Sunday, August 1 afternoon

Symposia sessions

Start	End	Room	Title
2:30	4:20	WH-119	Assessment in Chemistry Education
2:00	5:00	U-415	Bioanalytical Chemistry: Analytical Applications in Biological Sciences
2:00	5:00	U-417	ChemEd Bridges: A Retrospective on Its Impact
2:00	5:00	WH-122	Cognition in Chemistry Education
2:40	5:00	U-409	Community College and University: Sharing Funding, Research, Students, Faculty, Instruments and Expertise
2:00	5:00	U-412	Designing Innovative Chemistry Classrooms: Architecture and Pedagogy
2:00	5:00	U-413	Learning in the Laboratory: Evidence and Assessment
2:00	5:00	WH-117	MSPs: How K-12/College Partnerships Have Improved Chemistry Instruction
2:20	5:00	WH-113	Out of the Box: Teaching Chemistry with Case Studies and Applications
2:00	5:00	U-411	POGIL
2:00	4:40	WH-116	Problem-Based Learning Design and Utilization in Upper Level Chemistry Courses
2:00	4:40	WH-114	Teaching Environmental Chemistry
2:00	5:00	WH-115	Views from the Classrooms of Conant and Regional Award Winners

Symposia sessions

2:00 PM - 5:00 PM WH-119

S1: Assessment in Chemistry Education - Part 1 of 2

Michelle Dean (University of Connecticut, USA), *Tyson Miller* (University of Connecticut, USA)

Teaching in a college environment has its own set of challenges; however, these challenges have/are often turned into opportunities for novel ideas to be implemented and tested. One area rich in innovation is the assessment of student learning. This symposium will explore the variety of assessment methods.

2:20		introduction
2:25	Anne-Marie Nickel	P1: Laboratory practical exams and strategies for assessment of students' ability to design experiments
2:45	Christina Miller	P2: Laboratory assessment: A hands-on approach
3:05	Dalia Zygas	P3: Traditional AP lab reports vs. alternative laboratory assessments
3:25		break
3:40	Theodore Dolter	P4: Need for an objectives-driven standardized exam in introductory chemistry.
4:00	Paul Price	P5: Lessons learned from the 2010 AP Chemistry exam

P1: Laboratory practical exams and strategies for assessment of students' ability to design experiments

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

Laboratory practical exams and other assessment tools have been used to assess students' ability to design and conduct experiments, as well as to analyze and interpret data in general chemistry courses at the Milwaukee School of Engineering (MSOE). The MSOE chemistry faculty value this outcome in the chemistry curriculum, but it also serves to meet criteria of the Applied Science Accreditation Commission of the Accreditation Board for Engineering and Technology (ABET). The assessment strategies, results and ensuing curricular changes will be discussed.

P2: Laboratory assessment: A hands-on approach

Christina Miller (Adams State College, USA)

To assess student learning in our General Chemistry Laboratory we administer two exams each semester. These two hour exams consist of written questions as well as questions requiring students to design and conduct an experiment using concepts learned in the lab and write up their results. We believe this creative approach to lab exams invites students to think like chemists. In this talk I will discuss the design and administration of the exams and share our conclusions.

P3: Traditional AP lab reports vs. alternative laboratory assessments

Dalia Zygas (West Leyden High School, USA)

How well does a traditional lab report demonstrate student understanding? Does paraphrasing the purpose and procedure from the lab book show true comprehension of the concepts involved?

One or two members of a lab group may be getting the benefit of all of the critical analysis of the data. Alternative assessment strategies for labs will be presented. These test a student's ability to troubleshoot and predict the direction and outcome of lab errors. In addition, informal "mini labs" (short, student centered lab activities/demonstrations) will be discussed as additional hands-on learning experiences.

P4: Need for an objectives-driven standardized exam in introductory chemistry.
Theodore Dolter (Southwestern Illinois College, USA)
Standardized tests have an important (though not primary) place in the assessment of course objectives. Most usefully, they allow admissions officers at higher schools to compare the achievements of students from a variety of programs. Further, they allow these programs, and the individuals themselves, to determine the degree of mastery of the domain being tested, and to rank themselves in comparison to their peers, presumably with an eye toward self-improvement, if called for. In order for the exam to be useful in this regard, it needs to be reliable and valid. Validity itself can be viewed in a number of frameworks, among them being content validity, which looks at test content to determine whether it covers a representative sample of the domain being measured. Within the discipline of Chemistry, the ACS standardized exams have always been viewed as the first choice for test standardization, in part because of the vast number of schools which report their results. The reliability of these tests have not been challenged. However, when one of these tests—in particular the introductory chemistry exam—is evaluated for content validity, significant holes are discovered in the topics being evaluated. What is called for is a systematic reevaluation of the agreed upon course objectives for introductory chemistry classes, and the construction of a standardized test which is quite rigorous in evaluating as many of these objectives as possible within the constraints of the test structure.

P5: Lessons learned from the 2010 AP Chemistry exam
Paul Price (Trinity Valley School, USA)
Join members of the AP Chemistry Test Development Committee as they review specific areas of student difficulty on the 2010 AP Chemistry examination. Through examination of student responses and misconceptions, pedagogical techniques will be shared to improve student understanding of vexing topics in AP Chemistry.

2:00 PM - 5:00 PM U-415

S2: Bioanalytical Chemistry: Analytical Applications in Biological Sciences -

Mian Jiang (University of Houston – Downtown, USA), *Harvey Hou* (University of Massachusetts Dartmouth, USA)
This symposium aims at the broadly defined Bioanalytical Chemistry, which includes the analytical applications in Biochemistry, Biophysics, Environmental Sciences, Forensic Chemistry, Green Chemistry, Chemical Biology, and Biotechnology at undergraduate and graduate levels. This is the third symposium session focusing on the topic of Bioanalytical Chemistry presented in BCCE in the past three years. The previous symposium presenters enjoyed the stimulating interaction and discussion on novel ideas of implementing the Bioanalytical Chemistry components in the existing chemistry classes or developing the complete Bioanalytical Chemistry courses to enhance students learning. It is evident that Analytical Chemistry is increasingly focused on the analysis of biological activity and detection

of biological molecules in academia and industry. We believe that Bioanalytical Chemistry is one of the most promising enhancements in chemical education.

2:00		introduction
2:05	Dharshi Bopegedera	P6: A general chemistry laboratory “Exploring the impact of increased acid levels in ocean waters on coral”
2:25	Ray A. Gross Jr.	P7: On the stoichiometry inherent in the isotope patterns of compounds containing Br, Cl and S
2:45	Niina Ronkainen	P8: Bioanalytical chemistry and biosensors
3:05	Harvey Hou	P9: Teaching chlorophyll fluorescence analysis in the advance topics in chemistry
3:25		break
3:40	John Stankus	P10: Pedagogy of broken instruments
4:00	K. Joseph Ho	P11: Bioanalytical chemistry for science teachers
4:20	Dan Sykes	P12: Small mobile instruments for laboratory enhancement (SMILE)
4:40	Mian Jiang	P13: Designing operable bioanalytical curriculum and undergraduate research: Incorporating biosensor and bioassay components

P6: A general chemistry laboratory “Exploring the impact of increased acid levels in ocean waters on coral”

Dharshi Bopegedera (The Evergreen State College, USA), Alokya Perera (Bellarmine Preparatory School, USA)

It is believed that the burning fossil fuels, which results in an increase in the acidity of ocean waters, have a detrimental impact on marine life (specifically organisms with calcium carbonate based shells). Although this is a relevant topic for our students it is challenging to investigate, especially during a typical general chemistry laboratory period, because this impact develops over a long period of time. In this presentation we will discuss a method we have developed to study the impact of increased acidity on coral in the General Chemistry Laboratory. We will present ways in which this lab can be used as an “inquiry or discover based” experience. Data we collected and how this experiment could be used as a culminating laboratory experience where students would use many of the concepts and lab techniques learned earlier in the year will also be discussed.

P7: On the stoichiometry inherent in the isotope patterns of compounds containing Br, Cl and S

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

Several methods for analyzing isotope patterns obtained from low-resolution mass spectra for the presence of small numbers of Br, Cl, and S atoms will be discussed. The methods rely on the ideal low-mass to high-mass isotope ratios for one Br atom (1:1), one Cl atom (3:1), and one S atom (22:1). Methods will be shown for determining compositions from bar-chart patterns, from numeric patterns and from the number of molecules, N, in a unit sample. The value of N is determined from peak data in percentages. The talk concludes with a demo of an automated isotope-pattern analyzer, which is programmed in Microsoft Excel. These techniques may be useful in courses in beginning organic chemistry, qualitative organic analysis or mass spectrometry.

P8: Bioanalytical chemistry and biosensors
Niina Ronkainen (Benedictine University, USA)
In my view, the crossroads of such disciplines as Chemistry, Instrumental Analysis, Biochemistry, Biology, and the Medical Sciences is Bioanalytical Chemistry. Utilizing biochemically relevant examples to teach the students of these disciplines will aid in capturing their interest, add a sense of relevance to the concepts being taught and serve to foster student motivation and, ultimately, a sustained interest in learning Bioanalytical Chemistry. In addition, a thorough understanding of chemistry laboratory instrumentation and analytical protocols, problem-solving and data interpretation abilities are necessary skills needed to succeed in the physical or natural sciences regardless of one's eventual career path. Therefore, I have incorporated relevant aspects of Bioanalytical Chemistry into the undergraduate level courses that I teach; such as General Chemistry I & II, Instrumental Analysis, and Chemical Analysis. In addition, I have developed a special topics course titled Bioanalytical Chemistry and Biosensors aimed at junior and senior-level students who plan on pursuing graduate-level studies. The course involves reading and analyzing journal articles, writing scientific abstracts, and giving an oral presentation on any bioanalytical research topic of their choice. This presentation will describe the use of Bioanalytical Chemistry as a unifying discipline in the teaching of undergraduate chemistry courses from the freshman to senior-level at a small liberal arts university.

P9: Teaching chlorophyll fluorescence analysis in the advance topics in chemistry
Harvey Hou (University of Massachusetts Dartmouth, USA)
One advanced chemistry course, entitled "Advanced Topics in Chemistry: Chemical Biology and Technology" (CHM 550), employs chemical concepts to understand biological process using modern instruments and analytical techniques. The focus is to define a biological problem or process chemically, and employ these techniques to examine the problem. This course was team taught with participation from several members of Chemistry and Biochemistry faculty at UMD. One experiment, "probing photosynthetic activities of higher plants in vivo under stress conditions using chlorophyll fluorescence kinetics," was implemented into the class in the period of two weeks. The first week was used for lecturing the background and theory of chlorophyll fluorescence methodology and the second was used to apply the technique in plant biology via hands-on experience. The chlorophyll fluorescence transient provides rich information of photochemistry in photosynthesis in vivo and is used to probe the photosynthetic efficiency successfully in the field of photosynthesis research. From the fluorescence transient, an OJIP analysis reveals important parameters in terms of photosynthesis efficiency. In this experiment, plant tissue samples from the campus, students' home, and the supermarket, were examined by the chlorophyll fluorescence kinetics under high or low temperature, acidic, and basic conditions. Students worked as a group to develop their experimental procedures, conducted the measurements, and submitted a laboratory report in written form. The students were highly enthusiastic, and their feedback was positive with specific suggestions and ideas for future improvement.

P10: Pedagogy of broken instruments

John Stankus (University of the Incarnate Word, USA)
Broken and obsolete chemical instrumentation provide an opportunity for students to understand the underlying principles of operation. Advances in instrumentation have led to more compact miniaturized devices where it is difficult to see the individual components and how they interact. Student disassembly of some of our obsolete analytical instruments and identification of key components has led to a better understanding of how these instruments function. The older instruments have much larger discrete components and more easily identifiable optical paths. Additionally, having the students' repair some of the older instruments has provided increased confidence and overcome their fear of breaking something, as well as providing additional instrumentation capabilities for other courses.

P11: Bioanalytical chemistry for science teachers
K. Joseph Ho (University of New Mexico, USA), Valerie Varoz (Sandia High School, USA)
The application of analytical techniques in biological problems is an important yet ignored subject for secondary science teachers in their teaching. In our science teacher education, this area is usually ignored. Science teachers have received very basic training in biology and chemistry, and even have the knowledge of biochemistry, but they don't have any formal training in bioanalytical chemistry. They teach how important the biological molecules are in the living system but mention little about how these molecules are detected and how their activities can be analyzed. Although many topics in bioanalytical chemistry are too difficult for high school students, these topics can be taught in a simplified version emphasizing on concepts and principles. Teachers should gain the experience of bioanalytical chemistry both in the theories and laboratory practices in their education. The content of a proposed bioanalyctial chemistry course for teachers is discussed in this presentation.

P12: Small mobile instruments for laboratory enhancement (SMILE)
Dan Sykes (The Pennsylvania State University, USA)
The presentation addresses issues of fundamental reform in the chemistry curriculum via the use and integration of small, mobile instruments for laboratory enhancement (SMILE). The goal of SMILE is to develop, implement, and assess workshops for middle, high and post-secondary school teachers, which engage the teachers in the construction and testing of two instruments: a fluorometer and a Karl-Fisher apparatus. These instruments are rugged, lightweight, portable and inexpensive. We have developed a comprehensive suite of laboratory exercises which build in level of sophistication from simple qualitative analyses to more advanced time-dependent measurements. The educational materials include fully-supported powerpoint presentations of the basic concepts of spectroscopy and electrochemical titrations, teacher's manuals, and a detailed listing and discussion of the Pennsylvania State standards for STEM that each of the laboratory activities satisfy at the middle and high school levels. Furthermore, participants can purchase instrument kits to use in upper-level chemistry courses or independent research projects. As an example, students in the senior-level instrumental analysis courses at Penn State build these instruments from kits as part of their laboratory experience, which are then used by their younger peers in a lower-level analytical chemistry course. As the younger peers advance through the curriculum, they eventually construct and perhaps improve the design of the instruments. We have discovered that the use of student-built instrumentation enhances student competency in the sciences and engineering, and the co-curricular exposure fosters student ownership of the program's curriculum.

P13: Designing operable bioanalytical curriculum and undergraduate research: Incorporating biosensor and bioassay components

Mian Jiang (University of Houston – Downtown, USA)

Analytical chemistry is an application-driven science tackling versatile tasks and is therefore updated constantly with new development in the field. Life science is one of the most sophisticated disciplines which demands a fast, accurate determination. As an interdisciplinary field, bioanalytical chemistry covers wide range of backgrounds from chemistry to medicine, which can be mainly divided into the analysis of biological activity and detection of biological molecules. Nonetheless, most existing bioanalytical curricula are very much like biochemistry that needs advanced understanding or prerequisites of biology or microbiology. To expose students especially those are not in their senior year, we incorporated approachable, daily life – pertinent components into our analytical curriculum. Our approach includes biosensors based on plant tissues of daily grocery produce, nanocomposites of commercial enzymes, bioanalytical detection/bioassay based on commercial pencil leads, sugar/starch metabolism study with our new sensors, and possible nanowire/one-dimensional detector for bioapplication. While these may serve as combined or detachable modules suitable for the exposure of biotech into chemistry majors, the main advantages of our approach are the direct relevance to society and daily life, and the limited mathmatics implementation that would overwhelm the first-year students in approaching the bio era. With satisfactory results, our concepts have been applied into both classroom teaching and project-driven undergraduate research, which pave the stages for students of continuing interests. This on-going work is supported by the ORC and FDG grants from UH-Downtown, the UARP fund from SACP, NSF, Brown Foundation, MARC-NIH, and Welch Foundation (No. BJ-0027).

2:00 PM - 5:00 PM U-417

S3: ChemEd Bridges: A Retrospective on Its Impact

Thomas Higgins (Harold Washington College, USA)

This symposium will feature alumni of the ChemEd Bridges project, who will speak about their efforts at curriculum reform at their home campuses.

2:00		introduction
2:05	Harry Ungar	P14: ChemEd Bridges: Past, present and future
2:25	Torrey Glenn	P15: Two-year college faculty networking: Keeping the passion and remaining sane through the first years
2:45	Bal Barot	P16: Curriculum reform in chemistry at a community college
3:05	Christine Brooms	P17: Using web based resources to teach organic chemistry
3:25		break
3:40	Eun-Woo Chang	P18: NSF-DUE programs of interest to community colleges
4:00	Armando Rivera	P19: Bridging chemistry curriculum: Contextualization through instrumentation
4:20	Pamela	P20: Positive impact of ChemEd Bridges support at Hinds Community

	Clevenger	College
4:40		panel discussion

P14: ChemEd Bridges: Past, present and future
Harry Ungar (Cabrillo College, USA)
ChemEd Bridges is an NSF-funded project that provides career and professional development opportunities for chemistry faculty who teach at two-year colleges (2YCs). We broaden the interests and the horizons of the 2YC chemistry faculty by building bridges between them and the broader community of chemical educators. In particular, we strive to increase the involvement of 2YC faculty in ACS national and regional activities, and we work to strengthen relations between the chemistry departments of 2YCs and four-year colleges and universities. Over its three-year history CEB has sponsored eight symposia and workshops at ACS meetings and has supported the travel expenses of about 60 2YC faculty members. The ultimate goal of ChemEd Bridges is to improve the quality of foundational chemical education in the United States.

P15: Two-year college faculty networking: Keeping the passion and remaining sane through the first years
Torrey Glenn (City College of San Francisco, USA)
For the past three years, I have worked as a tenure-track chemistry instructor at City College of San Francisco, an urban community college which offers both credit and non-credit educational experiences to over 100,000 students each year. When I accepted the position, I considered this my “dream job.” However, there have been many unforeseen complexities and challenges. I will discuss how, with the help of ChemEd Bridges, I’ve established a supportive network of colleagues who have helped me to begin shaping this position into what I’ve always envisioned it to be.

P16: Curriculum reform in chemistry at a community college
Bal Barot (lake michigan college, USA)
At Lake Michigan College, in 2010, we have reformed chemistry curriculum for four different classes. These classes include introductory chemistry, organic chemistry, GOB chemistry and general chemistry. The course curriculum was strengthened by chemistry laboratory and classroom renovation and hiring lab staff. The specifics with progress guidelines will be presented.

P17: Using web based resources to teach organic chemistry
Christine Brooms (Prairie State College, USA)
This presentation will describe how organic chemistry at a community college is taught using web-based resources. This strategy was used out of necessity since very little instrumentation and time are available. After attending a few chemistry conferences, several methods and ideas were adopted and adapted to develop an organic chemistry course at Prairie State College. Strategies include having students analyze spectroscopic data from the web and complete web based pre-lab activities. Results include student surveys and instructor observations.

P18: NSF-DUE programs of interest to community colleges
Eun-Woo Chang (National Science Foundation, USA)

Numerous programs at the National Science Foundation (NSF) support the efforts of faculty at Community Colleges to improve the teaching enterprise and to increase the number of students interested in careers in Science, Technology, Engineering and Mathematics (STEM). Many of these programs are housed within the Division of Undergraduate Education (DUE) which serves as the focal point for agency-wide support for undergraduate education. This presentation will include a brief overview of NSF programs that support the work of community colleges.

P19: Bridging chemistry curriculum: Contextualization through instrumentation
Armando Rivera (East Los Angeles College, USA), Gayane Godjoian (East Los Angeles College, USA), Veronica Jaramillo (East Los Angeles College, USA)
The ChemEd Bridges program have helped faculty at East Los Angeles College by providing opportunities to participate at 2YC3 meetings, ACS national meetings, and NSF CCLI workshops. Through these various opportunities, we have gained knowledge and shared experiences with other community college faculty. These have allowed us to think outside the box and in different ways of bridging our curriculum; furthermore, how to develop and implement contextualization throughout different courses. Guided by the ChemEd Bridges team, we have worked on a CCLI proposal for the development and implementation of a more analytically advanced chemistry academic program. We have focused on how to use advance analytical instrumentation, such as IC and GC/MS, and its implementation in different chemistry courses. First, we want to expose students to research and educational instrumentation that is not common at the community college level. We introduce students throughout the different chemistry levels –from general chemistry to organic and analytical chemistry– to different levels of research, i.e. sample collection, preparation, analysis, etc. Second, we use a common topic throughout the curriculum to helps us contextualize our courses and teach them in a more unison manner –sustainability and environmental chemistry.

P20: Positive impact of ChemEd Bridges support at Hinds Community College
Pamela Clevenger (Hinds Community College, USA)
The presenter will share fist hand experiences of the direct and indirect opportunities stemming from receiving ChemEd Bridges (CEB) travel support to attend the 2008 American Chemical Society (ACS) National Meeting and Exposition in New Orleans, LA. One of the specific sessions attended at the meeting was on the ACS National Chemistry Week (NCW) program. Information acquired at that session has been used to help promote NCW on the Hinds Community College campus in Raymond, MS, and the NCW program has also been shared with local elementary school students. Additionally, meeting the organizers of the CEB project provided a foundation to broaden networking connections, exposing this recipient of CEB support to expanded regional and national chemistry education communities. These contacts have facilitated communication with others about chemistry education as well as positioning this educator to contribute to the field of chemistry education. This presentation will provide an example of how small amounts of support for travel can reap exponential returns

2:00 PM - 5:00 PM WH-122

S4: Cognition in Chemistry Education - Part 1 of 3

Mike Briggs (Indiana University of Pennsylvania, USA), *Daniel Domin* (Triton College, USA)
This symposium is designed to be a gathering of researchers and educators with an interest in the role of cognition in chemistry education. We will present our findings and discuss the cognitive

issues associated with the teaching and learning of chemistry. We invite researchers, graduate students and sponsored undergraduate researchers to join us in the conversation. We solicit scholarship associated with the cognitive processes of learning; the application of research findings to theoretical and practical teaching perspectives and methods; neurological and psychological foundations of learning and cognition; knowledge construction through mental models and other constructs; and other cognitive aspects of the learning/teaching paradigm.

2:00	introduction
2:05 Nick Potter	P21: Taking chemical education into the 3rd dimension via the 1st and 2nd dimensions...Of course!
2:25 Malka Yayon	P22: Using a knowledge-in-pieces representation to characterize chemical-bonding knowledge: The basis of a diagnostic tool
2:45 Katherine Havanki	P23: Process model for the comprehension of organic chemistry equations
3:05 Mike Briggs	P24: Cognitive components of inquiry learning in chemistry I
3:25	break
3:40 Mike Briggs	P25: Cognitive components of inquiry learning in chemistry II
4:00 LaKeisha McClary	P26: Assumptions, heuristics, and mental models: The case of acidity and acid strength
4:20 David Yaron	P27: Learning about student cognition by logging interactions with online activities
4:40 Stephanie Cunningham Ryan	P28: Student interpretations of number in solutions chemistry

P21: Taking chemical education into the 3rd dimension via the 1st and 2nd dimensions...Of course!

Nick Potter (University of Hull, United Kingdom)

During a PhD project in chemical education investigating the development of problem-solving skills in chemistry undergraduate students, a number of existing psychological and educational models and theories were used to inform the research: • Piaget's Genetic Epistemology • The Perry Scheme of Intellectual Development • Multiple Intelligences (MI) Theory • Constructivist Epistemology • The Information Processing Model • Working Memory Space (WMS) • M-Capacity • Field Dependence/Field Independence • Context-Based Learning • Problem-Based Learning (PBL) • Johnstone's Classification of Problems • Attitude and Motivation • and Phenomenography. Each of these models and theories was used to some extent within the research, producing some interesting results. The results and conclusions have led to the formation of a three-dimensional hypothetical model that combines aspects of previous theories and models. What we would like to know is what others think of this. That is, does it go some way to explaining teachers' and students' experiences? And, can it be used to improve the teaching and learning experience?

P22: Using a knowledge-in-pieces representation to characterize chemical-bonding knowledge: The basis of a diagnostic tool

Malka Yayon (Weizmann Institute of Science, Israel), David| Fortus (Weizmann Institute of

Science, Israel), Rachel Mamlok-Naaman (Weizmann Institute of Science, Israel)
Chemical-bonding knowledge is fundamental and essential to the understanding of almost every topic in chemistry, but it is very difficult to learn. While many studies have characterized the essential concepts that students should acquire in this topic, these concepts have not been systematically organized. Based on the knowledge-in-pieces perspective, we describe the development and testing of a matrix that represents a systematic organization of the canonical knowledge on chemical bonding required at the high school level. This matrix also serves as the basis for a tool to diagnose and represent students' knowledge of this topic. The matrix contains three strands: the structure of matter at the nanoscopic level, electrostatic interactions between charged entities, and energy aspects related to bonding. In each strand, there are hierarchically ordered cells that contain fine grain concepts. Students' knowledge of chemical bonding was assessed using various instruments and the resulting data was mapped onto the matrix, generating graphical representations of their knowledge. We believe that this organization and representation can be useful in pinpointing specific concepts that are misunderstood, areas of strength and weakness, tracking knowledge development over time, and developing learning progressions for chemical bonding.

P23: Process model for the comprehension of organic chemistry equations
Katherine Havanki (Catholic University of America, USA), Diane Bunce (Catholic University of America, USA)
The comprehension of organic chemistry equations is key to success in organic chemistry, but little is known about the cognitive processes that take place when a student reads an equation. Eye movements can provide information about the underlying cognitive processes that occur during reading. For this experiment, subjects were asked to read a series of organic chemistry equations of varying complexity. By analyzing where the subjects' eyes fixated and how long the fixations lasted, a cognitive model was developed and tested for the comprehension of organic chemistry equations. This new model which is based upon the Just and Carpenter (1980) model of reading comprehension includes a six stage process that accounts for the movement of the eyes over the chemical reaction (get next); the search of a chemical structure for key features (search); the encoding of features to create an internal representation (encoding and access lexicon); the assignments of relationships among features in the same molecule (intra-molecular relationship) and between molecules (inter-molecular relationship); and a check of the internal representation for inconsistencies (reaction wrap-up). Similar models have been successfully developed in a variety of other domains, including writing, reading, mathematics, and diagram comprehension.

P24: Cognitive components of inquiry learning in chemistry I
Mike Briggs (Indiana University of Pennsylvania, USA), George Long (Indiana University of Pennsylvania, USA)
Building on the work of researchers in learning and cognition, we will present an explanatory mechanism for constructivism in the form of a theory of mental models. In a coordinated study of learners who are learning chemical equilibrium at the college freshman level, we have identified three constituents of a mental model of the concept of chemical equilibrium. We will show the referents and labels used by participants to explain chemical equilibrium and the relations formed between these referents. We will also show how participants use syntax to communicate their mental models. These static constituents of a mental model are common

across several participants and activities. This research also leads to the discovery of dynamic constituents, sensemaking processes, which are given by another presentation in this symposium.

P25: Cognitive components of inquiry learning in chemistry II

Mike Briggs (Indiana University of Pennsylvania, USA), George Long (Indiana Univ. of PA, USA)

Guided-inquiry and other constructivist teaching methods are currently regarded as some of the best practices in Chemistry Education, but there seems to be little reported evidence of the cognitive details of student learning during these activities. Recently, we have used qualitative studies and the theoretical perspective of mental models to examine several cognitive aspects of inquiry learning. In particular, we have identified the importance of a “sensemaking process”, a constituent of a mental model, that seems important in inquiry-based activities and problem solving in general. We will report the results of studies on two different chemistry related activities, the classic “blue bottle” experiment and a “Periodic table puzzle”, and discuss the wider implications of the results with regard to the use of inquiry methods.

P26: Assumptions, heuristics, and mental models: The case of acidity and acid strength

LaKeisha McClary (University of Arizona, USA), Vicente Talanquer (University of Arizona, USA)

In the past few years, we have conducted research to identify the implicit assumptions and short-cut reasoning procedures (heuristics) that constrain and guide novice chemistry students' thinking when working on tasks that require qualitative reasoning (e.g., classification, explanation, comparisons, and ranking). These cognitive constraints seem to guide and frame the construction and operation of mental models that students build or employ to deal with the demands of specific tasks or situations. In the present study, we investigated the implicit assumptions and heuristics used by first-semester organic chemistry students when ranking chemical substances according to their acid strength. For this purpose, we conducted semi-structured interviews in which students were asked to think-aloud while ranking sets of three substances. Data analysis allowed us not only to identify the core assumptions and heuristics used by the majority of the students when making ranking decisions, but also to characterize the mental models of acidity built or employed by the interviewees when working on the task. In particular, we identified three major types of mental models labeled "proton-donor," "structural," and "hybrid." The results of our study suggest avenues of intervention to better support learning in the organic chemistry classroom and for designing valid and reliable instruments to assess student understanding.

P27: Learning about student cognition by logging interactions with online activities

David Yaron (Carnegie Mellon University, USA), Alex Borek (University of Cambridge, UK), Michael Karabinos (Carnegie Mellon University, USA), Gaea Leinhardt (University of Pittsburgh, USA), Bruce M. McLaren (Carnegie Mellon University, USA)

As education moves more-and-more towards online environments, the possibility arises of monitoring student interactions with learning materials in a fairly detailed manner. This potentially immense data stream can be used to understand student learning strategies, iteratively improve existing materials, and, ultimately, provide students with just-in-time support and feedback. We will begin by summarizing our work on interactions with tutors that offer students only a few choices at each problem-solving step and so generate data that is easily analyzed.

Next, we will consider data from the ChemCollective virtual lab (http://www.chemcollective.org), which supports inquiry by providing an open-ended environment in which students can design and carry out their own experiments. The resulting data is rich, in that all student actions are recorded, but challenging to analyze because of the open-ended nature of the activities. Nevertheless, we have made some progress in identifying student strategies and providing feedback in real time via a tutoring system (http://ctat.pact.cs.cmu.edu). We will close by discussing remaining challenges and opportunities in using student logs to extract information on how people learn.

P28: Student interpretations of number in solutions chemistry

Stephanie Cunningham Ryan (University of Illinois at Chicago, USA), Donald Wink (University of Illinois at Chicago, USA)

Number is an important component of solutions chemistry where it is assumed that students understand despite the variety of instances where number can represent different things. This study focuses on student interpretations of number in solutions chemistry. Four specific areas are explored using both domain-specific and isomorphic tasks: Same Volume/Different Molarity, Different Volume/Same Molarity, Balancing Equations, and Significant Figures. Student beliefs of Number and Matter are also explored for characterization purposes. The tasks and protocol will be presented along with preliminary data.

2:00 PM - 5:00 PM U-409

S5: Community College and University: Sharing Funding, Research, Students, Faculty, Instruments and Expertise - Part 1 of 2

Carolyn Judd (Houston Community College, USA)

Houston Community College, with no formal history of research, has just had a very successful summer research program with the University of St. Thomas in Houston. A $2.4 million 2-year Department of Education CCRAA Grant also funded instruments for HCC that were twins of those at the University of St. Thomas. Throughout the year, members of both institutions meet monthly for training, planning, and collaboration, forming a bond between the institutions. Examples of other cooperative ventures will be presented: from San Antonio to El Paso, from Rice University to Texas Wesleyan University and beyond.

2:40		introduction
2:45	Thomas Malloy	P29: University of St. Thomas: Strengthening higher education through shared funding and resources
3:05	Yiyan Bai	P30: Houston Community College: Adapting our environment to include research and fine instruments
3:25		break
3:40	Israel Garza	P31: Houston Community College and University of St. Thomas: Student prospective on joint environmental science research
4:00	Carolyn Nichol	P32: Rice University: Nanotechnology experience for community college students
4:20	John Moore	P33: Panel Discussion: A closer look: Does sharing work and who benefits

P29: University of St. Thomas: Strengthening higher education through shared funding and resources

Thomas Malloy (University of St. Thomas, USA)

Through a combination of internal support, Welch Foundation Departmental grants, an NSF MRI grant and an NSF CCLI grant, as well as significant donations of surplus equipment from industrial firms, the University of St. Thomas has been able to markedly increase the level of undergraduate research over the last decade. A dialogue between UST and Houston Community College faculty concerning involving students in at an early stage led to several proposals, one of which was successful. In 2008, a cooperative proposal for a Department of Education CCRAA-HSI grant, with UST as the lead institution, was successful. In addition to facilities modifications and a Science and Mathematics Summer Institute for entering freshmen at UST, the grant supplied significant funding for duplicating instrumentation at the two partner institutions. It also provided funding for a summer research program involving four pairs of faculty partners and eight pair of students from UST and HCC. Results from the first year of this two-year program will be discussed

P30: Houston Community College: Adapting our environment to include research and fine instruments

Yiyan Bai (Houston Community College, USA)

Through the CCRAA grant from DOE, jointly with University of St. Thomas, the Division of Physical and Natural Science of Central College, HCCS, was able to purchase several important instruments, such as FTIR, UV-Visible, Microwave Reactor, GC-MS and NMR. These instruments now play a pivotal role in our curriculum improvement and student learning. In addition, during the first summer of this two year grant, 7 faculty and 9 students carried out research in Chemistry, Biology, Physics and Environmental Science with UST faculty and students. Separate from the grant, research was also conducted at HCC to include international students so that the benefits were felt throughout our student body. To make a greater impact of the grant on student learning, several new experiments have been developed. A new chemistry lab manual was written and is being used in our newly equipped lab

P31: Houston Community College and University of St. Thomas: Student prospective on joint environmental science research

Israel Garza (Houston Community College, USA), Shuhsien Batamo (Houston Community College, USA), Karol Hernandez (University of St. Thomas, USA), Tammy Huynh (University of St. Thomas, USA), Elmer Ledesma (University of St. Thomas, USA), Tuong Nguyen (Houston Community College, USA), Damien Savino (University of St. Thomas, USA)

Houston Community College students involved in summer research at the University of St. Thomas learned how to do research and also how to operate the twinned instruments purchased with the CCRAA Department of Education grant. Results of one of the joint research projects will be detailed. Based on the Buffalo Bayou’s proximity to the city of Houston and its receipt of water run-off, an analysis of a group of samples was performed at various outflows and other locations near and along its banks. Using the EPA’s Standard Operating Procedures for Polycyclic aromatic hydrocarbons (PAH), the samples were analyzed by a Gas Chromatograph/Mass Spectrometer (GC/MS). The student response to the summer research will be emphasized.

P32: Rice University: Nanotechnology experience for community college students
Carolyn Nichol (Rice University, USA), John Hutchinson (Rice University, USA)
Rice University's Center for Biological and Environmental Nanotechnology (CBEN) and Smalley Institute for Nanoscale Science and Engineering hosts Research Experience for Undergraduates (REU) program that is specifically targeted to community college students. Working alongside graduate students and faculty in Rice's nanotechnology laboratories, qualified community college students participate in a 10-week summer internship program. Research areas that students can be involved in include characterization of nanomaterials, application of nanomaterials for treatment of diseases, and uses of nanotechnology in environmental cleanup. To synthesize and study new materials, students may use of state-of-the-art tools such as atomic force microscopy (AFM), dynamic light scattering (DLS), scanning electron microscopy (SEM), and nanolithography along with techniques such as DNA plasmid preparation, electrophoresis, inorganic and organic synthesis protocols, and mathematical modeling. The program also has an important emphasis on the ethical considerations of nanotechnology. This REU program is funded by the National Science Foundation and is designed to engage a diverse population of students in nanotechnology and to effectively prepare them for rewarding careers in science and engineering. Success stories of prior community college participants will be highlighted.

P33: Panel Discussion: A closer look: Does sharing work and who benefits
John Moore (University of Wisconsin – Madison, USA), Jeff Browning (Texas A&M College of Medicine, USA), Elizabeth Dorland (Washington University, USA), Elizabeth Moore (University of Wisconsin – Madison, USA)
John Moore of the University of Wisconsin will lead this panel discussion of a clear-eyed review of sharing. Elizabeth Moore from the University of Wisconsin, Elizabeth Dorland from Washington University, and Jeff Browning of the Texas A&M Health Science Center will bring their experiences to the discussion. The Moores will bring reflections based on their years of editing the *Journal of Chemical Education*. Both Elizabeth Dorland and Jeff Browning have taught at community colleges as well as universities. We expect a lively participation from the audience

2:00 PM - 5:00 PM U-412

S6: Designing Innovative Chemistry Classrooms: Architecture and Pedagogy

Kimberly Woznack (California University of Pennsylvania, USA)
We have reached an age during which many schools around the country are redesigning their chemistry classroom and their chemistry curricula. In the interest of sharing objectives, ideas and outcomes we invite talks about redesigning physical classroom spaces or redesigning or updating curricula. Many institutions have embraced an integrated lab/lecture course which sometimes requires a new space to work in and a new style of teaching. Other institutions have chosen to update their space and modernize a fairly "traditional" curriculum, while still others have implemented a new curriculum in a "traditionally" designed classroom and lab space.

2:00		introduction
2:05	L. Kraig Steffen	P34: Creating the Resource Center for Core Science: A laboratory/lecture space for natural science courses
2:25	Bradley Hall	P35: Redesigning the freshman laboratory to integrate lecture and research

		space for multi-faceted project based learning
2:45	Ron Briggs	P36: Design and implementation of the new Chemistry Collaborative Learning Center (CCLC) at Arizona State University (ASU)
3:05	Kimberly Woznack	P37: Implementing a student-centered studio chemistry approach at California University of Pennsylvania
3:25		break
3:40	Lisa Ponton	P38: Advanced general chemistry: Rethinking the approach
4:00	Larry Miller	P39: Redesigning classroom space and course content to accommodate a one-semester integrated laboratory/lecture General Chemistry course
4:20	Roberto Viña-Marrufo	P40: Going FAR?
4:40	Rebecca Kruse	P41: Designing an interactive, student-centered physical science curriculum for large enrollment, general education courses.

P34: Creating the Resource Center for Core Science: A laboratory/lecture space for natural science courses
L. Kraig Steffen (Fairfield University, USA)
The Resource Center for Core Science (RCCS) at Fairfield University opened spring of 2009. This 1800 square foot integrative teaching space incorporates both laboratory and classroom elements. The Center was designed for natural science core courses in physics, biology, or chemistry taken by students who are not science or pre-health majors. The Center includes design features that allow faculty and students to transition seamlessly from traditional lecture, interactive discussions, and bench-top laboratory experiences. Students can stand or sit at variable height four-student workbenches. Each bench also has two laptops on adjustable arms. Instrumental bench space, ample drawer storage, and an open area with removable low tables, give the room great flexibility. Faculty can present information using A/V equipment including two projectors, a document camera, and multiple layer white boards along two walls. After gathering ideas from other Universities and programs such as PKAL and SENCER, the RCCS was designed by a series of workshops and planning sessions, organized by our Center for Academic Excellence, involving Fairfield faculty, outside consultants, and University design professionals. The space has been well received. There have been challenges that will be presented to help others designing such a shared space. For example we are limited in the type of chemical experiments we can perform because some work has to be done in fume hoods on the periphery. HVAC noise has also been a challenge. The renovation was paid for by Fairfield University while curricular projects and workshops have been supported by an NSF-CCLI grant.

P35: Redesigning the freshman laboratory to integrate lecture and research space for multi-faceted project based learning
Bradley Hall (University of Texas at Austin, USA)
Designing multipurpose laboratory spaces integrating pedagogy and research is not trivial. Research grade equipment, experience and technologies can, however, co-exist with pedagogical imperatives. Designing such space requires a paradigm shift in physical space utilization, incorporating specific attributes for user-friendliness and safety for both students and instructors. UT-Austin has developed a new educational program that required us to create research labs with a teaching purpose. The Freshman Research Initiative (FRI), consists of 20 different research

groups and involves ~500 students each year, working in 5 dedicated laboratory facilities. Given that instructional lab space is difficult to secure, we achieved success by combining multiple groups into specific research teaching spaces. These include newly renovated classrooms, abandoned faculty labs and existing, though underutilized, teaching spaces. For example, my research group of around 30 students selects nucleic acid aptamers in a space shared with groups pursuing research in viral evolution, de novo gene construction and virtual drug discovery. This space was previously used by 50 students only three days a week. Now over 140 students share the lab, and it is in use seven days a week for 12 hours each day. We share common equipment and encourage collaboration between diverse disciplines. We will focus on lessons learned when designing these and future lab facilities for the university. We will present methods to overcome space and budget limitations. We will describe generic concepts of space utilization and specific hurdles including audio/visual requirements, backpack storage, line of sight, and coordinated scheduling of people and equipment.

P36: Design and implementation of the new Chemistry Collaborative Learning Center (CCLC) at Arizona State University (ASU)

Ron Briggs (Arizona State University, USA), Gary Cabirac (Arizona State University, USA), Pamela Marks (Arizona State University, USA)

In 2008/2009, the General Chemistry Program at Arizona State University (ASU) was redesigned with goals of improving access and excellence of instruction while simultaneously lowering costs. The focal point of this redesign effort was the planning and construction of a new classroom dubbed the Chemistry Collaborative Learning Center (CCLC), which successfully incorporated the ideas of multiple faculty, university planning offices, and technology/furniture vendors. This innovative new room utilizes 36 tablet PCs, 12 projection screens, and the Polyvision THUNDER virtual white board system to facilitate the active learning environment required for a new type of recitation experience. The CCLC has of footprint of only 1,623 sq. ft., yet effectively replaces several other high-demand classrooms by serving over 5,500 undergraduate students per year.

P37: Implementing a student-centered studio chemistry approach at California University of Pennsylvania

Kimberly Woznack (California University of Pennsylvania, USA)

California University of Pennsylvania has been supportive of the studio approach from both pedagogical and administrative productivity points of view. Our department launched a studio physics program in the spring of 2004. In the summer of 2004 we began the design of a General Chemistry Studio facility and curriculum. Over the course of four years the facility was designed and constructed. The General Chemistry Studio facility opened at the start of the Fall 2008 semester. A description of the final configuration of the physical space and the student-centered curriculum now in use for General Chemistry I and II will be provided.

P38: Advanced general chemistry: Rethinking the approach

Lisa Ponton (Elon University, USA)

The Chemistry Department at Elon University has refined their approach to the Advanced General Chemistry course. A more accurate description for the previous “advanced” course was “accelerated” as it covered a full year’s worth of material in a single semester. The course was populated with science majors having excellent high school backgrounds and high scores on an entrance exam. Despite their strong backgrounds, it became clear that the students had limited topic knowledge beyond stoichiometry. To finish the material in a semester, instructors often glossed over concepts creating knowledge gaps, which were revealed in upper level chemistry courses when compared to peers who had the standard general chemistry sequence. To better prepare the students, the advanced course reverted to a two semester sequence with the added explicit course goal of enhancing problem solving skills. The new advanced general chemistry sequence covers the same foundational concepts as the standard general chemistry sequence at a greater depth. In place of traditional lectures a combination of strategies including POGIL exercises, challenge problems, and data interpretation were employed. Students were recruited through a combination of self-selection and examination of high school experience (honors, AP or IB), math SAT score, and projected major. This presentation discusses how using a variety of non-lecture strategies fostered student learning, built confidence, and developed problem solving skills.

P39: Redesigning classroom space and course content to accommodate a one-semester integrated laboratory/lecture General Chemistry course

Larry Miller (Westminster College, United States)

This talk describes the redesign of both physical space and course content to restructure the traditional contact hours of three one-hour lectures and one three-hour laboratory period into three two-hour "blocks" per week. Designing a Smart classroom to be located next to laboratory space allows for movement between classroom and laboratory activities during the two-hour block as appropriate to the material. The shift away from a single three-hour laboratory period allows for data obtained in the laboratory to be discussed in a separate post-lab class period or for some lab activities to span more than one class period. As classroom periods are no longer limited to one hour, there is also added flexibility for group problem solving activities to extend beyond one hour as necessary. Benefits to this restructuring of the general chemistry course as well as challenges faced will be discussed.

P40: Going FAR?

Roberto Viña-Marrufo (University of Texas at El Paso, USA), James E. Becvar (University of Texas at El Paso, USA), Isaac Campos Flores (University of Texas at El Paso, USA), Mahesh Narayan (University of Texas at El Paso, USA)

Students often come to their first college-level chemistry course with extremely poor study habits, sometimes with almost none at all. Today's students are too often irresponsible learners; many have used only the 'cram before the exam' strategy. It's no wonder few remember much after the course. Both general chemistry courses at the University of Texas at El Paso utilize Peer-Led Team Learning (www.pltl.org) integrated in a required format within the curriculum. The second semester course now additionally incorporates a strategy borrowed and adapted from Team Based Learning. Gone are the hour exams; we give a short exam every class period. We call this Formative Assessment of Readiness, FAR. You might think these FAR exams are just quizzes; in a sense they are, but to stress the importance of being ready every class period, these FAR exams count 50% of the final grade in course. We report that an essential requirement for this strategy to be successful is immediate and full performance feedback to the students. This constant assessment and feedback is designed to provide students frequent guidance in their study experience outside of class, to reward their time on task, and to stress the importance of responsible learning.

P41: Designing an interactive, student-centered physical science curriculum for large enrollment, general education courses.
Rebecca Kruse (Biological Sciences Curriculum Study, USA), Edward Price (CSU San Marcos, USA)
We will introduce a general education physical science curriculum currently under development (NSF DUE-0717791). The LEarning Physical Science (LEPS) curriculum focuses on core conceptual themes of energy, force, and the atomic-molecular theory of matter. In addition, LEPS explicitly engages students in learning about the nature of science and learning. The course is designed to be richly interactive, student-centered, and collaborative, but is intended for use in large, lecture format classrooms or other settings where hands-on experimentation and whole class discussions are difficult. To overcome these limitations, LEPS makes use of interactive tools such as class response systems, interactive demonstrations, online homework, and computer simulations. We will describe the design principles underlying its development, show example materials, and present initial research findings from pilot and field tests. LEPS is adapted from the Physical Science and Everyday Thinking curriculum (NSF ESI-0096856), a small-class, experiment- and discussion-oriented curriculum.

2:00 PM - 5:00 PM U-413

S7: Learning in the Laboratory: Evidence and Assessment - Part 1 of 2

Jacob Schroeder (Iowa State University, USA), *Santiago Sandi-Urena* (University of South Florida, USA)
While most chemists agree that laboratory work is an important part of introductory science courses, there is scant evidence for the relationship between laboratory work and learning, particularly at the college level. The objective of this symposium is to create a space to present and discuss evidence and assessment for the effectiveness of laboratory environments in promoting learning, skills (technical and intellectual) and other types of gains in participants (students and teaching assistants). Studies of diverse laboratory formats and academic levels are welcomed.

2:00		introduction
2:05	Santiago Sandi-Urena	P42: Comparison of GTAs' experiences in two general chemistry laboratory programs using diverse levels of inquiry
2:25	Todd Gatlin	P43: Effect of a cooperative problem-based laboratory environment on students' and GTAs' development of scientific skills
2:45	Teresa Eckart	P44: GTA gains from general chemistry laboratory instruction
3:05	Claire Mc Donnell	P45: Did it work? Research awareness and readiness evaluation of undergraduates
3:25		break
3:40	Kereen Monteyne	P46: Model-based teaching and learning in a general chemistry inquiry laboratory
4:00	Ruth Shear	P47: Teaching through research: Evidence of impact from the Freshman Research Initiative at The University of Texas at Austin
4:20		discussion

P42: Comparison of GTAs' experiences in two general chemistry laboratory programs using diverse levels of inquiry

Santiago Sandi-Urena (University of South Florida, USA), Teresa Eckart (University of South Florida, USA), Todd Gatlin (University of South Florida, USA)

Large universities rely on their graduate students to serve as general chemistry laboratory instructors. Commonly, these in-training scientists undertake their teaching responsibilities with little or no preparation. Often, their expectations in term of what they can gain from the teaching experience, and those of their research advisers alike, seem to be limited. The impact of teaching on graduate teaching assistants (GTAs) has rarely been the focus of research. We decided to investigate the kind of effects that engagement in instructional environments has on GTA's, particularly on aspects related to their professional and scientific developments. Two general chemistry laboratory programs that represent two very different instructional frameworks were chosen for this study. The first used a cooperative project-based approach that in a dichotomous classification could be described as non-traditional. On the other hand, the second program used weekly, verification-type activities and would fall under the traditional category. Detailed characteristics of both programs will be presented. The purpose of elucidating the teaching experience as lived by the graduate assistants led us to utilize a phenomenological methodology of inquiry. Collection of data via GTA end of the semester interviews was continued until saturation was reached. Investigation of the two programs was sequential and in the order presented above. Separate findings from these two investigations are reported in other talks in this symposium. The purpose of this presentation is to report a comparative study of these findings and the implications this work may have on the designing of laboratory programs.

P43: Effect of a cooperative problem-based laboratory environment on students' and GTAs' development of scientific skills

Todd Gatlin (University of South Florida, USA), Gautam Bhattacharyya (Clemson University, USA), Melanie Cooper (Clemson University, USA), Santiago Sandi-Urena (University of South Florida, USA), Ron Stevens (UCLA, USA)

Laboratory practice is an undeniable part of chemistry education. No area in the field has received as much time, money and energy as laboratory reform. However, evidence supporting student gains, especially higher-order skills, through laboratory experience is scarce. In an attempt to gather evidence and contribute to the clarification of the pedagogical value of laboratory work, we undertook assessing a cooperative problem-based laboratory. First, a mixed-methods sequential explanatory designed study was used to assess the laboratory’s impact on students’ metacognitive skills and problem-solving abilities. Quantitative data was gathered using previously validated techniques. Students who participated in the laboratory demonstrated an increase in metacognitive awareness, skillfulness and problem-solving abilities. Qualitative data was gathered using semi-structured interviews. Analysis followed a phenomenological approach and enhanced and explained the prior findings. From these qualitative data, interesting student-graduate teaching assistant (GTA) interactions also emerged, leading us to believe the GTAs may be developing alongside their students while facilitating learning. This led us to undertake a second phenomenological study to explore the effects of the laboratory environment on GTAs metacognitive development and epistemological reflection. Findings suggest that facilitating the chemistry laboratory provides opportunities for GTAs to develop relevant skills for becoming scientists and researchers. Together these studies suggest a parallel development of students and GTAs' scientific skills. This work represents evidence consistently showing that the cooperative problem-based laboratory environment requires and supports students' and GTAs' metacognitive engagement and epistemological reflection thereby facilitating their development in these two dimensions.

P44: GTA gains from general chemistry laboratory instruction

Teresa Eckart (University of South Florida, USA), **Santiago Sandi-Urena** (University of South Florida, USA), Todd Gatlin (University of South Florida, USA), Santiago Sandi-Urena (University of South Florida, USA)

The idea that appropriately designed laboratory instruction can play a significant role in students' achievement of scientific literacy seems to be prevalent among chemistry educators. Consistent with this premise, related education research has focused on the implementation of different instructional approaches, and students' gains and perceptions. Interest in graduate teaching assistants (GTAs) has been mostly limited to training, and to their perceived expectations but little attention has been paid to the potential benefits from teaching. This study is part of a larger program that addresses this research gap. It uses a phenomenological approach to investigate the essence of the GTA experience in a traditional general chemistry laboratory course. By constructing a holistic description of the experience we intend to access the nature of the gains available to GTAs in this instructional environment. Evidence will be discussed that suggests that appropriate teaching experiences may contribute to better prepare graduate students for their journey in becoming scientists and to embark on successful research. We believe that a better understanding of potential GTA benefits in learning environments may place innovative instruction in a new light of appreciation.

P45: Did it work? Research awareness and readiness evaluation of undergraduates

Claire Mc Donnell (Dublin Institute of Technology, Ireland), Michael Seery (Dublin Institute of Technology, Ireland)

The aim of this work was to evaluate the effectiveness of the research-oriented, research-based and research-led measures introduced to undergraduate teaching in the School of Chemical and Pharmaceutical Sciences in Dublin Institute of Technology over the past four years. The main element of the changes made was the inclusion of project-based learning laboratory "miniprojects" in some modules (Spectroscopy and Medicinal Chemistry) for second and third year undergraduates. This study has provided some key insights into how appropriate and effective these measures have been and the perceptions of the learners involved of scientific research and of their own related skills, both subject specific and transferable. The methodology employed to obtain feedback from second and third year students on the research-oriented and research-based activities was to implement pre- and post-questionnaires containing both open and closed questions. Two control groups were surveyed to compare their attitudes and their research readiness and awareness. First year graduate students were also asked to complete a survey that required them to reflect on their experiences of undergraduate research projects and their perceptions of their readiness for graduate level research

P46: Model-based teaching and learning in a general chemistry inquiry laboratory

Kereen Monteyne (Northern Kentucky University, USA), Barbara L. Gonzalez (California State University Fullerton, USA)

The science laboratory is an ideal environment to help student bridge the different representations used by instructors in the chemistry classroom. Most classroom instruction emphasizes symbolic and mathematical representations, with limited use of particulate representations. Studies have shown that many students view particulate-level models as symbolic representations (i.e., drawing the chemical equation). The purpose of this project will be to investigate student ability to interpret, develop, and refine particulate-level models in a series of inquiry-oriented general chemistry laboratory experiments. As part of each laboratory activity, students developed and manipulated small-particle models in order to explain and predict the behavior of the observable, macroscopic world. Questions placed on course assessments were used to evaluate student understanding of particulate-level models for chemical concepts such as physical/chemical change and stoichiometry. The development and assessment of the laboratory activities will be discussed.

P47: Teaching through research: Evidence of impact from the Freshman Research Initiative at The University of Texas at Austin
Ruth Shear (University of Texas at Austin, USA)
The Freshman Research Initiative (FRI) in the College of Natural Sciences at UT-Austin is a reinvention of our undergraduate research paradigm recruiting over 500 freshmen each year into a faculty-initiated three-semester research-based degree course sequence that increases the number and diversity of students involved in research, and significantly impacts student success and engagement in science. Our model incorporates cutting-edge faculty research amenable to large-scale freshman training and experimentation, with a choice of (currently) 21 different research topics, covering fields including chemistry, biochemistry, and molecular biology. Our students experience curriculum coverage, laboratory training, and research, and are provided an array of professional skills essential to their future life as a scientist. The core principle behind FRI is the merging of the educational and research missions of the University to benefit both students and faculty, by creating an environment where teaching is based on authentic research projects of the faculty. Our student-centered goals for this reformation of undergraduate education are to (i) attract and retain students in the sciences; (ii) improve undergraduate academic success, science literacy and critical thinking skills; (iii) bridge the gap between education and research by using research as a vehicle for teaching; (iv) create an environment in which the effects of research training can be assessed; (v) drive curriculum reform; and (vi) enhance collaborations that promote education through undergraduate research. Our first three years of data showed significant progress toward all these goals. New data will be presented based on the first full FRI student cohort to graduate.

2:00 PM - 5:00 PM WH-117

S8: MSPs: How K-12/College Partnerships Have Improved Chemistry Instruction - Part 1 of 3

Doug Sawyer (Scottsdale Community College, USA), *Martin Brock* (Eastern Kentucky University, USA)
The establishment of Math and Science Partnership programs in the wake of NCLB has led to many shifts in post-secondary attitudes about K-12 teaching in areas related to chemistry. The purpose of this symposium is to share MSP experiences from college faculty and K-12 teachers and how they have informed: Use of inquiry pedagogy; Learning progressions; High school/college transition and the problems of readiness and retention; Structure of professional development programs; Pre-service science curricula; and other topics of related interest.

2:00		introduction
2:05	Jyotsna Thota	P48: From college classroom to a high school classroom: Teachers' reflections about a content based chemistry course
2:25	Elizabeth Roland	P49: One professional development structure for high school chemistry teachers: Field majors or non-field majors
2:45	Jill Barker	P50: Dual enrollment courses in Virginia
3:05	Donald Storer	P51: A dual-credit chemistry class using a blended delivery/team teaching approach
3:25		break
3:40	Bryan May	P52: Dual enrollment courses: Just like regular courses only different
4:00	James Valles	P53: How self-beliefs influence minority students' success in high school
4:20		discussion

P48: From college classroom to a high school classroom: Teachers' reflections about a content based chemistry course

Jyotsna Thota (Georgia State University, USA), Lisa Martin-Hansen (Georgia State University, USA)

The main goal of this study is to answer the question "How have aspects of the Chemistry for Teachers course transferred into the current teachers' (former pre-service teachers) planned teaching in their classrooms?" The study is divided into three components: summer chemistry course, interviews and a focus group. All the students enrolled in the course are participants of the TEEMS (Teaching Effectively in English, Mathematics, Science and Social Studies) program. California Diagnostic Test (CDT, high school equivalency level standard examination) determined the content for the course for the first semester and the same content was followed in the second semester. While most of the course modules were discussed by using learning cycle or problem based learning, some modules were discussed by using the stand and deliver method. From the comparison of the pre (CDT, Avg: 29 questions correct out of 44) and the post (ACS standard final examination, Avg: 44 questions correct out of 60), it was clear that the students' chemistry content knowledge improved. In this paper, we will discuss the course modules, CDT and final examination results and the interviews.

P49: One professional development structure for high school chemistry teachers: Field majors or non-field majors

Elizabeth Roland (Morehead State University, USA)

A guided-inquiry professional develop model was used for two institutes targeting chemistry teachers in the central Appalachian region. Guided-inquiry for these institutes is modeled after Physics by Inquiry (1996). Some topics addressed by these institutes include: redox chemistry, acid base chemistry, atomic structure, and periodic laws. Topics addressed were different for each institute. Targeted populations for the first institute was chemistry teachers with at least a major in chemistry and the second was for chemistry teachers with a minor or less in chemistry. Both institutes demonstrated changes in content knowledge over the two weeks via a pre-test/post-test scenario. Additional support for this form of guided inquiry comes from student quizzes and projects created.

P50: Dual enrollment courses in Virginia
Jill Barker (Millbrook High School, USA)
The history of dual enrollment in Virginia will be overviewed. Best practices for dual enrollment courses in Virginia as identified by the state department of education will be discussed. Conclusions form an Ed.D. dissertation examining perceptions of dual enrollment from parties both directly and indirectly involved will be shared.

P51: A dual-credit chemistry class using a blended delivery/team teaching approach
Donald Storer (Southern State Community College, USA), Glenna Rowe (Washington Court House High School, Fayette)
A pilot program in which high school chemistry students receive dual credit for both high school and college chemistry was implemented to test a blended delivery, team teaching approach. The use of both online and face-to-face delivery of course materials by both the high school teacher and the college professor allowed the college and high school to accommodate each other's schedules. Proximity of the college campus to the high school facilitated the students performing most labs at the college campus. The first year of the program was culminated by a research project involving the analysis of samples from an archaeological excavation at George Washington's home in Mt. Vernon, Virginia.

P52: Dual enrollment courses: Just like regular courses only different
Bryan May (Central Carolina Technical College, USA)
Dual enrollment courses provide opportunity for high school students, but these courses present several challenges for the host college that wants to offer a quality course comparable to their traditional science courses. Central Carolina Technical College has taught dual enrollment courses for several years in partnership with a local school district. Central Carolina has offered biology and chemistry courses in a variety of formats. Dual enrollment courses work best when the course is treated as a college course, not another type of advanced high school course. Some changes to the instruction are necessary to meet the needs of dual enrolled students. These changes must not result in a compromise of the quality of instruction. The laboratory portion of science courses can be especially challenging for dual enrollment courses. These courses must offer a laboratory that is at least comparable to the laboratory portion of the standard course. The ultimate success of a dual enrollment course is only possible by creating a strong and flexible plan and committing the resources necessary for proper execution of this plan.

P53: How self-beliefs influence minority students' success in high school
James Valles (Texas Tech University, USA), Dominick Casadonte (Texas Tech University, USA)
This presentation examines the self-beliefs and self-motivation of under-performing students at an urban high school in west Texas. The presenter wishes to show that the quality of education, and the seriousness of the students regarding their education, is affected by influences outside of the school setting. The goal of this study is to provide educators and administrators a glimpse into outside factors that should be considered and addressed when considering the educational needs of under-performing minority students. Of particular interest are the results of this study gathered from students in developmental high school Chemistry classes.

2:00 PM - 5:00 PM WH-113

S9: Out of the Box: Teaching Chemistry with Case Studies and Applications - Part 1 of 2

Matthew Johll (Illinois Valley Community College, USA)

The goal of this symposium is to present the audience with an understanding of how case studies and specific applications of chemistry can be used in their classroom. These methods can enhance student appreciation and understanding of the information and help to further develop their problem solving skills. Presentations from all levels of the chemistry curriculum are encouraged.

2:20		introduction
2:25	Colleen Kelley	P54: Nuts and bolts of using case studies in the 100-level chemistry classroom
2:45	sue salem	P55: CSI: It's not just entertaining - it's educational
3:05	Laura Eisen	P56: Case-based interdisciplinary course for non-majors: “The science of terrorism”
3:25		break
3:40	Scott Donnelly	P57: Chemical education alchemy: Connecting chemistry to everyday consumer products
4:00	Mark Richter	P58: Teaching chemistry with case studies: The good and the bad
4:20		discussion

P54: Nuts and bolts of using case studies in the 100-level chemistry classroom

Colleen Kelley (Pima Community College, USA)

This talk will present strategies for designing and implementing case studies for 100-level (introductory) chemistry courses. In addition, sample case studies will be used as examples.

P55: CSI: It's not just entertaining - it's educational

Sue Salem (washburn university, usa)

The CSI television shows engage students of all ages. This presentation will discuss use of the CSI television shows and real life case studies in an on-line forensic chemistry course for university general education.

P56: Case-based interdisciplinary course for non-majors: “The science of terrorism”

Laura Eisen (The George Washington University, USA)

Students often complain that introductory science courses are abstract and irrelevant. At The George Washington University, the typical undergraduate is interested in politics or international affairs, not science, so I decided to develop a science course that might appeal to these students. The “Science of Terrorism” uses case studies built around newspaper articles and popular media to provide a context for learning important science concepts. The course is divided into three units: Elements of Terror, Explosions, and Bioterrorism. We begin with a newspaper article claiming that thallium poisoning led to the death of Alexander Litvinenko in 2006. Students learn about atomic structure and periodicity from the perspective of an element that most have never heard of before. Reports that Mr. Litvinenko actually died from ingestion of polonium-210 introduce isotopes, radioactivity, and the threat of dirty bombs. Other elements of terror include chlorine (used in WWI) and phosphorus (used recently in the Middle East). The Oklahoma City bombing and recent attempts to blow up commercial airliners, along with controversy over Iran's attempts to obtain nuclear material, shift the focus to reactions and thermodynamics. Finally, the anthrax letters and the threat of a smallpox attack leads to an exploration of the structure and function of macromolecules and important ideas in biology. The laboratory includes simple problem-solving activities (such as identifying the ink used to write a "terrorist letter"), and also provides the students with a chance to use some of the methods of modern biotechnology that are described in the readings.

P57: Chemical education alchemy: Connecting chemistry to everyday consumer products
Scott Donnelly (Arizona Western College, USA)
In undergraduate chemical education there is a need for curriculum ideas that connect the chemistry discussed in lecture and lab to the "real world". In this talk the presenter will describe visually appealing, conceptual activities that illustrate the complementary relationship between chemical theory as taught in lecture and lab and application as practiced in the material world. Special emphasis will be placed on how chemistry principles can be taught using everyday consumer products that can be purchased in grocery stores or Do It Yourself home centers. Topical coverage in the presentation ranges from physical properties to visible spectroscopy.

P58: Teaching chemistry with case studies: The good and the bad
Mark Richter (Missouri State University, United States)
Case studies are stories that convey an educational message. They also attempt to shift the focus from the 'sage on the stage' model to active student engagement in the classroom. This talk will look at ways that case studies have been used in chemistry and non-science classes at Missouri State University; these include the traditional method of devoting a class period to a particular case and its discussion, and the use of case studies as writing assignments to augment lecture topics. The shift from lecture based courses also brings with it certain challenges titled, in a rather tongue-and-cheek fashion, the 'Good' and the 'Bad'. Examples of the 'Good' include ways of actively engaging students in the classroom and not letting them simply sit and watch, and presenting the material in a context that appears to resonate with certain types of student learners; while the 'Bad' includes the limited number of case studies available for chemistry courses, and the near impossibility of implementing a discussion in a class of more than 25 students, among others.

2:00 PM - 5:00 PM U-411

S10: POGIL – General Interest, Part 1 of 3

Tina Mewhinney (Eastfield College and University of North Texas, USA)
Process Oriented Guided Inquiry Learning - papers welcomed for all levels of POGIL use in science -- middle school, high school and college. Classroom experiences or research associated with POGIL are encouraged.

2:00		introduction
2:05	Rick Moog	P59: Introduction to POGIL: Process Oriented Guided Inquiry Learning
2:25	Mary Walczak	P60: ANA-POGIL: a consortial approach to writing and implementing POGIL activities in analytical chemistry courses

2:45	Caryl Fish	P61: Using POGIL to teach concepts in chromatography
3:05	John Goodwin	P62: Guided inquiry learning for the problem solving process in general chemistry
3:25		break
3:40	Ushiri Kulatunga	P63: Use of Toulmin's Argumentation Scheme for student discourse to gain insight about POGIL activities
4:00	Dan Libby	P64: Using the Toulmin Argumentation Model to improve student explanations in POGIL classrooms and laboratories
4:20	Kristina Lantzky	P65: Increases in student scientific reasoning skills in the POGIL classroom
4:40	Laura Frost	P66: POGIL: It's not just for chemists anymore!

P59: Introduction to POGIL: Process Oriented Guided Inquiry Learning
Rick Moog (Franklin and Marshall College, USA)
POGIL (Process Oriented Guided Inquiry Learning) is a student-centered approach to instruction that is based on research on how students learn best. In a POGIL learning environment, students work in groups (generally with assigned roles) on specially designed activities that guide them to develop important concepts. In addition to mastering content, an equally important focus of a POGIL implementation is the development of key process skills (such as problem solving, critical thinking, effective communication, teamwork). This presentation will provide a brief introduction to the POGIL philosophy and instructional strategy, and will present evidence of improved student learning outcomes in a variety of settings.

P60: ANA-POGIL: a consortial approach to writing and implementing POGIL activities in analytical chemistry courses
Mary Walczak (St. Olaf College, USA), Renee Cole (University of Central Missouri, USA), Juliette Lantz (Drew University, USA)
A consortium of analytical faculty members has been developing, reviewing, and testing POGIL materials specifically designed for analytical chemistry courses. The goal of the NSF funded project is to develop forty activities examining analytical concepts that can be used not only in traditional analytical chemistry or instrumental analysis courses, but any course that includes analytical chemistry principles. Now in its third year, the consortium is continuing to write new activities while alpha testing activities in our classrooms. This presentation will focus on three parts of the ANA-POGIL project: its overall structure and approach, collaborative writing of activities and alpha testing new materials. Collaborative writing is a successful approach utilized in the consortium with inherent benefits and difficulties. Implementation in consortium classrooms is the focus of the current alpha testing phase; the implementation strategies, assessment strategies, formative feedback structures and reflections from an alpha tester will be presented.

P61: Using POGIL to teach concepts in chromatography
Caryl Fish (Saint Vincent College, USA), Juliette Lantz (Drew University, USA)
Chromatography concepts are an integral component of analytical chemistry courses. Students are expected to have a solid understanding of separations and chromatography instruments as they enter the workforce. To enhance the learning of chromatography, we have developed both

in-class POGIL activities and project laboratories. The POGIL activities include Introduction to Chromatography, Band Broadening, and Comparison of GC and HPLC. These activities have been developed, reviewed and classroom tested through the ANA-POGIL project. In addition to the classroom activities, laboratories in chromatography have also been utilized in three different classes – organic chemistry, instrumental analysis, and biochemistry.

P62: Guided inquiry learning for the problem solving process in general chemistry

John Goodwin (Coastal Carolina University, USA)

The Process Oriented Guided Inquiry Learning in Context (POGIL-IC) project developed a series of advanced POGIL general chemistry activities that use interdisciplinary contextual themes as a way to introduce and frame chemistry problems. These activities are designed to to improve problem-solving skills. The workbook Solving Real Problems with Chemistry (Pacific Crest, 2009) includes "help" pages at different performance levels, labeled copper (which provides the most guidance), silver and gold (which provides the least guidance), for instructors to distribute to support students in the processes of problem solving. The activities include post-activity questions to engage students in meta-cognitive reflection about the problem solving skills they are developing. Near and far-transfer problems, called "Got It!" questions, allow students and instructors to assess student understanding of the activities. POGIL-IC activities have proven to be effective end-of-chapter summative assessment instruments that can be used to integrate the content and skill development from preliminary activities based on more focused and content-oriented POGIL materials, such as David Hanson's Foundations of Chemistry (Pacific Crest, 3rd ed. 2008).

P63: Use of Toulmin's Argumentation Scheme for student discourse to gain insight about POGIL activities

Ushiri Kulatunga (University of South Florida, USA), Jennifer Lewis (University of South Florida, USA), Rick Moog (Franklin and Marshall College, USA)

Our study focuses on the use of Toulmin's argumentation scheme to trace argumentation that occurs in peer-led sessions for a General Chemistry I course. We developed a coding scheme based on Toulmin's (1958) argumentation model and a framework for assessing the arguments based on both the strength of the arguments and the extent of collaboration among group members. Data was collected by videotaping one or two focal groups in the weekly peer-led sessions. This presentation focuses on the analysis of the argumentation patterns during the semester. We are investigating the relationship between the ChemActivities and both the quality and quantity of the arguments. Prompts in the ChemActivities are examined to see whether certain prompts elicit more argumentation than others. Argumentation patterns are also investigated to see any differences in the argumentation patterns based on the topic and the structure of the ChemActivity. This presentation provides some insights about characteristics of POGIL activities that promote effective group argumentation.

P64: Using the Toulmin Argumentation Model to improve student explanations in POGIL classrooms and laboratories

Dan Libby (Moravian College, USA)

Students often provide correct answers, but their explanations tend to have logical gaps. It is not unusual to receive an analysis like, "the NMR spectrum in Figure 3 clearly identifies the compound as acetylsalicylic acid." Although the conclusion may be correct, the answer gives no hint as to the thought process used to reach it. It seems that students believe that if the answer makes sense to them, the logic must be clear to anyone. Much of the problem with explanations seems to be a lack of understanding of the elements of a good explanation. Recently the Toulmin Argumentation Model has been used to analyze student discourse some POGIL classes. The model divides arguments into relatively simple elements. This presentation will describe a POGIL activity I have used to introduce the Toulmin Model to my students. The model provides structure and terminology to help students create better arguments.

P65: Increases in student scientific reasoning skills in the POGIL classroom
Kristina Lantzky (St. John Fisher College, USA)
POGIL has been used at St. John Fisher College in the two semester General Chemistry series. Scientific reasoning skills of students were measured using the Classroom Test of Scientific Reasoning by Anton Lawson. The exam was given to students on the first day of the semester and then again midway through the second semester. Results of these pre- and post-test measurements indicate that students with low scientific reasoning skills see a vast improvement in these skills after one and a half semesters of POGIL instruction.

P66: POGIL: It's not just for chemists anymore!
Laura Frost (Georgia Southern University, USA)
Georgia Southern University has several faculty outside of chemistry that have adopted the POGIL approach. How does this happen? This talk will describe how faculty across the colleges at Georgia Southern University have been working together through a university-wide faculty learning community to first learn about and later implement POGIL in classrooms as diverse as sales to child development. Successes and lessons learned in several disciplines will be discussed.

2:00 PM - 5:00 PM WH-116

S11: Problem-Based Learning Design and Utilization in Upper Level Chemistry Courses

Susan Hornbuckle (Clayton State University, USA)
This symposium will allow chemistry educators to share their experiences with the design and/or utilization of problem-based learning in upper level chemistry courses. Papers involving problem-based learning techniques for organic chemistry, biochemistry, analytical chemistry, medicinal chemistry, environmental chemistry, forensic chemistry, physical chemistry, and other upper level chemistry courses would be appropriate presentations for this symposium.

2:00		introduction
2:05	Susan Hornbuckle	P67: Case studies for environmental chemistry
2:25	Kenneth Yamaguchi	P68: Improving synthetic, laboratory and instrumental skills via combinatorial organic synthetic projects
2:45	Evonne Rezler	P69: Incorporating problem based learning into an enriched organic chemistry I course
3:05	Melissa Rhoten	P70: Chemistry capstone at Longwood University, part I: Creation and implementation

3:25	break
3:40 Keith Rider	P71: Chemistry capstone at Longwood University, part II – Analysis of biodiesel and simulation of a battery
4:00 Sarah Porter	P72: Chemistry capstone at Longwood University, part III: Stability studies on the active ingredients in over-the-counter cold medications
4:20 Christopher Gulgas	P73: Chemistry capstone at Longwood University, part IV: Organic synthesis of a functional molecule

P67: Case studies for environmental chemistry
Susan Hornbuckle (Clayton State University, USA)
In a 4000-level environmental chemistry course, students are assigned to groups consisting of 3 or 4 people at the start of the semester. These student groups function as consultant groups for various fictional EPA agents that are presented in case studies throughout the semester. Each of these fictional EPA agents is dealing with a particular environmental issue and is dependent on their consultants to supply them with up-to-date information on the issue. The consultant groups are responsible for determining the depth and scope of the research, collecting the data, and writing a technical report to advise the fictional EPA agent. Sample case studies, PBL classroom techniques, and the instructor's experiences will be presented.

P68: Improving synthetic, laboratory and instrumental skills via combinatorial organic synthetic projects
Kenneth Yamaguchi (New Jersey City University, USA)
Project-based labs have been developed for our instrumental analysis course and used successfully to enhance learning, critical-thinking, and laboratory skills. Students use a variety of combinatorial, microwave-assisted, and solid-phase synthetic techniques to generate a series of related synthetic products that are characterized by chromatographic and spectroscopic techniques. These project-based labs are well integrated into the instrumental analysis lab component and offer a meaningful way to reinforce laboratory and synthetic skills with important instrumental techniques. A description of these project-based labs will be presented.

P69: Incorporating problem based learning into an enriched organic chemistry I course
Evonne Rezler (Florida Atlantic University, USA), Donna Chamely-Wiik (Florida Atlantic University, USA), Jerome Haky (Florida Atlantic University, USA), Deborah W Louda (Florida Atlantic University, USA), Nancy Romance (Florida Atlantic University, USA)
Project ChemBOND is an ongoing revision of undergraduate chemistry courses to include conceptually based lectures, interactive learning and peer-led group activities with the purpose of improving student performance and interest. The ChemBOND initiative has been incorporated into the Organic Chemistry I course at FAU in the form of OrgoBONDing activities. Peer-led OrgoBOND group activities are conducted on a weekly basis in this course and are designed to reinforce key ideas presented in lecture. While most students find these activities helpful in learning organic chemistry, several of the top students in the course expressed a desire to be further challenged. In response we developed a problem-based learning (PBL) module on the spectroscopic identification of organic compounds. The topic of the module was chosen because it is one of the more difficult subject areas that students encounter in Organic Chemistry. The module was designed to promote greater conceptual understanding of spectroscopy and its

application for compound identification; its PBL format encouraged the students to take greater responsibility for their own learning. A select group of nine high achieving students were invited to participate in the PBL module conducted over a three week period. The design and content of the module as well as preliminary findings regarding its effects on student attitudes and performance will be discussed.

P70: Chemistry capstone at Longwood University, part I: Creation and implementation
Melissa Rhoten (Longwood University, USA), Christopher Gulgas (Longwood University, USA), Sarah Porter (Longwood University, USA), Keith Rider (Longwood University, USA)
There has been much discussion among the faculty and administration at Longwood University about incorporating undergraduate research into the curriculum. Open-ended research projects give undergraduates the opportunity to independently plan experiments and an opportunity to exercise the lab skills that they have learned in lower-division courses. Some students have good undergraduate research experiences as part of a summer internship or REU program, but many do not. The chemistry faculty feels that all chemistry majors should have a research-type experience prior to graduation. To this end, we have created a two-semester capstone sequence where students plan, collect and analyze data, and disseminate their findings in both written and oral formats. Specifically, in the first semester course (CHEM 402) students write several mini research proposals for projects that they will conduct in the second semester course (CHEM 403). The projects are open-ended and focus on instrumental and synthetic techniques normally encountered in a research laboratory. Not only does this capstone sequence instruct students in the use of chemical literature and scientific writing, it also teaches them how to effectively create an experimental plan with clearly defined objectives and predicted outcomes. At the completion of this sequence students have a greater understanding of all aspects of chemical research from experimental design through dissemination. Details about the creation and implementation of this capstone sequence as well as the challenges faced will be discussed.

P71: Chemistry capstone at Longwood University, part II – Analysis of biodiesel and simulation of a battery
Keith Rider (Longwood University, USA), Christopher Gulgas (Longwood University, USA), Sarah Porter (Longwood University, USA), Melissa Rhoten (Longwood University, USA)
CHEM 403 at Longwood is the second semester of a year-long capstone course where students carry out the research projects that they proposed in the first semester of the course. The projects are open-ended and focus on instrumental and synthetic techniques normally encountered in a research laboratory. Biodiesel is currently a popular topic in the field of green chemistry because it is a non-petroleum fuel that can be efficiently produced from waste vegetable oil. Over a multi-week period, students synthesize biodiesel, measure its heat of combustion, density and cloud point, and then compare these properties to petroleum diesel. Computer programming is a common component in undergraduate physics curricula, but many chemistry students have little or no exposure to programming. Designed as an introduction to computer programming and simulation, this project challenges students to write a simulation to predict the voltage vs. time behavior of a copper/zinc battery using Visual Basic. They also build a battery and measure the voltage as a function of time using a Pasco data acquisition system. The experimental data agree with the simulation qualitatively, but also contain some unexpected features, providing an opportunity for more experimentation. The design of the projects, including expected strengths and weaknesses, as well as student data and the results of the project will be presented. Finally,

findings from a student survey including opinions about the research process shall be discussed.

P72: Chemistry capstone at Longwood University, part III: Stability studies on the active ingredients in over-the-counter cold medications

Sarah Porter (Longwood University, USA), Christopher Gulgas (Longwood University, USA), Melissa Rhoten (Longwood University, USA), Keith Rider (Longwood University, USA)

CHEM 403 at Longwood is the second semester of a year-long capstone course where students carry out the various research projects that they proposed in written format in the first semester of the course. The projects are open-ended and focus on instrumental and synthetic techniques normally encountered in a research laboratory. In this project, students studied the stability of the active ingredients in cold medications under conditions such as UV light exposure and excessive heat. They used UV-Visible spectroscopy and the method of alternating least squares to analyze preparations containing two or more active ingredients. This project served to introduce the students to spectroscopic methods of analysis, as well as some of the principles of data handling and analyzing complex mixtures. The project also gave the students an introduction to techniques often encountered in the pharmaceutical industry. The students' experimental design and their results will be discussed. Finally, findings from a student survey including opinions about the research process shall be discussed.

P73: Chemistry capstone at Longwood University, part IV: Organic synthesis of a functional molecule

Christopher Gulgas (Longwood University, USA), Sarah Porter (Longwood University, USA), Melissa Rhoten (Longwood University, USA), Keith Rider (Longwood University, USA)

CHEM 403 at Longwood is the second semester of a year-long capstone course where students carry out the various research projects that they proposed in written format in the first semester of the course. The projects are open-ended and focus on instrumental and synthetic techniques normally encountered in a research laboratory. One of the overarching projects for the students to accomplish is the multi-step organic synthesis of functional compounds utilized for anion binding and fluorescence sensing. Students are engaged in setting up reactions, assessing the purity of products, purification and characterization methods, and evaluation of success and failure. This talk will address the challenges faced in designing productive 3-4 week individual group projects that require student input and fit together to satisfy the ultimate goal of the synthesis. The design of the projects, including expected strengths and weaknesses, as well as student data and the results of the project will be presented. Finally, findings from a student survey including opinions about the research process shall be discussed.

2:00 PM - 5:00 PM WH-114

S12: Teaching Environmental Chemistry

Stanley Manahan (University of Missouri, USA)

Authors of papers in this symposium will present their methods and/or their content for their environmental chemistry lecture and/or laboratory course(s). Innovative on-line resources and activities should be highlighted. Environmental chemistry research projects conducted by undergraduate students may also be presented.

2:00	introduction
2:05 Keith Kostecka	P74: Determination of cadmium in organic and non-organic lettuce using

		Atomic Absorption Spectroscopy (AAS)
2:25	Geoff Rayner-Canham	P75: A holistic approach to atmospheric chemistry
2:45	Daniel King	P76: POGIL-ENVY: POGIL activities for environmental chemistry
3:05	Muhamad Hugerat	P77: Teaching children to value solar energy
3:25		break
3:40	Stanley Manahan	P78: Environmental chemistry over the last four decades
4:00	Dean Campbell	P79: The day the nylons ran in Peoria: A classroom illustration of air pollution
4:20	Ted Clark	P80: Including in-class environmental chemistry research projects in general and analytical chemistry courses

P74: Determination of cadmium in organic and non-organic lettuce using Atomic Absorption Spectroscopy (AAS)
Keith Kostecka (Columbia College – Chicago, USA)
Cadmium is a heavy metal that, though it has many everyday uses, is toxic to a variety of tissues within the human body. It is commonly found in leafy green vegetables such as spinach and lettuce at levels ranging from 30 – 150 PPB. Our study looked at whether this was true or if more cadmium would be found in butterhead and romaine lettuce grown organically and/or non-organically. Samples of each type of lettuce were then prepared according to the procedure noted by Stafilov and subsequently analyzed by atomic absorption spectroscopy (AAS). Results obtained indicated that there was no difference between organically and non-organically grown butterhead and romaine lettuce though the butterhead lettuce had a higher cadmium content, still within the aforementioned range, for both the organic and non-organic types of lettuce

P75: A holistic approach to atmospheric chemistry
Geoff Rayner-Canham (Grenfell College, Canada)
Of all the environmental issues facing us on Earth, it is arguably the pollution of the atmosphere that is the most crucial. Yet even most physical science graduates have but a rudimentary understanding of the chemical processes involved. Teaching about the chemistry of the atmosphere is one of the most all-encompassing subjects. The course that I have developed incorporates geology, thermodynamics, kinetics, molecular orbital theory, inorganic chemistry, organic chemistry, spectroscopy, and environmental health, plus others besides. Some of the key features will be discussed.

P76: POGIL-ENVY: POGIL activities for environmental chemistry
Daniel King (Drexel University, USA)
Group activities can be used to create an interactive classroom learning environment. POGIL (Process Oriented Guided Inquiry Learning) is a pedagogical approach that uses group activities to teach content and process skills. In these group activities an initial model and a series of critical thinking questions are used to guide students through the introduction to new content. These activities have been incorporated into an environmental chemistry course to improve student engagement and learning. The first activities used were modified versions of general chemistry activities. New activities have been developed that use real-world data as the model.

The new activities also integrate more seamlessly into the corresponding lecture. One example of these new activities will be presented. In this activity, measurements of halocarbons in air and surface seawater are used to help students learn about the solubility of gases in water, including the temperature dependence of this process. Data will also be shown to demonstrate the effectiveness of the new activities.

P77: Teaching children to value solar energy

Muhamad Hugerat (The Academic Arab College For Education, Israel)

In this educational initiative, we suggest to build a real model of solar village inside the school, which uses only solar energy. These educational initiatives emphasize the importance of energy for a technological society and the advantage of alternative energy sources. In this scientific educational initiative, the pupils in three elementary schools in Israel were active participants in building systems that use solar energy to work. The study objective is to examine the educational, social and scientific impact of the initiative on students, parents and teachers and their readiness to support and participate in such educational initiative. The study results showed that the three groups highly appreciate the project educationally and socially. They feel that the execution of the initiative inside the school promotes creativity and thinking ability among students. Parents showed a great support for the project, because they see the positive impact of the project on their children's learning ability. Teachers considered this initiative quite important due to the students' interaction and interests, which leads to the success of the school. It also improves the learning skills of the students such as reading plans, executing research and writing reports.

P78: Environmental chemistry over the last four decades

Stanley Manahan (University of Missouri, USA)

Having first taught a course in environmental chemistry in 1968 that developed into a textbook published in various editions since 1972 ("Environmental Chemistry," Ninth ed., 2010), the author offers his perspectives on the development of environmental chemistry as an important part of the chemistry curriculum. Over the last four decades environmental chemistry has evolved from an earlier emphasis on pollution and its effects to the current emphasis on sustainability incorporating the concepts of green chemistry and industrial ecology. An outline of a course on environmental chemistry is presented organized on the basis of the five environmental spheres: (1) Hydrosphere, (2) atmosphere, (3) geosphere, (4) biosphere, (5) and anthrosphere (that part of the environment constructed and operated by humans). Resources for such a course and related materials pertaining to incorporation of environmental chemistry, green chemistry, and green science and technology into general chemistry and high school chemistry courses are available on the internet (see: http://sites.google.com/site/environmentalchemistry1/).

P79: The day the nylons ran in Peoria: A classroom illustration of air pollution

Dean Campbell (Bradley University, USA), Mike Hoehn (Bradley University, USA), Branden Kennedy (Bradley University, USA), Brian Maxfield (Bradley University, USA)

In 1970, deposition of fly ash from a coal-burning power plant in Peoria produced minor damage in the vicinity of the smokestack, including "runs" in the fabric of ladies nylon stockings. In this presentation, we narrate the historical event and discuss the chemistry behind the depolymerization of the nylon. Additionally, we will discuss experiments demonstrating how sulfur-based acidic vapors, similar to those produced by the combustion of coal, can dramatically attack nylon-based fabric.

P80: Including in-class environmental chemistry research projects in general and analytical chemistry courses

Ted Clark (The Ohio State University, USA)

Environmental Chemistry is an area of study capable of complementing instruction in both general and analytical chemistry courses, since this topic includes content meriting inclusion in chemistry courses (e.g. quantitative measurements, use of instrumentation) while also interesting many students due to it manifest significance. Unfortunately, the potential benefits accompanying inclusion of environmental chemistry in these courses rarely come to fruition for multiple reasons, such as overly narrow portrayals of environmental chemistry in general chemistry textbooks and the poor integration of supporting laboratory experiences. As an exemplar of how environmental, general, and analytical chemistry content may be combined, this presentation discusses the implementation of a successful in-class environmental chemistry research project over a five-year period. The evolution of the project will be discussed, from what began as a collection of independent projects in a single class to its current form as a large-scale authentic research collaboration that now includes more than 350 students each year.

2:00 PM - 5:00 PM WH-115

S13: Views from the Classrooms of Conant and Regional Award Winners

Laura Slocum (University High School of Indiana, USA)

The James Bryant Conant and ACS High School Regional Award winners are some of the best chemistry teachers in the nation. These teachers have much to share with other educators about best practices in the classroom. Winners typically have an opportunity to present an award address at ACS National and Regional meetings. But, how many of us get to hear their actual award presentations and learn from their experience? This symposium will give attendees a chance to meet and benefit from these award-winning teachers, as well as find out more about how to nominate a teacher for one of these awards and how each award selection process works.

2:00		introduction
2:05	Jeff Hepburn	P81: How to generate "chem-thusiasm"
2:25	Roxie Allen	P82: 25 years in the classroom? That is crazy!
2:45	Terri Taylor	P83: ACS national and regional awards for high school chemistry teaching: Nominations and procedures
3:05	Edmund Escudero	P84: 46 years in the classroom and counting
3:25		break
3:40	Ron Perkins	P85: 33 years of striving to maximize student learning
4:00	Kathy Kitzmann	P86: Mini labs throughout the year
4:20	Sally Mitchell	P87: Triple point: Chemist, teacher, student
4:40	Linda Ford	P88: A dynamic classroom over a 36 year career

P81: How to generate "chem-thusiasm"

Jeff Hepburn (Central Academy, USA)
A Regional and Conant Award winner will demonstrate various methods to generate "chem-thusiasm" in your classroom. This presentation will discuss and demonstrate some unique ways to excite your students and create an inquisitive classroom.

P82: 25 years in the classroom? That is crazy!
Roxie Allen (St. John's School, USA)
I never dreamed I'd still be here 25 years later. I'll share projects and labs that are my favorite, even after all these years. Hopefully I'll be around for 25 more!

P83: ACS national and regional awards for high school chemistry teaching: Nominations and procedures
Terri Taylor (American Chemical Society, USA)
The James Bryant Conant Award and the Regional Awards for Excellence in High School Teaching are designed to recognize, encourage, and stimulate outstanding teachers of high school chemistry who exhibit exceptional teaching that challenges and inspires students. This presentation will provide information on guidelines for each of these award programs. Procedures for nominations and awards will also be shared.

P84: 46 years in the classroom and counting
Edmund Escudero (Summit Country Day School, USA)
2010 marks the 46th year of my teaching chemistry. I will be sharing a couple of demos that stand out, experiments, and techniques that I have had to employ to help my students better understand chemistry.

P85: 33 years of striving to maximize student learning
Ron Perkins (Educational Innovations, Inc., USA)
Trained a chemist, equipped with two poorly taught education courses and no student teaching, Ron began teaching at a small NH school. He ended his teaching career in Greenwich, CT where in over 25 years he increased enrollment of AP Chemistry from 6 to 90, his students presented 2500 after-school, elementary science lessons and out of his classes came the first young women ever to attend the ACS International Chemistry Study Camp and to represent the USA at the International Chemistry Examination. Ron will share some of his unorthodox “teaching discoveries.”

P86: Mini labs throughout the year
Kathy Kitzmann (Mercy High School, USA)
One of the best things I've done in 36 years of teaching is to use "Mini Labs" (or lab stations) to teach a variety of chemistry concepts, in both first year chemistry and Advanced Placement Chemistry. I will present an overview of some of the experiments we've converted to this

approach.

P87: Triple point: Chemist, teacher, student

Sally Mitchell (Syracuse University, USA)

This presentation will highlight the experiences of teaching and laboratory work of the 2009 James Bryant Conant Award winner for high school chemistry teaching. Come and see how this teacher incorporates history, food science, and storytelling into her classroom.

P88: A dynamic classroom over a 36 year career

Linda Ford (The Seven Hills School, USA)

How do we keep our teaching fresh over long careers? A passion for doing science is an essential requirement. An enjoyment of teenage learners is another. I plan to share some methods that have helped me to keep my classroom lively and productive. I will include some environmental connections that I have been making over the last ten years.