STEW 314

S59: General and Broad Ideas for Teaching Chemistry - Session 1 of 1

Steven Gravelle (Saint Vincent College, USA), **Willy Hunter** (Illinois State University, USA)

This symposium of general interest to the Chemical Education community will encompass broad ideas across the chemistry curriculum.

| | | |
|-------|----------------------|--|
| 8:00 | | introduction |
| 8:05 | Al Hazari | P638: Chemistry in comics |
| 8:25 | Carmen Gauthier | P639: Great ideas in chemistry: A day of sharing |
| 8:45 | Rashmi Venkateswaran | P640: What in the world isn't chemistry...but do the students know that? |
| 9:05 | Steven Gravelle | P641: The math-science partnership of southwestern Pennsylvania |
| 9:25 | | break |
| 9:35 | Jeffery Orvis | P642: A learning community that brings department of chemistry, college of education, and local high school science faculty together: Offering and gaining multiple insights |
| 9:55 | Rachel Morgan Theall | P643: Informal avenues for teaching chemistry |
| 10:15 | Asfaha Iob | P644: Use of analogies that deal with family relationships (man/woman; marriage, divorce...) in teaching general chemistry |
| 10:35 | Nittala Sarma | P645: Teaching students word roots of chemistry terms for concept strengthening and communication skills development |

P638: Chemistry in comics

Al Hazari (University of Tennessee, USA)

Comics that depict chemistry situations and/or materials are most effective as a teaching strategy (tool) to reinforce a topic or concept students are currently studying. A sampling of chemistry comics is presented together with the learning situations into which they best fit.

P639: Great ideas in chemistry: A day of sharing

Carmen Gauthier (Florida Southern College , USA), **George Sellers** (The Vanguard School, USA)
The Florida Local section of the ACS submitted an Innovative Grant proposal to the national American Chemical Society to host an all day symposium for high school chemistry teachers. The event was a huge success with participation by Dr. Diana Mason representing the Division of ChemEd and the Journal of Chemical Education, Dr. William Deese presented his Dead Chemists Society routine, and the special guest was Sir Harold Kroto a 1996 Nobel Laureate. In this presentation information will be given on how the idea surfaced, how it developed and how it was transformed into a very successful event. The information that we are sharing can be used by any group to host such an event.

P640: What in the world isn't chemistry...but do the students know that?

Rashmi Venkateswaran (University of Ottawa, Canada)

Chemistry is one of the most applicable subjects in any student's life, yet it is one of the subjects in which we see the greatest reluctance on the part of the students. As a required course, we see many students taking chemistry but not being interested in actually learning the concepts with a view to applying them in future courses or in their lives. Their primary goal appears to be to pass the course, preferably with the highest mark possible. In this paper, I will discuss some of the techniques that my colleagues and I have tried to implement in order to keep the students interested and motivated so that we can hopefully increase the number of students who understand the direct relevance of chemistry to their lives.

P641: The math-science partnership of southwestern Pennsylvania

Steven Gravelle (Saint Vincent College, USA), Kevin Kelly (Allegheny Intermediate Unit, USA), Gabriela Rose (Allegheny Intermediate Unit, USA)

The Math-Science Partnership of Southwestern Pennsylvania (<http://swpa.mspnet.org/>) is a five-year, \$18 million project funded by the NSF whose purpose is to enhance math and science education from kindergarten through college in southwestern Pennsylvania. There are 48 school districts and four institutions of higher education participating in this grant. All the professional development experiences for teachers are tied to the National Science Education standards and focus on using researched-based curriculum. This presentation will focus on my experiences with three components of the project in which Saint Vincent College is participating: Summer Teacher Leadership Academies, Teacher Fellows, and Content Deepening Seminars. The goal of the Teacher Leadership Academies is to immerse high school teachers in inquiry-based instruction, and to prepare them to become teacher leaders of the program back in their own school districts. The Teacher Fellow program brings high school teachers into the college to collaborate with higher education faculty. I will discuss my experiences working with a Teacher Fellow who enrolled in one of my courses and helped me to incorporate more inquiry-based activities into the course. In the Content Deepening Seminars, teachers expand their understanding of science content through three-day courses taught by higher education faculty. All three examples bring together college faculty and teachers for the common purpose of improving K-16 science education.

P642: A learning community that brings department of chemistry, college of education, and local high school science faculty together: Offering and gaining multiple insights

Jeffery Orvis (Georgia Southern University, USA)

Supported by funding from the National Science Foundation, many colleges and universities in the

state of Georgia are engaged in a multiyear effort to improve science achievement of K-16 students. A major component of this effort is the establishment of learning communities that unite college science and education faculty with public school teachers. These communities are intended to support reform efforts throughout education. This paper presents the observations of a participant from Georgia Southern's department of chemistry, and details the surprising amount of learning and insight that flowed in all directions among the various participants. In short, this was a very positive and eye-opening experience, one that other college science faculty could benefit from.

P643: Informal avenues for teaching chemistry

Rachel Morgan Theall (University of Arizona, USA)

With increased pressure for students and teachers to meet state and national science education standards, less time is spent in the classroom on issues relevant to the broader community and students' lives. Learning about science in this context is left to the science centers and museums. While most science centers have little representation of chemistry at their facilities, there are ways for schools to provide opportunities for informal or informal-style education in chemistry. My project, Science in the City, a project of the NSF Division of Chemistry Discovery Corps Post Doctoral Fellowship, addresses this issue through a partnership with the local science center which assists teachers and students in the creation of science exhibits based on topics that address important community issues while targeting science education standards. Through Science in the City sponsored clubs and specially designed classes, high school students identify scientific issues relevant to their community, learn the science behind these issues, and develop science museum exhibits based on their findings. The projects are entirely student led, contain substantial amounts of chemistry, act as prototypes for larger exhibits and are part of community events and student led visits to middle schools. This presentation will focus on the different ways that chemistry teachers can interact with science centers, the successes of Science in the City to date, and what is planned for the future.

P644: Use of analogies that deal with family relationships (man/woman; marriage, divorce...) in teaching general chemistry

Asfaha Iob (Oklahoma State University, USA)

Many non-science students usually encounter a lot of frustration and difficulty when taking a 'required' chemistry course. To alleviate such fear and to motivate the students, and make them remember chemical terminologies, it is always a good idea to give family related analogies that they can relate to. Some of the analogies I use include, marriage, divorce, snatching boyfriend/girlfriend etc. in order to describe chemical reactions such as combination, decomposition, single replacement etc. I usually include relevant songs and images in my lecture notes (power point). These analogies and songs make the students remember the chemical terms and reactions. All of these plus other analogies I use in discussing the periodic table, cations, anions etc. will be discussed.

P645: Teaching students word roots of chemistry terms for concept strengthening and communication skills development

Nittala Sarma (Andhra University, INDIA)

Many technical terms in chemistry in English derive from a far fewer root words of foreign, eg., Greek and Latin origin. The root words of frequent occurrence are orthos, tropos, meros, meta,

isos, para, heteros, syn, homos, dia, pseudos, leiin, chronos, etc. For a starter, knowledge of the etymology of chemistry terms and the root words concerned can be potentially useful in many ways. It can for example, (i) convert the often intimidating appearance into a familiar field, (ii) help understand concept, at least the early concept, represented by the term succinctly, and (iii) apply the knowledge for understanding technical terms that are new, i.e., those hitherto not encountered but derive from the known root words.

8:00 AM - 11:00 AM STEW 214C

S13: Inorganic Teaching Experiences - Session 2 of 2

Dave Finster (Wittenberg University, USA)

This symposium will focus on innovative ways of presenting topics in lecture and lab for inorganic classes. The symposium will have two sub themes: Part A will discuss the non-physical based (“sophomore”) descriptive course and Part B will discuss the “senior” course which generally has physical chemistry as a pre- or co-requisite. Part A will include papers on innovative teaching practices implemented at the lower level sophomore inorganic course. These topics/concepts include, but are not limited to, the following subjects: student presentations, innovative worksheets, molecular modeling, laboratory developments, a specific inorganic concept, community service projects, or Scholarship of Teaching and Learning projects. Part B will focus on new ideas and pedagogy in the senior-level inorganic classes and labs; topics will include using active-learning strategies, integrating computational chemistry in the classroom and lab, new methods of teaching the “standard” content, and novel lab experiments.

| | | |
|------|----------------------|--|
| 8:00 | Lon Porter | P646: An “investigator-centered” approach to a capstone laboratory experience: Undergraduate proposal writing and collaborative research |
| 8:20 | Keith Walters | P647: Evolution of the NKU "modern" upperclass inorganic chemistry course |
| 8:40 | Dave Finster | P648: Fostering critical thinking in the advanced inorganic course |
| 9:00 | | break |
| 9:10 | Elvin Igartua-Nieves | P649: Experiment for the inorganic chemistry laboratory: [60]Fullerene displacement from (dihapto-buckminsterfullerene) pentacarbonyl tungsten (0) |
| 9:30 | Don Carpenetti | P650: Effects of substitution on the color of indenylidene anions: Correlation between P-HMO analysis and spectroscopy |
| 9:50 | Paul Rillema | P651: Synthesis and electronic properties of ruthenium(II) diimine complexes: An inorganic laboratory experiment |

P646: An “investigator-centered” approach to a capstone laboratory experience: Undergraduate proposal writing and collaborative research

Lon Porter (Wabash College, USA)

Since the advanced inorganic chemistry course is required for all graduating chemistry majors at Wabash College, it provides an excellent opportunity for utilizing an investigator model of laboratory learning. Student teams are responsible for the preparation of a formal, NSF styled proposal stating the goals, motivation, and plans for the execution of their laboratory project. This gives students a glimpse into the processes contributing to the design and execution of a collaborative research endeavor. Students are encouraged to explore methods of synthesis and characterization that may not have been encountered throughout the chemistry curriculum and to revisit the fundamental techniques that have. Emphasis is placed upon dissemination of research

results in the form of a paper, written in a contemporary journal article format, and an oral presentation given to the class. This experience provides students a glimpse into the planning, resources, and sweat equity that is required of modern research.

P647: Evolution of the NKU "modern" upperclass inorganic chemistry course

Keith Walters (Northern Kentucky University, USA)

The inorganic chemistry upperclass course at Northern Kentucky University has significantly evolved over the last four years, and the journey is detailed in this paper. The author's experiences over the past three years will be detailed, including the selection of a textbook, introduction of materials and bioinorganic topics, and the use of the angular orbital model (AOM) to greatly simplify the presentation of MO theory to students without significant physical chemistry experience.

P648: Fostering critical thinking in the advanced inorganic course

Dave Finster (Wittenberg University, USA)

A main goal of college and university curricula is to foster critical thinking and intellectual growth. Critical thinking can, and should, mean different things at various points in the curriculum. The advanced inorganic course provides a wonderful opportunity to build upon the content and thinking and problem-solving skills previously developed in general chemistry (and other mid-level courses such as organic chemistry and quantitative analysis). This paper will present an overview of some intellectual development goals that are appropriate for advanced courses and describe specific teaching strategies used in an advanced inorganic course to help students see chemistry (and their chemical education) as a process of developing increasingly sophisticated models.

P649: Experiment for the inorganic chemistry laboratory: [60]Fullerene displacement from (dihapto-buckminsterfullerene) pentacarbonyl tungsten (0)

Elvin Igartua-Nieves (University of Puerto Rico Mayaguez Campus, US), **José E. Cortés-Figueroa** (University of Puerto Rico, Puerto Rico)

The kinetics experiments on the ligand/[60]fullerene exchange reactions on (dihapto-[60]fullerene) pentacarbonyl tungsten(0) ((C₆₀)WCO)₅) form an educational activity for the inorganic chemistry laboratory that promotes graphical thinking as well as the understanding of kinetics, mechanisms, and the temperature dependence of rate constant values. It provides an opportunity for students to apply the concept of activation parameters to confirm or disprove a proposed mechanism and the relation between activation enthalpy and activation energy with the thermodynamic bond enthalpy and bond energy, respectively.

P650: Effects of substitution on the color of indenylidene anions: Correlation between P-HMO analysis and spectroscopy

Don Carpenetti (Marietta College, USA), *William Fogle* (Marietta College, USA)

During the course of synthesizing various 1- or 2-methyl substituted indene derivatives a striking color difference was observed. A solution of 1-methylindene treated with butyl lithium was observed to immediately result in a deep red solution while the corresponding un-substituted indene or 2-methyl substituted indene remained pale yellow in color or became only slightly darker respectively upon addition of 1.2 equivalents of butyl lithium. These compounds were analyzed using visible spectroscopy and modeled using perturbation HMO analysis to explain the observed

color differences. The use of this experiment to highlight the connections between calculations, group theory analysis and spectroscopy will be discussed.

P651: Synthesis and electronic properties of ruthenium(II) diimine complexes: An inorganic laboratory experiment

Paul Rillema (Wichita State University, USA)

We have carried out an experiment in the inorganic chemistry laboratory allowing students to integrate their prior learning experiences in analytical, organic and physical chemistry by synthesizing ruthenium(II) diimine complexes after first synthesizing various diimine ligands. Students then examine the electrochemical properties of the complexes by cyclic voltammetry where oxidations of the metal center are observed in the positive voltage region and reductions of the ligand are found in the negative voltage region. Students also obtain electronic absorption spectra and assign the observed electronic transitions to charge transfer and ligand centered properties. Emission properties are then examined by obtaining emission spectra and determining the emission lifetime of the complexes. The emission lifetimes are obtained by exciting the complexes with a nanosecond pulsed laser.

8:00 AM - 11:00 AM STEW 310

S3: Inspiring Ideas for Physical Chemistry Lecture and Laboratory - Session 2 of 2

Richard Schwenz (Univ. of Northern Colorado, US)

Presenters will share ideas for teaching physical chemistry lecture and laboratory that can be incorporated into classes. The symposium will also seek to answer important underlying questions such as “How do you know when your students understand physical chemistry?”, “How do you address the issue that physical chemistry overlaps the other subdisciplines of chemistry more than ever?”, and “what can you possibly leave out of the already overcrowded curriculum?”

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|-------|-------------------------|--|
| 8:00 | | introduction |
| 8:05 | Erica Harvey | P652: Student Learning Outcomes for Physical Chemistry |
| 8:25 | Kristina Lantzy-Eaton | P653: Raman Spectroscopy and Group Theory in the Physical Chemistry Laboratory |
| 8:45 | Chrystal Bruce | P654: Teaching Students to Think Using Topics in Thermodynamics |
| 9:05 | John Hagen | P655: A Revised Surface Tension Lab |
| 9:25 | | break |
| 9:35 | Paul Endres | P656: Integrated Laboratory / Project Approach |
| 9:55 | Carlos Contreras-Ortega | P657: How Dilute is dilute? |
| 10:15 | Derek Gragson | P658: Developing Technical Writing, Data Manipulation, and Mathematical Computation Skills in the Physical Chemistry Lab |
| 10:35 | | discussion |

P652: Student Learning Outcomes for Physical Chemistry

Erica Harvey (Fairmont State University, USA)

Specific student learning outcomes have been defined for both semesters of a junior-level physical chemistry course. Learning outcomes address both physical chemistry content and “meta-skills”

such as clear and logical writing, explaining material to peers, presenting derivations and demonstrations, self- and peer-critiquing skills, and solving problems with the help of symbolic math software such as Mathcad. Mastery of outcomes is demonstrated in a variety of ways, including individual solution of word problems (multiple attempts are allowed), collaborative group solutions to open-ended application problems, concept-mapping, performance on randomized electronic quizzes, and demonstrated ability to write/explain/present/critique. Teaching with explicit learning outcomes forces faculty to make hard choices upfront, during course development, about what can and will be covered in the course. Students appreciate knowing what they are expected to learn and how they will be able to demonstrate their acquired knowledge and skills.

P653: Raman Spectroscopy and Group Theory in the Physical Chemistry Laboratory
Kristina Lantzky-Eaton (St. John Fisher College, USA)

The coverage of group theory in physical chemistry has declined recently often being deferred to inorganic chemistry. The implementation of a Raman spectroscopy experiment in the physical chemistry laboratory, which implements group theory to determine vibrational modes of small organic compounds, offers an inorganic overlap experience for upper level students. Students model the given organic molecule with Gaussian03 and then obtain Raman spectra. Mode assignments are made by comparing Gaussian03 calculations to the vibrational components from the reduced representation.

P654: Teaching Students to Think Using Topics in Thermodynamics

Chrystal Bruce (Erskine College, USA), Carribeth Bliem (University of North Carolina at Chapel Hill,), John Papanikolas (University of North Carolina at Chapel Hill, USA)

As educators, we want our students to be independent thinkers and creative problem solvers, yet we sometimes find it easier to attempt to fill their brains with our knowledge in the lecture setting. At Erskine College and the University of North Carolina at Chapel Hill, we have incorporated the Virtual Substance software program into the physical chemistry curriculum to foster authentic learning by doing “real” science. The use of this molecular dynamics simulation program as a tool for guided inquiry and its applicability to topics in thermodynamics will be presented.

P655: A Revised Surface Tension Lab

John Hagen (California Polytechnic State University, USA), Marc Bresler (,)

Many physical chemistry lab courses include an experiment in which the students measure surface tension as a function of surfactant concentration. In the traditional experiment the data are fit to the Gibbs isotherm to determine of the molar area for the surfactant, and the critical micelle concentration is used to calculate the free energy of micelle formation. In our experiment, the students fit their data to the Szyszkowski equation, which allows them to also calculate the free energy of surface adsorption. In addition, this experiment is the context in which the students learn to do nonlinear custom curve fitting.

P656: Integrated Laboratory / Project Approach

Paul Endres (Bowling Green State University, USA)

For a number of years we have operated a junior level laboratory that combines experimental work traditionally found in physical chemistry, instrumental analysis and inorganic chemistry laboratory courses. The course has a fixed set of experiments, but we have generally encouraged students to

finish the year with more creative projects. In 2004-2005 we eliminated the list of required experiments and replaced it instead with a set of specific goals. These goals were often easiest to meet with standard, well documented experiments; however students were encouraged to develop longer term open-ended projects. Most projects originated from a reprint file provided by the instructor, but students were then expected to develop the experimental approach. We encouraged a team approach, often passing one project though several teams of students or having different teams cover different aspects of a common topic. In 2004-2006 students have been involved in projects with fullerenes, conductive polymers, photochromic materials, nanoparticles and nanowires, analysis of complex food products, testing consumer products and developing prototype instruments. Students generally begin with conventional experiments from past years, but many quickly sought out alternatives. Reports were generally greatly improved, in part because the reports were no longer formal exercises, but a real effort by students to communicate their methods, results, conclusions and frustrations.

P657: How Dilute is dilute?

Carlos Contreras-Ortega (Universidad Católica del Norte, Chile), Nelson Bustamante (Universidad Católica del Norte, Chile), Juan Luis Guevara (Universidad Católica del Norte, Chile), Victor Kesternich (Universidad Católica del Norte, Chile), Carlos Portillo (Universidad Católica del Norte, Chile)

How dilute does a solution have to be before it is considered "dilute." Similarly, what do we mean when we say "low pressure" or "high temperature?" Common questions to those of us how the teach chemistry, but what's the answers? This presentation will explore these and other common questions in terms thermodynamics, limiting physical conditions, fundamental mathematical relationships, and the interpretation of data. Examples of ways of engaging students in this type of analysis and of ways of relating to them the relevance and importance of these methods will shared.

P658: Developing Technical Writing, Data Manipulation, and Mathematical Computation Skills in the Physical Chemistry Lab

Derek Gragson (California Polytechnic State University, USA), John Hagen (California Polytechnic State University, USA)

Writing formal "journal-style" lab reports is often one of the requirements in the physical chemistry laboratory. Helping students develop technical writing skills is one of the reasons writing is required in the p-chem lab. The approach we have adopted at Cal Poly not only fosters development in technical writing, but also focuses on learning data manipulation and mathematical computation software. In doing this we have developed assignments for physical chemistry lab that emphasize and assess writing as well as proficiency with data manipulation programs such as ExcelTM and mathematical computation software such as MapleTM. We will present these assignments, how student progress is assessed, and how everything fits together in the grand scheme of improving student abilities in each of these areas.

8:00 AM - 11:00 AM STEW 322

S60: Partnering to prepare the 2015 technician workforce - Session 1 of 1

Jodi Wesemann (American Chemical Society, USA)

When considering the state of the chemical enterprise in 2015, presenters at the Spring 2005 presidential event "Enterprise 2015: Preparing for careers in chemical technology" emphasized that

the significant changes in responsibilities and expectations for technicians that have occurred over the past ten years will continue over the next ten years. The challenge is to help students prepare for these changes. This symposium will address the roles that industry, academic institutions, and community organizations can play in creating strong partnerships that are responsive to changing needs. The use of skill standards and assessment in designing and keeping industry-driven curricula current will be discussed, along with other strategies for addressing the critical issues facing technician education.

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|-------|------------------|---|
| 8:00 | | introduction |
| 8:10 | Connie J. Murphy | P659: Partnerships in the evolving chemistry enterprise |
| 8:50 | Joan Sabourin | P660: Formation of the Great Lakes Process Technology Alliance: Benefits and challenges |
| 9:10 | | break |
| 9:20 | Connie J. Murphy | P661: Building successful partnerships |
| 10:10 | Jodi Wesemann | P662: Developing partnerships: Responding to changing needs |

P659: Partnerships in the evolving chemistry enterprise

Connie J. Murphy (The Dow Chemical Company, USA), **Joan Sabourin** (Delta College, USA), William Carroll (x, x), John H Engelman (S. C. Johnson & Son, Inc., USA), Michael Tinnestad (American Chemical Society, USA)

The chemistry enterprise, including industry, academe, and government laboratories, is an ever-changing entity. The forces accelerating those changes are growing stronger year after year. Today the enterprise is affected by the changing nature of the discipline – the blurring of the lines between chemistry, biology, physics and other sciences – as well as economic and social factors like globalization and the demographics of the student and workforce populations. To prepare the technician workforce of the future and deal with these change agents, it is increasingly important to forge partnerships between all stakeholders. This panel will explore the changing landscape for the enterprise and why these partnerships are critical to everyone's success.

P660: Formation of the Great Lakes Process Technology Alliance: Benefits and challenges

Joan Sabourin (Delta College, USA)

The vision for the Great Lakes Process Technology Alliance (GLPTA) states that the GLPTA is the regional hub for partnerships between industry, education, and community leaders dedicated to the development of a respected, qualified, and successful Process Technology workforce. The process of establishing this alliance and the impact of the partnership on employers, education providers, and local and regional communities will be discussed.

P661: Building successful partnerships

Connie J. Murphy (The Dow Chemical Company, USA), **Ronald L. Good** (Delta College, USA), William Killian (Ferris State University, USA), Susan Sonchik Marine (Miami University - Middletown, USA), Thomas Neils (Grand Rapids Community College, USA), John Singer (Jackson Community College, USA)

The workforce that supports the chemistry enterprise is estimated at more than 1 million

employees, including hundreds of thousands of chemical laboratory and process technicians. In order to ensure that the technician workforce is ready for the challenges and opportunities of the workplace of future, partnerships between various stakeholders – industry, education, labor, government and the community – have been forged on a local or regional basis. This panel will examine the range of partnerships that exist and discuss how to start, fund, build, and sustain them.

P662: Developing partnerships: Responding to changing needs

Jodi Wesemann (American Chemical Society, USA), **John Galiotos** (Houston Community College, USA), *Mary Henderson* (Ivy Tech Community College, USA), *Todd Pagano* (Rochester Institute of Technology, USA), *Rajiv Soman* (University of Cincinnati, USA)

A range of changes are facing the stakeholders in technician workforce development. The chemical industry needs technicians with increasingly versatile technical and employability skills. Its technician workforce is likely to become more mobile. Institutions of higher education face changing demographics, increasing accountability, and shrinking budgets. Economic development organizations are under increasing pressure to attract industry. This panel will focus on how partnerships have responded to such changes and addressed critical issues in chemical technology education.

8:00 AM - 11:00 AM STEW 318

S45: Peer-Led Team Learning (PLTL) - Session 2 of 2

Anne Bentley (Purdue University, USA), **Pratibha Varma-Nelson** (Northeastern Illinois University, US)

The goal of this symposium is to provide an opportunity for new implementers of the PLTL model to present their data, experiences with implementation of the model in their courses, and discuss the future of PLTL at their institutions.

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|-------|----------------|--|
| 8:00 | | introduction |
| 8:05 | Lucille Garmon | P663: Group Size and Workshop Effectiveness |
| 8:25 | Lucille Garmon | P664: How to Keep Going When the Funding Runs Out; How to Get Started Without a Grant |
| 8:45 | Shilpi Bhargav | P665: Can we predict the PLTL Leaders gains from personality inventories? An Analysis of the dimensions of PLTL Leader growth in academic and personal growth. |
| 9:05 | Shannon Sykes | P666: Peer-led Team Learning Leaders: Contrasts in learning gains and perceived values of course interventions |
| 9:25 | | break |
| 9:35 | Shilpi Bhargav | P667: PLTL Orientation Sessions: Making Students Successful Leaders |
| 9:55 | Joel Detchon | P668: Peer-Led Team Learning: New Explorations at Miami University |
| 10:15 | Alexsa Silva | P669: Undergraduate Teaching Assistants as Peer-Led Team Leaders |
| 10:35 | | panel discussion |

P663: Group Size and Workshop Effectiveness

Lucille Garmon (Univ. of West Georgia, USA)

One of the established Critical Components of successful workshops, organizational arrangements, includes group size and refers to the accepted norm that peer-led team learning will work effectively with groups of about six to eight students. Space, enrollment, scheduling and financial pressures, however, have sometimes led to groups of twelve or more. Such an increase was seen at the University of West Georgia between fall semester 2005 and spring semester 2006. This paper will present the findings of a study on the effects of increased group size on how workshops are perceived by students and by both new and experienced leaders. The study considers also the impact of group size on student learning as measured by course grades and standardized test scores.

P664: How to Keep Going When the Funding Runs Out; How to Get Started Without a Grant

Lucille Garmon (Univ. of West Georgia, USA)

When a grant is productive the expectation is that the innovation supported will not disappear at the conclusion of the grant's funding period. But where does the money come from to keep PLTL and similar programs going in perpetuity? Even when institutionalized, programs can be at risk when financial exigency arises. This paper will examine various strategies that bring PLTL closer to being self-supporting.

P665: Can we predict the PLTL Leaders gains from personality inventories? An Analysis of the dimensions of PLTL Leader growth in academic and personal growth.

Shilpi Bhargav (IUPUI, USA), Mark Hoyert (Indiana University Northwest, USA), David Malik (IUPUI, USA), Shannon Sykes (Indiana University Purdue University Indianapolis, USA)

Consistent with the traditional paradigm for an effective PLTL intervention, our faculty and leaders have weekly meetings to assess progress of the workshops, both from administrative and logistical as well as academic points of view. Our leaders formally enroll in a one credit upper division course with an array of expectations: training in the resolution of procedural problems, pedagogical training, and content-specific training. In addition to the meetings, our leaders go through intense orientation, observations by their peers and super-leaders, as well as writing a weekly online journal in response to case studies, or other hypothetical (or real) problems. We have analyzed a variety of perspectives on leader involvement and educational growth. Four dimensions have been identified as the key gains made via PLTL experience: general leadership skills, personality assessment and adaptation, enthusiasm for chemistry, and enhanced critical thinking and learning skills. The Meyers-Briggs Type Inventory was administered to leaders and the results of the inventory, along with the online journal responses, helped to gauge the leaders' perceptions of adapting their personality types and accommodating those of others in order to maximize learning. A co-study sought to identify students as being either performance-motivated or learning-motivated, and the results aimed at promoting the benefits of the latter. The results of the project have provided insight into leader motivation and the role of PLTL to enhance their learning skills.

P666: Peer-led Team Learning Leaders: Contrasts in learning gains and perceived values of course interventions

Shannon Sykes (Indiana University Purdue University Indianapolis, USA), David Malik (IUPUI, USA)

Most faculty and departments are introducing new interventions and course components to improve student success and retention in introductory chemistry courses. Program assessment of these interventions is imperative in measuring the benefits and efficacies of course objectives, pedagogical methods, and resources available to the students. The Student Assessment of Learning Gains (SALG) is a helpful tool for instructors to spot the elements in the course that best support student learning and those that need improvement. SALG is a web-based instrument consisting of statements about the degree of “gain” which students perceive they have made in specific aspects of the class (Seymour, Wiese, Hunter, 2006). In the past decade, we have introduced numerous interventions and components designed to improve student learning. The SALG was administered to two groups: students who are currently taking first semester general chemistry and students who have taken the course in a previous semester and are now workshop leaders in the Peer Led Team Learning (PLTL) program. An addition, we have re-evaluated SALG surveys for leaders after completing one or more semesters of PLTL leading, thus affording us a pre and post-analysis. Evaluation of nine dimensions of course evaluation and structure are correlated with value perceptions. We will present the perceptions of PLTL workshops with the following three groups: communication and interaction, understanding chemistry concepts and problem solving, lecture and gaining understanding of concepts and interrelationships among them, and level of enthusiasm for the subject. Overall perception differences between students and leaders will be presented.

P667: PLTL Orientation Sessions: Making Students Successful Leaders

Shilpi Bhargav (IUPUI, USA), David Malik (IUPUI, USA), Bonnie Stevenson (Indiana University - Purdue University at Indianapolis, USA), Shannon Sykes (Indiana University Purdue University Indianapolis, USA)

PLTL Programs virtually always have an orientation meeting for new and, perhaps, veteran leaders to adequately prepare them for experience. Our pre-semester training includes a mandatory six hour orientation meeting including the usual elements of PLTL structure: roles of leaders, administrative organization of our implementation, and other less commonly included components. Our presentation will describe these other components and their efficacy assessed. One example is the Myers-Briggs Type Inventory that was administered to leaders whereby their own personality types was determined to provide additional insight into the conduct of their workshop sessions. The impact of these inventories was assessed by leaders themselves for improving their workshop experience and effectiveness.

P668: Peer-Led Team Learning: New Explorations at Miami University

Joel Detchon (Miami University, USA), Jerry Sarquis (Miami University, USA)

Miami University has been using the Peer-Lead Team Learning(PLTL) model of instruction in general chemistry since 1998. This paper will report on a study of the performance (hourly exams and ACS first semester final) of students in a class wherein some chose the standard PLTL format while the remainder chose an online homework format. This paper will also report on a scatter plot study comparing the performance of PLTL students and non-PLTL students on conceptual and algorithmic test questions on the ACS first semester general chemistry exam.

P669: Undergraduate Teaching Assistants as Peer-Led Team Leaders

Alexsa Silva (SUNY Binghamton, US), Wayne E. Jones Jr. (SUNY Binghamton, US)

This study is an evaluation of the introduction of the Peer-Led Team Learning (PLTL) approach for the freshman general chemistry courses CHEM 107 and CHEM 108 at Binghamton University, Binghamton, New York. The Chemistry Department has been using undergraduate teaching assistants (UGTA) to help the general chemistry courses for several years but without continuity between semesters. The Peer-Led Team Learning (PLTL) approach offered the possibility of engaging the UGTA's in a continuous program aiming the development of communication skills and subject mastery among others. In this presentation, we will report the initial efforts to engage and train juniors and sophomores to lead discussion sections in a collaborative learning environment.

8:00 AM - 11:00 AM STEW 214B

S47: Polling Systems in College Chemistry Classes - Session 2 of 2

William Donovan (The University of Akron, USA)

This symposium will include papers discussing the use of polling systems (aka "clickers") in college chemistry classes. Presenters will present results regarding the effects of the polling systems on student attitudes and learning, as well as to share best practices in the use of the systems.

8:00 AM - 11:00 AM STEW 306

S55: Research in Chemical Education: Theoretical Frameworks - Session 2 of 2

MaryKay Orgill (UNLV, USA)

The type of data a chemist collects in an experiment is influenced by his or her choice of instrumentation. For qualitative research studies, a theoretical framework plays a role analogous to the role of the instrument. A theoretical framework is a system of ideas, aims, goals, theories and assumptions about knowledge. It tells us how research should be carried out and how research should be reported, influencing what kind of qualitative experiments can be carried out and the type of data that result from these experiments. During this symposium, different theoretical frameworks will be discussed in the context of chemistry education research. The focus of this symposium is on the theoretical underpinnings of individual frameworks and their application to designing qualitative research, not on specific research results.

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|------|------------------|--|
| 8:00 | | introduction |
| 8:05 | Michael Thompson | P670: Charting New Territory with the Afrocentric Framework: What does it mean to conduct research in chemistry/science education in a cultural environment. |
| 8:25 | Willy Hunter | P671: Action Research in Chemical Education |
| 8:45 | Mike Briggs | P672: Models and Modeling as a Theory of Learning |
| 9:05 | Chana Hawkins | P673: Details and dynamics of the Afrocentric Idea: Re-positioning the approach to science education research |
| 9:25 | | break |
| 9:35 | Justin Read | P674: Conceptual Change Theories as Frameworks for Chemistry Education Research |

- 9:55 Aliya Rahman P675: Communities of practice in science education research
- 10:15 Matthew Miller P676: Pedagogical Content Knowledge and science teacher education research

P670: Charting New Territory with the Afrocentric Framework: What does it mean to conduct research in chemistry/science education in a cultural environment.

Michael Thompson (Purdue University, USA)

There are many different theoretical frameworks that can be used for qualitative research in chemical education. The use of these theoretical frameworks in qualitative research has facilitated great insight to chemistry/science education research. However, traditional theoretical frameworks used for qualitative research now have to adopt a perspective that fits an increasingly diverse environment. According to the literature, culture has been shown to affect all aspects of education. As a result, we need to have culturally relevant qualitative theoretical frameworks. The Afrocentric framework provides a theoretical framework to navigate qualitative chemistry/science education research in a diverse educational climate. The Afrocentric view should not be assumed for only "black" people, it can be useful for more than a single out-group. In this paper we will discuss how the Afrocentric framework can be used as a companion with other traditional qualitative research theoretical frameworks

P671: Action Research in Chemical Education

Willy Hunter (Illinois State University, USA)

In this presentation, I will give a brief overview of Action Research, the range of its implementation, and particular advantages it provides for researchers. This paper will fit into the Theoretical Frameworks symposia which can be used to guide chemical education research.

P672: Models and Modeling as a Theory of Learning

Mike Briggs (IUP, USA)

In researching how students learn chemistry, one requires a perspective. The perspective one chooses determines what kind of questions one might choose to research and whether one can answer the research question. Models and Modeling is fruitful in answering the question: "What are the structure and processes in the mind that students must possess to learn chemistry?" In concurrence with an appropriate methodological framework, Models and Modeling can illuminate how students learn specific chemical concepts and show which mental model constituents are present or absent in the mind. I will show a qualitative research design using Models and Modeling.

P673: Details and dynamics of the Afrocentric Idea: Re-positioning the approach to science education research

Chana Hawkins (Purdue University, United States)

With the disproportionate representation of racial/ethnic groups in chemistry and science in general and the issues related to recruitment, retention, and attrition—particularly groups of Native American, Hispanic, and African descent—the aforementioned questions present us with the opportunity to begin to explore re-positioning the approach to certain issues in science education. There are two reasons, for example, that we should engage in this opportunity: first, there are questions that remain unanswered regarding the participation of underrepresented groups in

science; second, the cultural position of those represented, the culture of science, and the context of a science education are often not in the foreground of science education research. The Afrocentric Idea is one such guide or theoretical framework that considers first the cultural perspectives while framing the research questions to be asked in a cultural context and the analysis within the Afrocentric Idea considers a person's conception of existence, history, society, and values. This paper will explore the details and dynamics of the Afrocentric Idea, the underpinnings of the Afrocentric Idea, and its application to designing qualitative research.

P674: Conceptual Change Theories as Frameworks for Chemistry Education Research

Justin Read (The University of Sydney, Australia), Adrian George (University of Sydney, AUSTRALIA), Michael King (The University of Sydney, Australia), Anthony Masters (The University of Sydney, Australia)

There is a significant body of science education literature which deals with the process of conceptual change. Despite this fact, research into students' conceptions of chemistry is often published without an explicit recognition of a theoretical framework. This may, in part, be due to difficulties associated with 'decoding' the language of the education literature, which can make choosing an appropriate theoretical framework difficult. This presentation will begin with a brief description of some theories of conceptual change. This will be followed by a discussion of how they can be used to guide the design of qualitative research into students' conceptions of chemistry, and of their use in understanding research findings. Research findings concerning student misconceptions are most useful if they provide insight into the origins of the misconception, as this allows an instructor to consider how best to minimise the chances of future students developing the misconception. The final part of this presentation will concern the use of theories of conceptual change to aid in this process.

P675: Communities of practice in science education research

Aliya Rahman (Purdue University, USA)

A community of practice may be thought of as a self-organizing group of people who share a common concern for the work that they do, and who learn to do and improve this work through shared, lived experiences. For science education researchers, this group takes on multiple forms: it may be a peer study group of first-year undergraduates, a small enclave of study abroad students learning how to navigate a host university, or a graduate student association working to provide social events for its members. In every case, students learn to interact with large, complex systems through smaller communities that emerge from the interplay of individual identities. Centered around a discussion of learning as a social system, this presentation will consider the use of community of practice theory as a framework for science education research. In doing so, it will also explore the relationships between communities of practice, situated learning, and chaos and complexity theory.

P676: Pedagogical Content Knowledge and science teacher education research

Matthew Miller (South Dakota State University, USA)

Pedagogical content knowledge (PCK) is a construct originally suggested by Shulman (1986) as a necessary component of knowledge for expert teachers. Although in this original context PCK represented a specific type of knowledge, the methodologies used by researchers in teacher education have been impacted by the development of this model. Research studies in science teacher education must consider the synergistic impact of all types of teacher knowledge (content,

pedagogy, contextual, student, etc) on overall teacher expertise. This session will discuss the potential role of PCK as a theoretical framework in science teacher education. The basic assumptions guiding the use of PCK as a framework, the methods used to study PCK, and the types of data that have resulted from the study of PCK will be addressed.

8:00 AM - 11:00 AM STEW 214A

S48: Service-Learning in Chemistry - Session 2 of 2

Susan Suthemer (Green Mountain College, USA)

The pedagogy of service-learning links the classroom to the community using a service component embedded within the course. Presenters will share examples of exemplary service-learning projects in chemistry, information on finding and working with community partners, ways to encourage chemistry faculty participation, and similar topics related to service-learning in chemistry.

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| 8:00 | Lynn Maelia | P677: Community service as a component of a general chemistry course for science majors |
| 8:20 | Joan Esson | P678: Service-learning projects for introductory chemistry: Pairing with elementary and middle schools |
| 8:40 | Dominick Casadonte | P679: Service-learning as a tool for teaching introductory chemistry to non-science majors: A longitudinal study |
| 9:00 | Marisa Burgener | P680: Service-learning through National Chemistry Week and Chemists Celebrate Earth Day |
| 9:20 | | break |
| 9:30 | Annie Lee | P681: Learners as teachers: A chemistry tutoring project |
| 9:50 | Kimberly Aumann | P682: Developing a one-credit service-learning in chemistry course |
| 10:10 | Louise Liable-Sands | P683: Service-learning in chemistry for elementary education majors |
| 10:30 | | discussion |

P677: Community service as a component of a general chemistry course for science majors

Lynn Maelia (Mount Saint Mary College, USA)

Freshman science students are required to perform community service as an integral component of their general chemistry course work. In the first semester, they are required to plan, prepare and perform a scientific demonstration as part of their course requirements. Students are expected to develop a pre-lab plan for their demonstration that includes information about the science behind the demo, their materials and space requirements, safety precautions, and a "script" for their presentation. The chemistry students present their demonstrations to sixth grade students from a local elementary school during their regularly scheduled laboratory period. In the second semester, students are required to perform three hours of community service in a scientific capacity. Rubrics, expectations, and student feedback will be presented.

P678: Service-learning projects for introductory chemistry: Pairing with elementary and middle schools

Joan Esson (Kalamazoo College, USA)

This presentation details the best practices of service-learning in Introductory Chemistry at Kalamazoo College. Two service-learning projects in Introductory Chemistry will be outlined, including one involving the development of chemistry experiments with K-6th graders that reinforce the various topics covered in lecture, and a second involving a lead poisoning prevention project that incorporates testing for lead in paint and toys using a simple colorimetric assay and atomic absorption spectroscopy with 7th and 8th graders. In addition to details of the project, the effects of the service-learning projects on student attitudes, both of the elementary/middle schoolers and college students, will be discussed.

P679: Service-learning as a tool for teaching introductory chemistry to non-science majors: A longitudinal study

Dominick Casadonte (Texas Tech University, USA)

This study was designed to determine whether service-learning could provide an effective mechanism for teaching introductory chemistry to science-phobic non-science majors. A secondary aim was to probe whether service learning could be an effective tool in generating a positive attitude toward chemistry. This project is part of a two-year study. In the first year the same faculty member was involved with two lab sections. In the second year of the study, the transferability of the model to another faculty member was monitored, with the faculty member involved in the first-year study teaching a traditional, control lab. In the study, students in an Honors Integrated Science Lab for Non-Science Majors were required to plan and perform a one-half to one-hour long chemical demonstration show to a community group of their choosing after appropriate instruction and team building. The students were graded on the content, accuracy, and creativity of their shows. Further assessment included course assessment, general content understanding, and attitudinal assessments.

P680: Service-learning through National Chemistry Week and Chemists Celebrate Earth Day

Marisa Burgener (American Chemical Society, USA)

The American Chemical Society's Chemists Celebrate Earth Day (CCED) and National Chemistry Week (NCW) programs occur annually in April and October, respectively. Each year a community event is selected for both of these programs and members nationwide are encouraged to participate. These two events can become annual service-learning opportunities for your students. Other possibilities beyond the community events will be discussed as well.

P681: Learners as teachers: A chemistry tutoring project

Annie Lee (Rockhurst University, USA)

A community based tutoring program (service learning) was attempted in the fall of 2005. Students in a Principles of General Chemistry course (a course required for pre-nursing students) completed a minimum of 10 hours of tutoring at University Academy (UA), a nearby charter high school in the Kansas City, Missouri school district. The students provided worksheets for the UA students covering basic principles of chemistry ranging from math skills to laboratory experiences. After each session, student tutors answered 1-2 directed questions on WebCT about their experiences. They were asked to describe an incident from the day, analyze it in terms of their own reaction or the reaction of others, and indicate what they could do differently if faced with a similar situation in the future. The rationale for the project was that the students would master the concepts more deeply through teaching them and that the students would take a personal interest in their own

learning. Results from this project will be presented including preliminary assessment data, lessons learned and improvements for the future.

P682: Developing a one-credit service-learning in chemistry course

Kimberly Aumann (Indiana University, USA)

Most chemists remember the first demonstration that caught their attention and excited them about chemistry. In our new service learning course this past spring, we provided an opportunity for our undergraduate chemistry students to do some of the inspiring. We teamed up our service learning class with four local agencies offering after school programs for elementary and middle school students. Over the course of the semester, the college students developed a series of eight interactive activities that they presented over the course of the semester to capture the imagination of the youngsters while sparking their interest in chemistry. This presentation will address the issues involved in developing a service learning course in chemistry such as this. I hope to provide you with resources on connecting with community groups, planning and implementing hands-on activities, and promoting student awareness of community and community concerns.

P683: Service-learning in chemistry for elementary education majors

Louise Liable-Sands (Widener University Science Division, USA), Mark Bradley (Widener University Science Division, USA)

An inquiry-based laboratory course to accompany an introductory one-semester general chemistry course for elementary education majors has been developed to enhance the science experience and to help meet state and national science teaching standards. This course allows our students to contribute to the well-being of the surrounding community by participating in civic engagement in their local schools. Students completing this course experience a chemistry activity three times, first by doing the activity, second by writing about the activity to be performed in a lesson plan and lastly by teaching the activity in a middle school classroom. This experience gives the students multiple methods of understanding. They learn by doing, by writing, and by teaching it to a middle school class. The elementary education majors work with a middle school science teacher during the semester, and coordinate their activities with the material which is being covered in the classroom. The middle school students are exposed to inquiry-based chemistry activities that will engage them in problem solving and empower them by requiring them to become active learners. The middle school teacher acquires inquiry-based chemistry activities that utilize readily available, safe and inexpensive materials. The elementary education majors gain hands-on experience performing the activities in an actual classroom, and this improves their oral and communication skills.

8:00 AM - 11:00 AM STEW 206

S61: Survivor Skills for 1st to 5th year Chemistry Teachers - Session 2 of 2

Esther Freeman (Retired; Tabb High School, USA)

National research data claims that one out of every five novice teachers leaves the teaching profession after only three years and 50% leave in the first five years. Often, these teachers are frustrated and feel overwhelmed because they are held to the same accountability standards as veteran teachers. One of the major reasons cited for leaving is the lack of support and guidance. In this symposium, veteran teachers will offer themselves as role models for novice teachers or other educators seeking to improve and fine tune their classroom instruction and management skills. These veteran teachers will share a full range of resources such as great lesson plans, teaching

strategies, activities, projects, or demonstrations that can help prevent novice teachers from having to “reinvent the wheel.”

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| 8:00 | | introduction |
| 8:05 | Esther Freeman | P684: Outstanding songs by Mike Offutt |
| 8:35 | Bette Bridges | P685: Alternative assessments in chemistry |
| 9:05 | Thomas Jose | P686: 10 Things high school students (and teachers) should know before taking college level science |
| 9:35 | | break |
| 9:45 | Andrew Cherkas | P687: Survival kit and help for new teachers |
| 10:15 | Doug Ragan | P688: What is a Chemical Hygiene Plan (CHP) and why is it so important? |
| 10:45 | | discussion |

P684: Outstanding songs by Mike Offutt

Esther Freeman (Retired; Tabb High School, USA)

I have taken many of Mike Offut's chemistry songs and incorporated them in PowerPoint presentations. These are easy to use to introduce a concept or as may be used as a reinforcement. The students love them.

P685: Alternative assessments in chemistry

Bette Bridges (Bridgewater-Raynham Regional High School, USA)

How can you be sure your students are actually learning what you want them to? How can projects and assignments be done in the internet age with out plagerism? These ideas answer these questions.

P686: 10 Things high school students (and teachers) should know before taking college level science

Thomas Jose (Blinn College, USA), Elizabeth Heise (University of Texas at Brownsville, United States)

Ever wonder if your students leave your class prepared to go on and take a college-level science course? This presentation, developed by two instructors with both junior college and university level teaching experience, will reveal what they believe is important for high school students to know before taking any college science course. What may surprise some is that not all 10 things are content based. Techniques that build student active learner centered skills will be shared. The hope is that an open dialogue is fostered between high school and college level instructors so that no child (or teacher) is left behind.

P687: Survival kit and help for new teachers

Andrew Cherkas (Stouffville DSS, Canada)

A Guide to how we help student teachers build a portfolio of lesson plans, ideas and skills. How new teachers need help with interview skills. A survival kit for the new teacher including mentoring and workshops.

P688: What is a Chemical Hygiene Plan (CHP) and why is it so important?

Doug Ragan (Hudsonville High School, USA)

As a science teacher you have to constantly ask yourself, "Is my classroom and laboratory safe?" Unlike other teachers, the proper storage, handling, and disposal of chemicals are part of our job. Guidelines for creating a safer classroom and laboratory can begin with creating a CHP. Ideas for creating such a plan including resources for disposal and other general chemical safety tips will be discussed.

Workshops

Thursday, August 3 morning

W40: Advanced POGIL Workshop: Improving Classroom Facilitation Skills

8:00 AM - 11:00 AM STEW 320

Rick Moog (Franklin and Marshall College, USA)

This workshop is for experienced POGIL implementers who are interested in enhancing their facilitation skills in the POGIL classroom. Discussion will include dealing with typical issues and problems. Analysis of a classroom experience will also be included. Participants should have been implementing POGIL in their classrooms for at least one full semester to enroll in this workshop.

Capacity: 24 Fee: none

W41: Advanced POGIL Workshop: Using and Designing POGIL Laboratory Activities

8:00 AM - 11:00 AM STEW 313

Rick Moog (Franklin and Marshall College, USA)

In many traditional laboratory settings, a concept that has been previously introduced in class, or presented as part of the pre-lab preparation, is confirmed through the "experiment". In contrast, in a POGIL laboratory experience, a chemical concept is developed based on the data collected in the laboratory, and the students often have minimal background information about the concept. Students work in teams and gather data from experiments run under a variety of conditions. They use a set of in-lab and post-lab guided inquiry questions to examine the pooled data (from their own lab section and often from other lab sections) from which they construct theories to explain experimental results. This workshop will include a discussion of the criteria for successful POGIL laboratory experiments, examine model experiments, work with student-generated data in a simulated laboratory setting, and convert existing and currently-used lab activities to POGIL experiments. Workshop participants should bring copies of lab activities for conversion to POGIL experiments. Participants in this workshop are expected to have attended the "Introduction to POGIL" workshop at this meeting, or have equivalent prior experience and knowledge of POGIL (<http://www.pogil.org>).

Capacity: 36 Fee: none

W42: Exploring Spectroscopy and the Interaction of Light with Atoms

8:00 AM - 11:00 AM WTHR 212

Peter Garik (Boston University, USA)

Through hands-on explorations with interactive computer software, participants in this workshop will be introduced to materials to teach quantum concepts to high school and college general

chemistry students. As scientists increasingly use technologies that manipulate single atoms and molecules, the importance of these concepts is becoming ever more important. Based on extensive research with chemistry students, the materials presented in this workshop were developed to improve students' grasp of fundamental quantum concepts. This workshop will focus on modules to teach atomic spectroscopy and the mechanism of the interaction of light with atoms. Anchoring analogies are provided through introductory work with classical oscillating systems. The transition is then made to the wavefunction, its time dependence, and the time dependence of superposed wavefunctions. Each learning activity is centered on a discovery process involving a problem or a conceptual puzzle to be resolved, and can be used by individual students, or by students working in small groups. At the end of the workshop, participants will receive a CD with the software and activities.

Capacity: 30 Fee: \$0

W43: MeasureNet – The High School Setting

8:00 AM - 11:00 AM BRWN 2134

Edmund Escudero (Summit Country Day School, USA)

Experience Measurenet. Hear how the system is used in two different high school settings. Course use ranges into physical science through AP Chemistry and AP biology. While at the workshop you will have the opportunity to perform a series of experiments that demonstrate the broad range of overall experiments available with the system.

Capacity: 20 Fee: none

W44: WebAssign--I Wouldn't Teach Without It!

8:00 AM - 11:00 AM WTHR 214

Margaret Gjertsen (WebAssign, US)

WebAssign is the perfect homework management system for chemistry. Create assignments easily using questions from leading intro, general, organic, and analytical chemistry textbooks or write your own questions. Your students can complete assignments anytime, anywhere over the web and receive instant feedback. View their progress at any time. Come to our workshop and see why so many chemistry teachers now have more time for teaching and spend less time grading homework with WebAssign. By partnering with leading chemistry textbook publishers we offer a large database of ready-to-use, end of chapter homework questions. Questions are in a variety of formats, often with several formats mixed within one question: numerical, image map, multiple answers, fill in the blank, multiple choice, rank order, true/false, essay, symbolic, file upload, and poll. Each student receives unique questions with randomized variables. WebAssign supports significant figures with hints to alert students to insert the appropriate number. For organic chemistry questions, the JME drawing tool allows students to input complex organic molecules. WebAssign is a simple to use, hosted service. Sign up for a faculty account and begin using it immediately. WebAssign works for you 24/7. See why hundreds of chemistry teachers would not teach without it.

Capacity: 30 Fee: 0

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