# The 2012 Conference on Transforming Research in STEM Education – Poster Session #2
Wednesday June 6, 8:00 PM
Odd numbers at your poster 8:00-8:45 PM
Even numbers at your poster 8:45-9:30 PM

**1. Development of the Dominance Relationships Concept Inventory (DRCI)**

Joel Abraham, *California State University, Fullerton*
Eli Meir, *SimBio, Inc*
Rebecca Price, *University of Washington, Bothell*
Kathryn Perez, *University of Wisconsin, La Crosse*
Mike Smith, *Mercer University*
Kathleen Fisher, *San Diego State University*
Jon Herron, *University of Washington, Seattle*

The EvoCI Toolkit Working Group, supported by the National Evolutionary Synthesis Center, is developing tools to diagnose undergraduate conceptual understanding of key aspects of evolution. This poster focuses solely on the development of the Dominance Relationships Concept Inventory (DRCI). The current draft of the DRCI has 13 items with distractors linked to naïve conceptions about dominance relationships of alleles, such as linking dominance with fitness or allele frequency. Seven experts reviewed the DRCI, which is now undergoing a first round of validation with non-major and major biology students. Students complete the DRCI and explain their responses to each item. These data will help us refine the DRCI and ensure that the item options are well-aligned with expert and naïve conceptions about dominance relationships. We will follow up this stage with pilot tests of the DRCI in introductory biology courses, and hope to make it available to instructors and researchers soon.

**2. An Instrument to Uncover Students' Reasoning with Organic Chemical Spectra**

Shannon Anderson
Erika Offerdahl
*North Dakota State University*

Little work has been done in examining student reasoning about organic spectroscopy. As a result, the number of available instruments for probing students' unconscious commentary is small. Here we describe the creation and implementation of an instrument to explore students' ability to solve spectra. We adapted the 3 Phase-Single Interview Technique (3P-SIT) previously used to uncover student reasoning with visual representations in biochemistry. The first phase probes the participant's conceptual knowledge underlying a particular visual representation before being presented any representations. In the second phase the participant is given the representation to interpret, and in the third phase the participant evaluates and critiques the representation. The unique features of the 3P-SIT and the ways in which we adapted the protocol to examine students' reasoning in the novel context of organic chemical spectra will be presented.

**3. Group Work: When it Works and When it Does Not**

Janelle Arjoon
Jennifer E. Lewis
*University of South Florida*

While group work has been shown to be effective in a general sense, individual differences may lead to some students within a group participating more than others. In this study, interactions among students in a small group in General Chemistry I peer-led sessions are examined. Data was collected by video recording weekly peer-led sessions with a focus on a single small group. Arguments constructed via discourse within the student group are analyzed via a framework supported by Toulmin's Model of Argumentation. Results show that group work is a more passive experience for some students than for others, and that incidents of participation from those more passive students may be linked to more robust arguments. These results immediately suggest several possible instructor interventions.

**4. Student Thinking in Linear Algebra**

Spencer Bagley
Jeff Rabin
*University of California, San Diego*

In this work, we examine students' ways of thinking when presented with a novel linear algebra problem. We have hypothesized that in order to succeed in linear algebra, students must employ and coordinate three ways of thinking, which we call computational, abstract, and geometric. This study focuses on the variety of ways in which the computational way of thinking is used productively by honors undergraduate linear algebra students, and the ways in which they coordinate the computational mode of thinking with other modes.

**5. Disciplinary Dependence of Student Reasoning about Approximations**

Danielle Champney, *University of California, Berkeley*
Eric Kuo, *University of Maryland, College Park*

One interest of interdisciplinary research and instruction is students' application of knowledge and skills from one discipline to another. We explore this issue in the context of Taylor series expansions as approximations in the disciplines of mathematics and physics. Through clinical interviews, we illustrate the context dependence of student reasoning about these approximations - specifically the ways in which students' notions of the two disciplines drive how they engage in and reflect on the practice of approximating. Therefore, we argue that "approximation" doesn't consist only of discipline-general knowledge or skills that easily move between different disciplinary contexts, but rather that it is reasoned about differently in ways that are tied to the students' notions of the two disciplines. Toward this end, we speak not only to how students reason with approximation differently, but also why students reason differently with the concept of approximation, across these disciplinary contexts.

**6. Teaching Methods Comparison in a Large Introductory Calculus Class**

Warren Code,
Costanza Piccolo
David Kohler
Mark MacLean
*University of British Columbia*

With a modified structure for a teaching methods comparison involving a Calculus 1 student population, we have implemented a classroom experiment similar to a recent study in Physics (Deslauriers, Schelew, & Wieman, 2011): each of two sections of the same Calculus 1 course at a research-focused university were subject to an "intervention" week where a less-experienced instructor encouraged a much higher level of student engagement by design. Our instructional choices encouraged active learning (answering "clicker" questions, small-group discussions, worksheets) during a significant amount of class time, building on assigned pre-class tasks. The lesson content and analysis of the assessments were informed by existing research on student learning of mathematics. We report improved student performance, on conceptual items in particular, in the higher engagement section in both cases.

**7. Development of a Molecular Biology Capstone Assessment (MBCA)**

Brian Couch
Jennifer Knight
Bill Wood
*University of Colorado-Boulder*

Students majoring in molecular biology take a semi-prescribed series of courses aimed at helping them to master central concepts, develop practical competencies, and pursue interests in various sub-disciplines. We are developing a capstone assessment to measure how well students understand core molecular biology concepts and their ability to apply these concepts to novel scenarios. Targeted at senior-level students, this assessment has been designed to cover fundamental concepts that faculty value as essential, as determined through interviews of twenty faculty members. For each concept, we have generated multiple-response items consisting of a question stem followed by 4-5 true-false statements. This question format is aimed at better capturing the range of student thinking, including mixed conceptions, and better controlling for related knowledge that affects the ability of the student to address the core concept. Both open-ended and think-aloud interviews of students have been used to generate distractors for the questions, and the questions have been pilot-tested and refined through multiple administrations. Once complete, the MBCA will provide a tool that can be used to measure student learning and discover areas of conceptual difficulty.

**8. Case Study: Investigating the Evolution of Understanding of Function among Three Precalculus Students**

Eyob Demeke
Vince Mateescu
Anek Janjaroon
*University of New Hampshire*

Functions are a crucial topic in the study of mathematics. Research (Ferrini-Mundy & Graham, 1991; McDonald, Mathews, & Strobel, 2000) has found that a lack of deep understanding of functions is one of the main reasons why students struggle in calculus and concluded that understanding of functions is necessary for students to have a solid understanding of the sequence concept, in particular. In light of these studies, we tried to investigate, using traditional paper and pencil assessments, concept maps, and an interview, what pre-calculus students' understanding of functions is and how it evolves over a semester. We found the following: (1) as Williams (1998) suggested, concept maps do reveal something that traditional assessments do not; (2) participants do not seem to apply the definition of function they gave (which was correct); (3) some participants have trouble giving non-examples of functions; and (4) there does not seem to be a major change in participants' understanding of functions over time -- a plausible explanation why has been given in our paper. We believe that this study has the implication that concept maps have potential as a different form of assessment in school mathematics.

**9. Students' Differing Experiences in Calculus I**

Jessica Ellis
*San Diego State University/University of California, San Diego*

The number of students completing degrees in STEM continues to fall short of the demand for workers in these fields: not only are too few students pursuing STEM fields, but also many who originally intend to pursue these fields leave after introductory STEM courses. Based on data gathered in a national survey, I present an analysis of 5381 STEM intending students enrolled in introductory Calculus in Fall 2010, over 12% of whom switched out of a STEM trajectory after their experience in Calculus I. When asked why these students no longer intended to continue taking Calculus, 31.4% cited their negative experience in Calculus I as a contributing factor. In order to better understand the nature of students' classroom experience in Calculus I, I analyze how students' perceptions of their Calculus I instruction was related to their persistence in Calculus, using the instructor's description of the class as basis for this comparison.

**10. Abstraction Transition Taxonomy to Classify Summative Assessment**

Sarah Esper
Beth Simon
*University of California, San Diego*

We perform an analysis of introductory programming lecture materials to identify what knowledge and skills we ask students to acquire. We are interested in knowledge and skills as situated in the activity, tools, and culture of what programmers do and how they think. The materials analyzed are 133 Peer

Instruction lecture questions that support cognitive apprenticeship. We have developed an Abstraction Transition Taxonomy for classifying the kinds of knowing and using we engage students in as we seek to apprentice them. We find students are asked toanswer questions using and transitioning between three levels of abstraction: English, CS Speak, and Code. Through this lens we find that summative assessments tend to emphasize a small range of the skills fostered in students during the formative/apprenticeship phase. We propose a similar taxonomy can be applied to other STEM areas to enlighten instructors on what they expect their students to know and be able to do upon course completion.

**11. Assessing Calculus Knowledge**

John Gruver
*San Diego State University*

Teachers are under mounting pressure to help students gain conceptual understanding of Calculus concepts. Yet, how is a professor to assess this type of understanding? I plan to study study the aptitude of the AP test for assessing conceptual knowledge. I hope to understand the aspects of questions, which require students to go beyond a procedural understanding. In my poster presentation I will describe the design of my study and seek feedback.

**12. Connecting Calculus to Elementary Mathematics and Science: Is it Possible?**

Karen Keene
*North Carolina State University*

As part of a CCLI NSF grant, we are developing a calculus for a mathematics requirement for future elementary teachers. Our commitment is to include larger concepts that connect the calculus to science and mathematics at the elementary level. We are working at this, but the poster will show some work and hopefully get feedback to improve the work. We are particularly looking at modeling with calculus as a way to relate it to elementary math and science.

**13. Becoming Chemists and Physicists: A Community Perspective**

Sissi Li
Michael E. Loverude
*California State University, Fullerton*

When undergraduates decide on a major to declare and pursue, they are making a choice to join a professional community. This decision becomes a more concrete action and meaningful commitment as they begin their upper division major courses and begin to interact more deeply with the community. According to Wenger’s community of practice (CoP) framework, membership in a community is built on alignment of common goals and practices, active participation in social interactions, and perception of belonging in the community. In the process of completing a science major, students transition their identity towards being a member of their science field. In this study, we use the CoP lens to examine identity development in order to understand what it means for students to become chemists or physicists. We observed chemistry and physics majors in their junior level course communities and conducted individual semi-structured interviews to consider the ways in which students position themselves within the specific classroom, broader academic, and general science communities. In this poster, we present preliminary findings about the ways in which students perceive their identity and how it develops as they work towards becoming future chemists and physicists.

**14. Investigation of Instructional Strategies for Problem-centered Learning in Electrical Engineering Courses**

Jia-Ling Lin
Tamara Moore
Paul Imbertson
*University of Minnesota--Twin Cities*

In light of statistics showing shrinking enrollment in undergraduate electric energy systems curriculum, the power programs nationwide have reacted responsively. The Department of Electric Engineering at the University of Minnesota Twin Cities has provided a comprehensive plan to revamp the core courses. One of the fundamental changes in instructional approaches is to utilize problem-centered learning. Students are instructed to learn theories before coming to the class, and will solve problems with peers inside the classroom. Investigating how instructors lead discussions is the focus of our current study. A method of design-based research is applied to allow the research and instructional strategies to advance concurrently. It requires close collaborations between researchers and instructors. The study identifies the Five Practices as a basic model, and applies iterative cycles to refine theories that are used to improve practices. Instructional strategies applied in this class and their impact on students' learning will be reported.

**15. Using PER to Transform Purdue's Modern Mechanics Course**

Rebecca Lindell
John Doyle
Max Kagen
Adam Szewciw
Andrew Hirsch
*Purdue University*

Purdue's introductory calculus-based physics course, Modern Mechanics, utilizes the Matter and Interaction curriculum by Chabay and Sherwood. Incorporating the results of modern physics, this text presents an alternative approach to presenting the physics content, specifically utilizing a few fundamental principles to explain modern mechanics. In addition, students learn how to visualize physics using computational modeling. We have spent the last year researching ways to transform how we teach this course by utilizing many of the approaches developed by Physics Education Research (PER) and other education researchers. Specific interest was spent on how to make this course more interactive and integrated. In this poster we will present our research-based model for this transformed course as well as examples of the materials we have developed/ adapted for use with this course redesign.

**16. Investigating Student Understanding of the Approach to Thermal Equilibrium**

Michael Loverude
*California State University, Fullerton*

As part of an ongoing project to examine student learning in upper-division courses in thermal and statistical physics, we have examined student reasoning about the approach of macroscopic objects to thermal equilibrium. We have examined reasoning in terms of heat transfer, entropy maximization, and statistical treatments of multiplicity and probability. In this poster, we present examples of student responses from written problems and individual student interviews. Supported in part by NSF CCLI grant DUE-0817335.

**17. Resources: A Framework for Analyzing Students' Computational Modeling Practices**

Brandon Lunk
*North Carolina State University*

With the growing push to include computational modeling in the physics classroom, we are faced with the need to better understand students' computational modeling practices. While existing research on programming comprehension explores how novices and experts generate programming algorithms, little of this discusses how domain content knowledge can influence students' programming practices. Although Resource Theory, which models cognition as the activation of vast networks of knowledge elements called ``resources,'' has generally been limited to describing conceptual and mathematical understanding, it also provides a means for addressing the interaction between content knowledge and programming practices. I will present a framework for formally extending the Resource Theory to describe students' computational modeling practices.

**18. Embodied Physics Learning: Student Reasoning Differences Depend on Sensorimotor Experience**

Daniel Lyons, *University of Chicago*
Carly Kontra, *University of Chicago*
Susan M. Fischer, *DePaul University*
Sian L. Beilock, *University of Chicago*

Undergraduate students in an algebra-based introductory physics course participated in a laboratory activity designed to leverage theories of embodied cognition to improve learning about the concepts of angular momentum and torque. Students were randomly assigned to take part in laboratory activities that either physically or visually introduced them to the idea of angular momentum as a vector quantity. Quiz and homework responses were analyzed to investigate differences in student reasoning as a function of laboratory experience. Results show that differences in student reasoning may depend on access to physical, sensorimotor information acquired during the lab activity. Particularly, this appears be the case for those physics problems that require students to apply spatial temporal reasoning to the physical scenarios rather than merely applying physics concepts by rote.

**19. Problem Solving Computer Coaches: Applications for Life Science, Education Majors**

Andrew Mason, *University of Central Arkansas*
Mishal Benson, *University of Central Arkansas*
Qing Xu, *University of Minnesota, Twin Cities*
Kenneth Heller, *University of Minnesota, Twin Cities*
Leon Hsu, *University of Minnesota, Twin Cities*

Computer coaches have been designed by the Physics Education Research group at the University of Minnesota, Twin Cities to improve problem solving skills for science and engineering students. Currently these coaches are in the process of being experimentally tested in a calculus-based physics course (Q. Xu et al.). Additional branches of the study include adapting the coaches to suit the needs of a) different institution types, and b) students of other intended majors, e.g. science education majors and life science majors. At the University of Central Arkansas, algebra-based physics courses are offered to life science majors, many of whom intend to enroll in medical and similar professional schools. Students pursuing a science education degree with the intent to teach physics at a secondary school level may also benefit from the use and adoption of computer coaches in terms of teaching and learning problem solving skills. We propose to build coaches for algebra-based physics problems to address these needs, and plan to test them in a similar fashion as the currently existing set of coaches. Possible applications include adapting biologically-oriented physics problems for life science majors and designing coaches for training purposes for science education majors.

**20. Student Facility and Engagement with PhET Simulations in the Classroom**

Emily Moore, *University of Colorado, Boulder*
Timothy Herzog, *Weber State University*
Katherine Perkins, *University of Colorado, Boulder*

PhET Interactive Simulations (sims) are educational tools in which students learn through scientist-like exploration and experimentation. The PhET project has developed over 100 sims for teaching and learning physics, chemistry, biology and math. The development of PhET simulations involves an iterative design process by a team of content, pedagogical and interface experts, informed by student interviews. But does this design process result in sims that students can use and engage with in a classroom setting? We present the results of a study on the use of PhET sims (Balancing Chemical Equations; Molecule Shapes; Molecule Polarity) in three large lecture chemistry classes. Students were given 10 minutes to play with the sims in self-selected groups, without explicit instructions of how to interact with the sim. Using audio recordings, screencapture and clicker questions, we investigate student facility with the sims and ability to engage with the sims in a large lecture setting.

**21. Development of Visual Thinking Skills: An Analysis of Textbook Visualizations**

Erika Offerdahl, *North Dakota State University*
Jessie Arneson, *Illinois Central College*
Jordyn Hull, *Illinois Central College*

Visualizations are ubiquitous in science. The process by which a person extracts meaning from visualizations frequently requires one to translate across levels of organization (e.g. from the macroscopic down to the submicroscopic). While science instruction makes extensive use of visualizations in textbooks, it is unclear the degree to which they support students' abilities to reason across levels of organization. The goal of this study was to explore the degree to which textbook visualizations (1) require students to translate across levels of organization and (2) make explicit the transition between levels. Preliminary findings indicate that textbook visualizations represent only a single level per visualization. When multiple levels are represented, the relationships between levels are mostly implicit. Further, there is little progression in complexity of visualizations when comparing introductory biology to upper-level biochemistry. These results suggest that visualizations used in traditional science instruction lack the complexity necessary to explicitly support the development of visual thinking skills.

**22. It Takes a Village to Raise a Scientist**

Craig Ogilvie
Anne Powell-Coffman
Gene Takle
Tom Greenbowe
Cinzia Cervato
*Iowa State University*

The goal of our project at Iowa State University (funded by HHMI) is to increase student learning and enthusiasm for science. We are embedding inquiry activities and research projects into all our foundational science courses allowing students to experience the excitement of designing experiments to answer their questions. We are implementing changes across several departments (Biology, Chemistry, Physics, and Geology) simultaneously. Students take a network of connected courses, hence a transformed way of looking at science is reinforced and amplified in successive courses. Over 7000 students are impacted by this reform annually. As we reflect on our progress, we are forming a working hypothesis that large-scale reform requires three components, 1) community of faculty taking charge at the grass-roots, 2) energy from agents of change who have time, and 3) a network of reformed courses.

**23. Virtual Volcano: Employing Simulation-driven Inquiry in the Geosciences**

Thomas Parham
Cinzia Cervato
*Iowa State University*

Research evidence supports that, when properly designed and supported, computer simulations have the potential to improve conceptual understanding of complex systems, particularly among younger learners in the STEM disciplines. Initially driven by the results of the 2006 Volcanic Concept Survey, Virtual Volcano (V-Volcano) seeks to remediate misconceptions related to the physical dynamics of volcanism using a concept-targeted 3D computer simulation embedded within the Process Oriented Guided Inquiry Learning (POGIL) framework. For the past five years, V-Volcano has evolved through an iterative development process grounded in user-centered design practices and the emerging simulation design principles of coherence, apprehension, and guided discovery. Recent data suggests that students consistently favor the simulation-based approach, which grounds concepts in relatively concrete representations and allows direct manipulation of key variables, over a purely theoretical approach wherein key concepts would be far more abstract. Moreover, Virtual Volcano has proven effective in addressing numerous commonly held non-scientific conceptions of eruption process dynamics and promoting awareness of the natural hazards associated with volcanic eruptions across a geographically and demographically diverse sample of learners in entry-level geoscience courses.

**24. Eye-tracking Studies of Student Approaches to NMR Problems**

Norbert Pienta
Joeseph Topczewski
Anna Topczewski
Hui "Tom" Tang
*University of Iowa*

Eye-tracking studies have been used to examine the approaches of different groups (i.e., 2nd semester organic students vs organic research students) to solving NMR problems. Thus, the students are given a set of NMR spectra, each with a set of potential structures, and are asked to choose the structure that matches the spectral data.

**25. Comparing General and Organic Chemistry Content Maps: Understanding the Differences in Content Coverage**

Jeffrey Raker, *Iowa State University*
Kristen Murphy, *University of Wisconsin - Milwaukee*
Thomas Holme, *Iowa State University*

For the past 4 years, the ACS Examinations Institute has been working with college faculty to develop content maps for the chemistry disciplines. These maps begin with ten ‘Big Ideas’ that span the four-year undergraduate curriculum; three additional levels of articulation (i.e., enduring understandings, subdiscipline articulations, and content details) subdivide these ideas into discipline specific content. The General Chemistry Content Map has been published (JCE, 2012, ASAP); the Organic Chemistry Content Map will be available fall 2012. This poster will highlight the development of the content maps, note specific features of the General and Organic Chemistry Content Maps, and emphasize the differences in the content coverage between these two courses.

**26. Student Ratio Use and Understanding of Molarity Concepts Within Solutions Chemistry**

Stephanie Ryan
*University of Illinois at Chicago*

This poster presents results and conclusions about a study of student ratio use and understanding of molarity concepts within solutions chemistry. Data were collected from incoming first year students prior to start of the semester using a structured interview approach. Grounded theory was used to analyze student responses which led to theoretical statements with a focus on intensive quantities in molarity to determine ways in which conceptions of ratio affected students' understanding and use of ratio within solutions chemistry. A ratio in this context is the idea of two measured quantities in relation to each other (e.g. density is measured in grams per milliliter). An example of a ratio within solutions chemistry is molarity, which is measured in moles per liter and represented by the capital letter M. Results from this study indicate that most students did not have an intensive view of molarity but rather interpreted M to mean moles, which is an extensive quantity. This caused students to have difficulty reasoning through concentration in the Different Volume/Same Molarity (DVSM) task despite success in representing concentration as an intensive quantity qualitatively through structurally similar painted blocks tasks. Students in this study were successful proportional reasoning problem solvers in the direct proportion problems but attempted to use direct proportions for inverse relationships in the chemistry problems, which led to incorrect answers. A recommendation from this study is for instructors to make explicit connections between molarity and the structurally similar painted blocks tasks so that the intensive nature of molarity is emphasized despite its extensive-disguised singular unit (M).

**27. Effortful and Effortless Conceptual Blending**

Eleanor Sayre, *Kansas State University*
Hunter G. Close, *Texas State University*
The Conceptual Blending Group

Conceptual Blending (Fauconnier and Turner) is a cognitive theory in which thinkers generate new ideas by blending together old ideas, oftentimes successively. In one perspective, blending is ubiquitous, rapid, and requires no visible effort on the part of the thinker (Turner). In another perspective, to create and run a blend requires careful coordination of myriad resources and an attendant amount of effort on the part of the thinker (Podolefsky and Finkelstein). In this poster, we present analyses of blending from both the effortful and effortless perspectives on the same piece of data: a student making sense of harmonic motion on a rotating platform.

**28. Use of CMS for data collection in a GOB course**

Lianne Schroeder
Ginevra Clark
*University of Illinois, Chicago*

Course management systems (CMS) are an important component of many university classes. While grade management and online homework management are two commonly used features of many CMS, other features may help in the improvement of learning environments. A little used feature of our CMS (Blackboard) was used to implement weekly student surveys in an organic and biochemistry course for allied health majors. Surveys were intended to serve multiple purposes including: weekly feedback regarding different components of the course, encouraging student reflection, and providing information to be used in the redesign and updating of the course. Using early analysis of a full semester of class level data, this poster will discuss the potential of using on-going class survey to support active student learning and to gather qualitative research data.

**29. Extended Research Modules in Chemistry Laboratory Courses: Description and Impacts**

Michael Slade
Keith Woo
Nicola Pohl
Craig Ogilvie
*Iowa State University*

In an effort to engage students with more compelling laboratory coursework early in their academic careers, and without the self-selection process that is often the norm, extended research modules have been developed and piloted in laboratory courses for chemistry and related majors at Iowa State University. The first, for first-year students in an advanced general chemistry course, is related to the professor's research interest in the electrochemical reduction of carbon dioxide to ethylene and other useful hydrocarbons. The second module, for an organic laboratory course, is a 'research-like' experience which aims to simulate a typical synthetic research laboratory: a novel target has been selected, but the students must find and modify literature procedures to attempt a synthesis of the target. The projects will be described and the preliminary analyses of their impacts on students' understandings of the nature of science and their expectations for learning chemistry will be presented.

**30. Expanding and Sustaining Research Capacity in Engineering and Technology Education**

Karl Smith, *University of Minnesota*
Ruth Streveler, *University of Minnesota*
Robin Adams, *Purdue University*

Research capability-building project focused on: (1) Designing and delivering a new generation of programs to educate engineering and engineering technology faculty and graduate students to conduct and use educational research which are effective, flexible, inclusive, and sustainable after funding ends, (2) Fostering a virtual community of engineering and engineering technology education researchers through the use of Purdue HUBzero-based technology, and (3) Conducting evaluation on the impact of these programs on individuals who participate and on the participants' students and institutions.

**31. Level of Inquiry of Laboratories Published in Science Education Journals**

Marilyne Stains
*University of Nebraska-Lincoln*

One of the factors involved in closing the gap between science education research and instructional practices in science courses in higher education is instructors' access to research-based instructional materials. The main resources for college-level materials are professional organization, peer-reviewed education journals, which mainly publish laboratory experiments. Science education research has shown that inquiry-based rather than traditional experiments are more effective in developing students' understanding and reasoning skills. In this study, we investigate the level of inquiry of laboratory experiments published in the Journal of Chemical Education, Physics Teacher, and the American Biology Teacher from 2000 to 2010. The level of inquiry is characterized with a published rubric. Preliminary findings (N=173 articles) indicate that over 80% of the laboratories described in the chemistry and physics journals are at the lower levels of the inquiry scale, while the biology journal contains the highest proportion of open-ended inquiry laboratories.

**32. Math Preparation of Undergraduates in General Chemistry**

Cynthia Stanich
Colleen Craig
Sarah L. Keller
*University of Washington*

Gatekeeper courses for undergraduates wishing to pursue careers in biophysics and other STEM fields include introductory chemistry, physics, and biology. At the University of Washington, as at many other peer institutions, a high level of math is required for enrollment in main sequence General Chemistry. Specifically, students must have fulfilled a calculus requirement or be co-enrolled in calculus. Moreover, the average high school GPA of freshmen entering directly from high school is 3.7. Nevertheless, we find that significant fractions of students enrolled in General Chemistry are unable to complete problems in which they are asked to manipulate exponents (~20%), logarithms (~40-50%), or probabilities (~40%). Researchers at University of Minnesota have documented similar results [Leopold and Edgar, 2008, Chemical Education Research 85:724]. We find that some math deficiencies among undergraduates persist into the senior year, at least for biochemistry majors. Here we track undergraduate math competencies through the first two academic terms of General Chemistry after introducing an intervention of a math quiz and feedback. We separately track competencies after student use of a program called ALEKS, which uses adaptive questioning to determine student competencies and then instruct on deficient topics.

**33. Development of a Card-Sorting Task to Investigate Novice-to-Expert Transitions in Undergraduate Biology Education**

Kimberly Tanner, *San Francisco State University*
Elijah Combs, *San Francisco State University*
Julia I. Smith, *Holy Names University*

University biology education is aimed at producing students who possess biology expertise. However, little is known about the extent to which biology majors develop biology expertise during their undergraduate years. Expertise has been described in cognitive psychology as not only knowledge within a discipline, but also the structure of that knowledge. To investigate expertise in undergraduate physics, Chi and colleagues developed a task in which participants sorted physics problems into groups (Chi, 1981). These researchers demonstrated that physics novices sorted problems based on “surface” features (e.g. pendulum problems), while physics experts sorted problems based on “deep” features (e.g. Newton’s first law problems), suggesting differences in how these populations structured their knowledge of physics. Using theoretical frameworks and methodologies from cognitive psychology, we have developed a card-sorting task to investigate differences in novice and expert thinking in undergraduate biology education. Biology problems were adapted from undergraduate textbooks, such that each card represented both a hypothesized “surface” feature and a hypothesized “deep” feature of biology. This novel card-sorting task was conducted with non-biology majors, entering biology majors, advanced biology majors, and biology faculty from a small, private college and a large, public university. Multiple analyses of card-sorting task results will be presented.

**34. Assessment opportunities and challenges in the FIU science collaborative**

Adrienne Traxler
Laird H. Kramer
Eric Brewe
David Brookes
Ophelia Weeks
Joseph Lichter
*Florida International University*

The FIU Science Collaborative Project is an HHMI-funded effort to transform undergraduate science education in biology, chemistry, and physics. Each year a cohort of Faculty Scholars propose how they will reform a course that they teach. To implement that reform, scholars receive financial support and the science education expertise of the FSC co-directors, who come from all three departments. They also benefit from the presence of undergraduate Learning Assistants in their classroom. The project encompasses course reform efforts in a variety of contexts, from introductory non-science majors through near-graduation STEM majors. In many cases, there are no research-based curricula that faculty scholars can simply adopt wholesale. Measuring the effects of course transformation on students and faculty also faces a paucity of research-based assessments. While these are challenges, they also provide opportunity for faculty scholars to explore reform more deeply as they build it from the ground up.

**35. Conceptualizing “Disciplinary” in Research and Design of Interdisciplinary Learning Contexts**

Chandra Turpen
Vashti Sawtelle
Julia Svoboda
Edward F. Redish
*University of Maryland, College Park*

Our interdisciplinary team of scientists and educational researchers has begun the daunting task of thoughtfully redesigning and researching the transformation of an introductory physics course for biologists. We are constantly faced with making decisions about how the disciplines of physics, chemistry and biology are being portrayed in our tasks as well as in classroom discussions. As Strober (2011) says, “They [disciplines] provide not only ‘a conceptual structure,’ but also ‘an instructive community’ and ‘a communication network,’ as well as a ‘cultural system’ and a sense of personal identity.” This poster will discuss various lines of rhetorical argumentation for conceptualizing “disciplines” in the context of interdisciplinary learning articulating both literature bases one might draw from as well as analytical approaches one might take in current on-going research efforts. We present a framework which relies on two particular dimensions. First, “who is characterizing the discipline?” for example, social scientists, natural scientists, or students. Secondly, “what disciplinary activities are being examined?” such as a) the talk and practices of professionals or disciplinary experts, b) the preparation of newcomers into the discipline, or c) out-of-school, informal, or everyday contexts.

**36. Implementing Problem-solving Discussion Sections in First Semester Organic Chemistry**

Sarah Wilson
Pratibha Varma-Nelson
Robert Minto
Ryan Denton
*Indiana University Purdue University, Indianapolis*

The Department of Chemistry and Chemical Biology at IUPUI serves approximately 500 first semester organic chemistry students annually. A problem-solving workshop series was added to the course to improve exam performance, reduce an undesirable DFW rate, and boost student perceptions. To increase student engagement in their own learning processes, we borrowed principles from the Peer-Led Team Learning model, which has proven to be effective in organic chemistry and other STEM courses.

However, our workshop series included a smaller student-to-peer leader ratio and problems are based on content discussed by the lecturers in advance. Our peer-led problem-solving discussion sections were organized as a 75-minute additional meeting for this 3-credit first semester organic chemistry course and fostered the development of small-group learning communities that extend outside the lecture, developed mentoring relationships, and promoted active group learning. Moreover, we lowered the DFW rate and increased student performance on the ACS Organic Chemistry exam.

**37. Internet Computer Coaches for Introductory Physics Problem-Solving**

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Based on the theory of cognitive apprenticeship and the research on expert problem solving frameworks, some internet based computer coaches were developed at the Physics Education research group at the University of Minnesota. Experimental studies are also to be conducted to test the effectiveness of the computer coaching tutorial. The students' problem solving ability is measured by using a problem-solving rubric that was developed by our physics education research group.

**38. Why is This Sentence True: Learning to Read a Textbook**

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Students have difficulties comprehending science texts. The interrogation method, which prompts students to read sentences from the text and answer, "Why is this true?" has been developed to enhance students' ability to read science texts. To enact this method, instructors must choose sentences that are both important conceptually and deeply able to be interrogated (interrogatable). We explored the use of this method in an introductory physics course for non-physics majors. The teaching assistants (pre-service teachers), learning assistants (undergraduates who took the course last year), and the course instructor chose sentences for each chapter of the text, and the students were asked to interrogate 2-4 of the sentences each chapter. We analyzed the conceptual importance of the sentences and their interrogatability, based on underlying epistemologies. We then interviewed the course instructor to determine how he chose the interrogatable sentences. Based on analysis of the chosen sentences and interview responses, we developed a model for choosing productive sentences to interrogate.