CULTURAL PERSPECTIVES ON LEARNERS' PERFORMANCE & IDENTITY IN PHYSICS

PHYSICS EDUCATION RESEARCH CONFERENCE
AUGUST 1–2, 2012
PHILADELPHIA, PA

PERC 2012: Schedule

Wednesday, August 1

3:30 – 6:00	AAPT/PERC Bridging Session	Inn at Penn Woodlands Ballroom
6:00 – 6:30	Poster Set-up	Houston Hall Hall of Flags
6:30 – 8:00	PERC Banquet	Sheraton Ben Franklin Ballroom
8:30 – 10:30 *8:30 – 9:30* *9:30 – 10:30*	Contributed Poster Session *Odd-numbered posters* *Even-numbered posters*	Houston Hall Hall of Flags

Thursday, August 2

7:30 – 8:15	Breakfast	Sheraton Ben Franklin Ballroom
8:15 – 10:45	Morning Plenary Session	Sheraton Ben Franklin Ballroom
11:00 – 12:30	Morning Parallel Sessions	Sheraton Breakout Rooms
12:30 – 2:00	Lunch	Sheraton Ben Franklin Ballroom
2:00 – 3:30	Afternoon Parallel Sessions	Sheraton Breakout Rooms

PERC 2012:
Cultural Perspectives on Learners' Performance & Identity in Physics

As new research questions have emerged related to the variability of student reasoning and practices across contexts, the community has begun to attend to the relevance of culture and identity in physics learning. In conducting this work, the PER community has begun to draw from fields such as social psychology, anthropology, linguistics, and sociology along with new methodologies associated with these fields.

In particular, these fields offer new ways of thinking about performance. For example, achievement on various assessment instruments (such as FCI, problem-solving tasks, etc.) is a student performance that researchers and instructors commonly focus on. However, other student performances, such as how students talk and participate in ongoing classroom activities, can also offer valuable sources of evidence about understanding and development. Often, careful consideration of these different performances suggests different accounts of student understanding that are in tension with each other (or seemingly incongruent). Socio-cultural theoretical and methodological tools are useful in developing robust and coherent accounts of student understanding that span these different contexts.

The PER community has also begun to explore identity as a lens for understanding student development and participation in physics. Students' past patterns of engagement with other communities may offer productive resources for engaging in disciplinary practices. Similarly, students' engagement with other communities may also sit in tension with typical school science. From a socio-cultural perspective, identity is constantly a work in progress and enacted with others in cultural activities. This perspective draws attention to the fact that the people and artifacts around you influence (and therefore are partially responsible for) your identity and the performance enacted. Examining and characterizing identity in these ways involves drawing on data beyond the individual and using methodological tools that can account for this broader scope.

One of our goals in this conference is to highlight these emerging research directions and draw attention to the theoretical tools and methodological considerations of cultural practice perspectives on learning and performance. This conference will bring in national experts from these fields as plenary speakers, exemplify how these perspectives shape the methods, claims, and analyses of learning environments, and work to foster integration of these theoretical and methodological perspectives into the work of the PER community.

Organizers:
Ayush Gupta
Eleanor Sayre
Chandra Turpen
Jessica Watkins

Additional information on the PERC website:
http://www.per-central.org/perc/2012/

PERC 2012: Table of Contents

PERC 2012: Plenary Speakers

Megan Bang, University of Washington

Megan Bang is an Assistant Professor in Learning Sciences and Human Development at University of Washington's College of Education. Bang received her Ph.D. in 2008 from the Northwestern University School of Education and Social Policy. Her dissertation explored the kinds of explanations, arguments, and attentional habits Native American children are exposed to and learn in community settings as they relate to school science learning. Her current research follows this work, examining the ways in which culture – understood as a diverse repertoire of practices individuals and community engage in – impact learning, development, and teaching in science education. Towards these ends, Bang is engaged in three primary lines of work, including: 1) the study of learning and development in everyday contexts across cultural communities using interdisciplinary approaches and methods including basic cognitive studies, field studies, ethnography, and indigenous and critical methodologies, 2) design research – in her case community-based design research – that builds learning environments from community-based epistemologies; and as a result of 2, 3) the study of child and teacher learning in novel environments. The combination of these three strands of scholarship work towards issues of equity and transformation in teaching and learning.

Indigo Esmonde, University of Toronto

Indigo Esmonde is an Assistant Professor with the Department of Curriculum, Teaching, and Learning at the Ontario Institute for Studies in Education at the University of Toronto. Esmonde's research is situated at the intersection of two fields of study: the learning sciences, and equity studies. Broadly speaking, researchers in the learning sciences consider the process of learning in a wide variety of contexts, while those in equity studies consider the ways in which schools and other institutional contexts perpetuate inequitable relations of power in society, and how to subvert and challenge these injustices. Dr. Esmonde's research at the intersection of these two fields has focused on learning mathematics across a variety of contexts, both inside and outside schools, and considers issues of power and identity in mathematics teaching and learning. This research is framed primarily through sociocultural and cultural-historical theories of learning, and draws from a variety of research methods, including ethnographic, discourse analysis and conversation analysis, and video interaction analysis.

Kris D. Gutiérrez, University of Colorado at Boulder

Kris D. Gutiérrez is Professor of Learning Sciences and Literacy and holds the Inaugural Provost's Chair at the University of Colorado, Boulder. She is also Professor Emerita of Social Research Methodology at GSE&IS at UCLA. Gutiérrez is a member of the National Academy of Education and is the Past President of the American Educational Research Association and the National Conference on Research on Language and Literacy. Gutiérrez was recently appointed by President Obama and confirmed by the U.S. Senate to be a member of the National Board for the Institute of Education Sciences. Her research examines learning in designed learning environments, with particular attention to students from non-dominant communities and English learners. Her work on Third Spaces examines the affordances of hybrid and syncretic approaches to literacy, new media literacies, and STEM learning and the re-mediation of functional systems of learning. Her work in social design experiments seeks to leverage students' everyday concepts and practices to ratchet up expansive forms of learning. Gutiérrez has used her expertise to improve the educational condition of immigrant and underserved students in out of school and formal schooling settings and to design effective models for expansive learning and teacher preparation. For over 15 years, Professor Gutiérrez served as the principal investigator and director of an after-school computer learning club for low-income and immigrant children (UCLinks, Las Redes) and for over ten years was the Director of the UCLA Migrant Scholars Leadership Program, a residential summer academic program for high school students from migrant farmworker backgrounds. Currently, she directs El Pueblo Mágico, a STEM oriented change laboratory for K-5 children that focuses on design and building computational thinking. These programs have been touted as exemplary models of excellence and transformative change.

Reed Stevens, Northwestern University

Reed Stevens is a Professor of Learning Sciences at Northwestern University. His research examines and compares cognitive activity in a range of settings including classrooms, workplaces, and science museums. On the basis of this comparative work, he is exploring new ways to conceptualize cognition and organize learning environments. Stevens' specific interests include how mathematical activity contributes to various settings and how technology mediates thinking and learning. His multidisciplinary research draws on cognitive science, interactionist traditions, and the social studies of science and technology. To understand learners' naturally-occurring activities, he collects audio-video records of people working and analyzes them with a variety of methods adapted from cognitive science, science studies, and ethnomethodology/conversation analysis, in addition to long-term ethnographic fieldwork and interviewing. He also designs curriculum, activities, and technologies, including Video Traces software that allows people to collect digital video clips and annotate them with talk or gestures.

PERC 2012: Plenary Sessions

AAPT/PERC Bridging Session: 3:30-6:00, Wednesday

Inn at Penn, WoodlandsBallroom
Discussant: David Hammer, Tufts University
Moderator: Leslie Atkins, California State University, Chico

Where do physics students come from and what do they become? A look at knowledge and identity pathways through and beyond school experience

Reed Stevens, Northwestern University

Abstract: In this talk, I will present a perspective that conceptualizes learning in cultural practice terms. Cultural practices are differently 'sized' patterns of interaction among people and things to which people orient and hold each other accountable. Learning then involves coming to participate in these patterns of interaction and undergoing possible changes to body, mind, and identity in the process. Cultural practices are often knotted together to make normative cultural paths, through and around which people traverse specific pathways.

Drawing on a conceptual framework for studying young people's learning pathways toward "becoming" engineers (Stevens et al., 2008), this presentation will examine the knowledge and identity formation processes in everyday physics, physics education, and professional physics. I will consider an additional dimension of importance, how people individually and with cultural support, navigate through sanctioned institutional passage points and rituals. I will use this framework to generate a set of future-looking questions for physics learning and physics education research.

Stevens, R., O'Connor, K., Garrison, L., Jocuns, A. & Amos, D. (2008). Becoming an Engineer: Toward a three-dimensional view of engineering learning. Journal of Engineering Education, 97, 355–368.

Practice-Linked Identities, Social identities, and Mathematics Learning

Indigo , University of Toronto

Abstract: I will talk about two different ways of thinking about identity as it relates to learning, and discuss the importance of integrating both perspectives. First, I'll talk about practice-linked identity: a sense of self that develops through participation in a set of cultural or collective practices. These identities are shifting and changeable, and are developed in relation to other people in the context. Second, I'll talk about social identity: a sense of self --or a perception of others -- based on socially meaningful categories like race or gender. These identities are seen as quite static (although they may not be experienced that way) and are related to broader systems of oppression in society. I will give examples from my research in mathematics education, and discuss how these concepts can be useful in the study of physics education.

PERC 2012: Plenary Sessions

Morning Plenary Session

Sheraton, Ben Franklin Ballroom
Discussant: Noah Finkelstein, University of Colorado at Boulder
Moderator: Hunter Close, Texas State University–San Marcos

Cultural variations in epistemological orientations: Impacts on knowledge, meanings, and reasoning about the natural world

Megan Bang, University of Washington

Abstract: Increasingly, learning scholars have focused on how race, culture and class have been used to define deficit-oriented discourses about students from non-dominant communities understandings, thinking, experiences, and language use (e.g., what comprises an effective explanation or convincing data; what "smart" looks and sounds like) and restrict the intellectual opportunities these youth have to learn in school (e.g. Lee, 2009; Gutierrez et. al, 2009; Barton & Tan, 2008). We have sought to understand how these issues place epistemological demands on Indigenous students, specifically in thinking and sense-making about the natural world towards the goal of creating more affective learning environments. Through a micro-analysis of two contexts, one an informal interaction between a child and their parent, and one in a learning environment, I explore how relational epistemologies, and variations in causality and inference are embedded in these issues and raise questions and possibilities in the design of learning environments.

When Everyday and Scientific Concepts Grow Into One Another: Syncretic and Connected Learning

Kris Gutiérrez, University of Colorado at Boulder

Abstract: As schools become increasingly irrelevant to meaningful learning for young people, they also fail in fulfilling their social equalizing agenda. There is a growing disconnect between the interests and everyday practices of our nation's students and formal schooling's approaches to engaging them in rigorous, meaningful, and relevant learning. Of concern, there are social and cognitive, as well as personal, institutional, and economic consequences to disconnected learning. Today's students move across a range of contexts and produce artifacts that reflect the intercultural, hybrid, and multimodal practices of which they are part. These repertoires developed across the ecologies of interest and everyday life should be cultivated as important dimensions to consequential learning. From a cultural historical learning perspective, transformative learning involves shifts between and across new combinations of contexts and tools that can be leveraged across ecologies and domains of learning (Engeström, 2003; Gutierrez, 2008). Drawing on the best of what we know about how people learn, this paper focuses on how we can ratchet up learning across a range of ecologies by designing openings and forms of support that create opportunities for new learning pathways into the future. In particular, it focuses on the affordances of syncretic and connected learning approaches in supporting the development of toolkits that have utility across tasks, purposes, disciplinary boundaries, learning environments, and future-oriented trajectories and identities.

PERC 2012: Morning Parallel Sessions

Innovations and Issues with Conceptual Assessments

Poster Symposium – Ben Franklin Ballroom V

Organizers: Rebecca Lindell, Purdue University and Lin Ding, The Ohio State University

Abstract: This symposium is focused on cutting edge research concerning conceptual assessments. It brings together four developers of concept inventories and the work they are doing probing new areas of interest in the development, use and dissemination of said assessments.

Adopting Theories and Methods from Outside PER

Poster Symposium – University II

Organizers: Noah S. Podolefsky and Katherine K. Perkins, University of Colorado, Boulder

Abstract: PER has grown by drawing on theories and methods in cognitive science, psychology, sociology, and other fields outside of physics. PER has assembled these various perspectives into its own approaches to education research. In this session, presenters will describe their recent efforts to bring new approaches from outside of PER to their work. While varied in content, these efforts will converge along several themes: the scope, power, and limitations of these new-to-PER perspectives, as well as alignment between theory and methods. Presenters will discuss the process of adopting outside theories and methods to PER specific research problems. Participants can gain insight into the specific theories and methods used by presenters. Following the conference theme, we also hope to present a general case for how PER can benefit and grow by following its own tradition of looking outside itself.

Shaping Identity through Membership in Communities

Poster Symposium – Fairmount I

Organizer: Vashti Sawtelle, University of Maryland, College Park

Abstract: What do American cookies, Korean immigrants, Danish networks, and chemistry students have in common? Work on identity often focuses on how an individual perceives oneself without drawing attention to the role that an individual plays in larger community contexts. However, alternative interpretations on identity focus on the role of positioning within communities and how identities are shaped by interactions with members of those communities. This targeted poster session will focus on understanding what it means to be a part of a community of scientists and learners. The posters presented in this session use a variety of methodological tools and analytic lenses to investigate how communities form and invite members to participate. Each of the presenters will discuss the role that participation in these communities play in the shaping of identity for individuals and for the communities themselves.

Cultural Influences on Physics Teaching: Identifying Factors, Implementing Change

Poster Symposium – Fairmount II

Organizer: Natan Samuels, Florida International University

Moderator: Benedikt Harrer, University of Maine

Abstract: Members of the PER community have recently been using classroom culture as a lens to examine current pedagogies, as well as to develop new and effective instructional methods. As such, many researchers are asking what makes classroom cultures productive? What beliefs, commitments, discourses, and practices do students and instructors bring into classrooms? How is the creation of a culture negotiated between its members? This session seeks to address these questions by presenting new findings from various physics learning contexts. Attendees will learn about: the influences of urban undergraduates' cultural background on teaching and learning physics, how a high school teacher's responsiveness to students' learning preferences changed her classroom instruction, how a group of physics graduate students enacts undergraduate courses that reflect their affirmative value system, and how evidence-focused labs and adaptations to a research-based curriculum influenced high school students' participation in scientific discourse. An interactive discussion will follow the presentations.

PERC 2012: Morning Parallel Sessions

Next Generation Science Standards and the Physics Education Research Community
Roundtable Discussion – Penn II
Organizer: Scott Bonham, Western Kentucky University
Abstract: The Next Generation Science Standards (NGSS) are currently under development by a multi-state collaboration. The NGSS are structured around core ideas in each discipline, cross-cutting concepts, and science and engineering practices. These standards will direct future state wide assessments and therefore K-12 science and physics instruction. Experience has shown that standards and the corresponding assessments can bring about both positive change and unintended consequences in K-12 physics education, is affected by the preparation of teachers, curricular materials available, and methods of assessment. In this roundtable discussion, we will collectively explore the impact of standards and assessment, discuss to what extent the educational goals of the PER community align with those of the NGSS, think about ways the NGSS could be leveraged to address our goals of improving physics education, and identify research, teacher preparation, materials and assessment development activities the community might undertake to support good adoption of the NGSS.

Reading of Scientific Texts as Means of Exposing Students to Authentic Disciplinary Practices
Talk Symposium – University I
Organizers: Shulamit Kapon, Tel Aviv University and Edit Yerushalmi, Weizmann Institute of Science
Discussant: Ruth Chabay, North Carolina State University
Abstract: How to bridge the dynamics of scientific discoveries with teaching in an introductory physics classroom is a long standing challenge. In chemistry and biology the incorporation of scientific articles in the high school curriculum is a subject of recent inquiry and interest, whose goal is to expose students to authentic scientific processes and facilitate their enculturation into the discipline. However, such scientific texts are hardly ever included as part of introductory physics courses. This session presents examples of how physics instruction can integrate readings of scientific texts at the introductory level. The readings discussed here encompass contemporary research papers adapted to the introductory level, historical lab-notebooks and popular scientific articles of famous scientists, and computational codes. The session and the related discussion aim to scrutinize the instructional affordances of various types of scientific texts, the adaptation and instructional use of each kind, and the learning that takes place.

Video Analysis Workshop: Reconciling Cognitivist and Interaction Analysis Methodologies
Workshop – Chestnut
Organizers: Ayush Gupta and Andy Elby, University of Maryland, College Park; David Hammer, Tufts University; and Reed Stevens, Northwestern University
Abstract: Within learning sciences, tensions sometimes arise between researchers espousing cognitivist versus interactionist perspectives. Broadly speaking, the cognitivist perspective conceptualizes learning as changes in the form and content of knowledge in the head. The interactionist perspective, on the other hand, conceives of learning as a social phenomenon, embodied in the learners' talk, action, and interaction with other living participants and materials in a setting. This workshop is aimed toward the goal of seeking reconciliation between the perspectives. We will show two video clips, excerpts from video-taped problem solving done during a (i) clinical interview and a (ii) classroom small-group discussion. During the first half of the workshop, participants will unpack the phenomena observed in the videos. We expect that as a result of this observational emphasis, the participants, to varying degrees, will attend to the content of students' knowledge as well as to features in the interaction that become salient to the activity, including affect and situational identity. The second half of the workshop will be used for sharing and synthesizing analysis and comments, and reflecting on whether and how such close analysis of unfolding activity draws on and contributes to both perspectives.

Supporting and Sustaining the Holistic Development of Students into Practicing Physicists
Workshop – Penn I
Organizers: Corinne A. Manogue, Elizabeth Gire, and Mary Bridget Kustusch
Abstract: This workshop expects to leverage the broad expertise inherent in the PERC community to begin structuring a research agenda that might guide future efforts to support the holistic development of students into practicing physicists. Participants will brainstorm the following questions in small groups and synthesize the results as a whole group. Conclusions will be summarized for the community in a proceedings paper.

1) What concepts, habits of mind, skills, and representations thread through the sub-disciplines of upper-division physics?
2) What are the characteristics of curricula that scaffold student acquisition of these concepts, habits of mind, skills, and representations throughout the upper-division?
3) What aspects of institutional culture might facilitate the development, support, and sustainability of these curricula?
4) What models of research are currently available to address the questions above and where are new models needed?

Social Hierarchies and Accessibility in Physics
Poster Symposium – Fairmount I
Organizer: Geoff Potvin, Clemson University
Moderator: Robynne Lock, Clemson University
Abstract: The establishment of hierarchical social structures, either explicit and conscious or implicit and unconscious, can hinder student participation resulting in their marginalization and disengagement. As part of the regular process of education, students experience social hierarchies in their studies stemming from aspects of their "invisible backpacks" and from day-to-day experiences in the classroom. In this symposium, we explore how social hierarchies arising from both of these sources are formed and the implications for student engagement with physics, physics identity development, and physics participation. In the former case, the impacts of sociocultural factors (including immigrant generation and college generation) are examined with respect to physical science career interests. In the latter case, the effects of teacher practices including positioning and authoritativeness on student engagement and attachment to physics are studied. These results are important for understanding how social hierarchies can impede entry into physics-related fields and how to address these concerns.

Learning Assistant Model Variation and Emulation: Toward a National Research Agenda?
Poster Symposium – Fairmount II
Organizers: Valerie Otero and Kara E. Gray, University of Colorado at Boulder
Abstract: The Colorado Learning Assistant model has demonstrated effectiveness in improving learning gains, improving student attitudes, and in better preparing teachers to teach in K-12 schools, through CU Boulder studies. In this session, we explore the replication of such studies at other universities as well as the development of explanatory models for LA program effectiveness. Posters will present traditional measures of program effectiveness such as learning gains, attitudes, and DFW rates as well as how these measures play out with populations traditionally underrepresented in physics. Further, by in-depth case studies of LAs' experiences, their experiences in the pedagogy course, and their written and verbal reflections, we establish models of identity through participation that can help us understand why the program is effective and what it truly affects. Ultimately, by critically evaluating traditional measures of program effectiveness in light of explanatory models of LA program effectiveness, we seek to establish an agenda for future research on personal and social elements that are critical to the success of an LA-style program, or any program that capitalizes on the development of identity through participation.

Research on the Learning and Teaching of Thermodynamics: Insight from Many Perspectives
Poster Symposium – University II
Organizer: Warren Christensen, North Dakota State University
Abstract: Investigations into how what we should be teaching students about thermodynamics, when it should be taught, and how they think about it has occurred among middle school students up through physics faculty. This session collects a cross-section of some of this rich work for a holistic view of what we're trying to understand through our research in this area and what methods and frameworks can be employed to parse this significant area of research. Synergies across these invited posters will enrich our perspectives on the content itself, how others understand it and how we can effectively analyze it.

Logistics of (Inter)National Database of Assessment Results
Roundtable Discussion – Penn II
Organizers: DJ Wagner, Grove City College and Sam McKagan, American Association of Physics Teachers
Abstract: The PER community has long been in need of a database where teachers can upload student scores on PER-based assessment instruments and get analysis of their results along with peer group averages to use as a measure of comparison. Such a database would also be a boon to researchers who could have access to large amounts of data from diverse institutions. The PER User's Guide (http://perusersguide.org) and Grove City College are collaborating to develop an assessment results database. Before putting this database on line, however, many logistical issues need to be addressed: usability, privacy concerns, IRB approval, authenticating users, concerns of assessment authors, etc. Anyone interested in providing input and feedback on this project is welcome to join the dialogue.

Finding a Home for All of Myself: Intersectionality in Identity Formation for Women of Color in Physics
Talk Symposium – University I
Organizer: Apriel K. Hodari, Council for Opportunity in Education
Discussant: Megan Bang, University of Washington
Abstract: Intersectionality, coined by Kimberle Williams Crenshaw (in law) and pioneered by Patricia Hill Collins (in sociology), posits that minority women's experiences can amount to "greater than the sum of racism and sexism" (Collins, 1989; Crenshaw, 1989; Wei 1996). In this symposium, we will present four papers on the application of intersectionality to identity formation for women of color in physics. Katemari Rosa focuses on the life story of a single woman, as a vehicle for understanding intersectionality in physics identity formation. Angela Johnson and Heidi

Carlone will apply their authoring science identity model to physics, illustrating intersectionality as an analytical tool. Lily Ko and Maria (Mia) Ong analyzed intersectionality in the lives of 23 women of color in physics and physics-related fields. Rachel Kachchaf, Apriel Hodari and Lorelle Espinosa discuss how these collective works inform politics and policy in the current STEM-focused education policy context.

Identifying Identity: Using Video Analysis to Track the Dynamics of Students Identities in the Learning of Physics
Workshop – Chestnut
Organizers: Luke Conlin and Lama Jaber, Tufts University
Abstract: This workshop concerns analytical and methodological challenges related to studying identity in physics learning. Identity encompasses macro-level categorizations (e.g., gender, ethnicity, academic major, etc.) as well as micro-level dynamics in face-to-face interactions. Here, we use video analysis to explore the intersection of macro/micro notions of identity, as they play out moment-to-moment in physics learning. We will consider the following questions: How do we identify and characterize markers of identity in video data? How do we bound salient moments where students' identities are influencing their interactions and vice versa? How do we empirically support claims pertaining to the role of identity in learning? We will approach these questions through collaborative viewing and analysis of video from classrooms and interviews. We begin with a large group discussion, followed by breakout sessions where participants work in small groups to analyze clips provided by collaborating researchers currently studying issues of identity in physics learning.

Beyond the Physics Classroom: Exploring Disciplinary Factors that Influence Students' Reasoning about Approximation, through Video Data
Workshop – Penn I
Organizers: Danielle Champney, University of California, Berkley and Eric Kuo, University of Maryland, College Park
Abstract: Physics students are not only taking physics. When examining how students reason with concepts and tools in physics, it is productive to consider their reasoning and experiences with those same concepts and tools in other disciplines. An ongoing interdisciplinary research program is investigating students' reasoning about approximation, and the perceived discipline- and context-dependent factors that influence their choice and evaluation of different approximation practices. Interviewed students reasoned through a number of approximation problems designed to cue experiences from either math or physics.
In this workshop session, participants will collaboratively explore students' orientations to Taylor series approximation through video interview data. The session will be grounded in the exploration of the many different ways that student strategies and approximation practices are tied to the disciplinary commitments that they perceive in physics and mathematics contexts, and how those perceptions drive students' engagement in and reflection on the practice of approximating, in general.

PERC 2012: Invited Symposia Abstracts

Innovations and Issues with Conceptual Assessments

A web-based take-home FCI?

Lin Ding, The Ohio State University and Rebecca Lindell, Purdue University

Abstract: Many physics instructors are interested in using the FCI to evaluate their courses, but are concerned about losing valuable class time in administering it. To meet this need, there are now several web-based versions of the FCI available, which instructors can assign as either in-class or out-of-class assignments. To be able to compare results of the web-based FCI and the original FCI, the equivalency between the two versions must first be established. As a first step in establishing this equivalency, we analyzed a 4000+ student database of one version of the web-based FCI. Students, who completed this version of the FCI, completed it on their own time prior to beginning their first semester of an engineering program at a large Midwestern university. Results of this analysis will be presented.

Expanding access to assessing conceptual understanding: ciHub.org, a virtual community supporting conceptual learning

P.K. Imbrie and Teri Reed-Rhoads, Purdue University

Abstract: Transforming learning environments for science, technology, engineering, and mathematics (STEM) students requires merging of theories of learning and state-of-the-art assessment tools that allow faculty to identify patterns of conceptual understanding and misconceptions. Conventional measurement/evaluation approaches typically do not help faculty discover the extent to which students have actually acquired conceptual fluency within a particular subject. To this end, STEM disciplines are increasingly using Concept Inventory (CI) assessment to measure the value added to student learning through new methods of teaching important material.

The paper describes the creation of a virtual community referred to as ciHUB.org, which is a cohesive, borderless community of CI developers, researchers, faculty and students. This national/international collaborative effort was created to support both: a) continued development, refinement, analysis, and application of multiple CI instruments; and b) engagement of the engineering STEM education community in productive conversations about assessing and improving conceptual understanding.

Cross-Concept Inventory Research Starting with the Force Concept Inventory

Teri Reed-Rhoads and P.K. Imbrie, Purdue University

Abstract: In today's globally-engaged and technology-rich educational environments, an online resource where concept inventory (CI) developers and users can access, discuss, develop, and refine concept inventories and their uses is a needed resource. ciHUB.org meets this need by providing a shared space to researchers and users where inventories can be uploaded and focused discussions can ensue. Because a wide variety of different CIs can be gathered in this one-stop virtual community, the gathering of data across multiple CIs and longitudinal tracking of student learning is now possible. Therefore, this type of community facilitates research not just within a specific topic area relative to a specific CI, but it also allows research between CIs. For example, the Force Concept Inventory might be the correct pre-test to the Concept Assessment Tool for Statics, typically a second-year course in the engineering curriculum. This type of research could have larger implications as CI development progresses into upper division course content.

Establishing Reliability and Validity: an Ongoing Process

Rebecca Lindell, Purdue University and Lin Ding, The Ohio State University

Abstract: Establishing validity and reliability is a necessary step in any conceptual assessment instrument. But once validity and reliability are established, it is not the end of the story. Reliability and validity are not an inherent property of the assessment instrument or its individual items, but something that must be reestablished with any changes of the instrument items, order, administration techniques or population being studied. In this paper we will discuss how validity and reliability can be established or reestablished. We will also discuss common instances in instrument development and use that requires reliability and validity to be reestablished.

Adopting Theories and Methods from Outside PER

Implicit Scaffolding: Blending Vygotsky with Human Computer Interaction

Noah Podolefsky and Katherine K. Perkins, University of Colorado at Boulder

Abstract: Computer simulations are increasingly popular teaching and learning tools among physics educators. In this poster, we present implicit scaffolding, a theoretical framework that underlies the design of PhET simulations. This framework is based on the tool-mediated learning theory of Vygotsky and the affordance-constraint theory of Norman, a pioneer in human-computer interaction. While developed in the context of computer simulations, implicit scaffolding also lends itself well to non-computer-based learning tools, such as lab equipment or textbooks. We will demonstrate the use of implicit scaffolding with cases of middle school students building circuits using both a simulation and real equipment. 6th grade students were readily able to build working circuits using both the simulator and real equipment

with little to no instructions. Our central claim is that learning tools designed according to implicit scaffolding can "guide without students feeling guided," allowing students to feel a heightened sense of ownership and agency.

Six Degrees: Social Network Analysis in PER

Eric Brewe, Florida International University

Abstract: We recount research questions and theoretical motivations that led us to adopt network analysis in understanding the formation of a learning community as an illustrative example of Social Network Analysis (SNA) as applied to PER. Social Network Analysis (SNA) and the more general form, Network Analysis, are a set of representational and quantitative tools that can be used to identify patterns among complex, interconnected data. Thus the methodology is well suited seeking patterns among humans engaged in learning within a disciplinary context as we pursue in PER. Two recent papers in PRST-PER [1,2] reflect the flexibility of NA, drawing on different data types (transcripts and surveys), and addressed very different questions (community and epistemic development). While this methodology is well established in other fields, it remains in its infancy in PER; thus the limitations are not well known nor are the approaches clearly fruitful as applied to learning.

[1] E. Brewe, L. Kramer, and V. Sawtelle, "Investigating student communities with network analysis of interactions in a physics learning center," Phys. Rev. ST Phys. Educ. Res. 8, (2012).

[2] M. Bodin, "Mapping university students' epistemic framing of computational physics using network analysis," Phys. Rev. ST Phys. Educ. Res. 8, 010115 (2012).

Promoting proximal formative assessment with relational discourse

Rachel Scherr, Seattle Pacific University; Hunter G. Close, Texas State University–San Marcos; and Sarah B. McKagan, American Association of Physics Teachers

Abstract: The practice of proximal formative assessment – the continual, responsive attention to students' developing understanding as it is expressed in real time – depends on students' sharing their ideas with instructors and on teachers' attending to them. Rogerian psychology presents an account of the conditions under which proximal formative assessment may be promoted or inhibited: (1) Normal classroom conditions, characterized by evaluation and attention to learning targets, may present threats to students' sense of their own competence and value, causing them to conceal their ideas and reducing the potential for proximal formative assessment. (2) In contrast, discourse patterns characterized by positive anticipation and attention to learner ideas increase the potential for proximal formative assessment and promote self-directed learning. We present an analysis methodology based on these principles and demonstrate its utility for understanding episodes of university physics instruction.

Using Activity Theory to Understand Technology in the Classroom

Edward Price, California State University San Marcos

Abstract: Research-based innovations in physics education often restructure social interactions in the classroom and introduce new tools. Assessments such as pre-post testing can provide an overall evaluation of these changes, but do not provide insight into the process by which they are enacted. Activity theory provides a framework for understanding the complex classroom situation through structured attention to roles, rules or norms, community, and tools. Activity theory is particular useful in diagnosing failure modes and understanding unexpected outcomes. I will describe how activity theory can be used to understand efforts to support interactive pedagogy with technologies such as digital cameras, photo sharing websites, and in-class videos of experiments. I will characterize the circumstances under which innovations in pedagogy and technology support each other, leading to results that would not have been possible with either alone.

Modeling Middle Student Learning with Cognitive Developmental Psychology

Nicole Hallinen, Stanford University

Abstract: Cognitive developmental psychology often seeks to describe students' qualitative understanding of physical phenomena. In turn, educators can use this research to improve instruction. Siegler (1981) developed the "rule assessment" model for characterizing children's development of multi-factor reasoning. By conceptualizing a multi-factor domain as a phenomenon comprised of dominant and subordinate factors, this model analyzes students' responses to discern whether their thinking appropriately includes neither factor, only one factor, or the relationship between both factors. Students' rule levels can then be used in future analyses. Here, we provide several examples and a demonstration of how we have used this method with middle-school students who learned about torque, projectile motion, and collisions using different instructional methods around simulations. We show how the technique helps characterize various levels of qualitative reasoning, how these relate to quantitative reasoning, and how the method helps pinpoint the factors students attend to in their reasoning.

Shaping Identity through Membership in Communities

Cookies as agents for community membership

Idaykis Rodriguez, Renee Michelle Goertzen, Eric Brewe, and Laird Kramer, Florida International University

Abstract: When becoming a member of a community of practice, a novice must adopt certain community norms to participate, and these include the social norms of the group. Using the analytical perspective of Legitimate Peripheral Participation in a Community of Practice, this paper explores the social role of cookies as agents for community participation and membership in one physics research group. We analyze data from an ethnographic case study of a physics research group weekly research meeting. The mentors bring cookies to each meeting and view the cookies as a token of appreciation for the graduate students' work. These cookies take on a subtler role of initiating guests and students into scientific conversations and participation. Via the cookies, members also share personal histories and stories that help members validate their participation. The study of social norms in this research group is part of a larger study of physics expert identity development.

Identities in identity research in science education: What should we study

Minjung Ryu, University of Maryland, College Park

Abstract: In the present study, I define identity as a type of personhood--the ways in which an individual and surrounding people view the person--that the individual develops as participating in various local, social practices. In science classrooms, students shape their identities along various dimensions, such as identity in relation to the classroom community, science, and racial, ethnic, and linguistic groups. These multiple identities are not independent but often intertwined. An analysis of a-year-long ethnographic study in a high school biology class shows how Korean immigrant students' identities with respect to their immigrant status and language use influence the ways in which they participate in science classroom practices and their participations are perceived. Findings of the study suggest that students' classroom participations and identities in a classroom community should be understood in conjunction with their identities along other social dimensions that are locally constructed.

Identifying community structure in multiple networks: Academic and social aspects of learning behaviour

Jesper Bruun, University of Copenhagen

Abstract: Science researchers have been concerned to understand the ways in which science learning and social relationships are connected. Networks of social interactions have preciously been used to get snapshot pictures of broad aspects of student interactions. Here, I include (1) multiple interaction categories and (2) student self reports of these multiple interaction categories over a period of a semester to create sequences of different types of specific academic and social networks. The cohort is primarily first year physics majors from a Danish university. Once established, a cluster algorithm splits each network into groups of students. The stability across categories and time of groups as well as the attributes of students in each group characterize the cohort as a set of communities of practice. Seen in this way, the networks investigate the dynamics of quantifiable aspects of communities of physics learners in a particular setting.

Identity and belonging: Are you a physicist (chemist)?

Sissi L. Li and Michael E. Loverude, California State University, Fullerton

Abstract: When science undergraduates begin their upper-division coursework, their declaration of major becomes more concrete and meaningful as they have opportunities to interact more deeply with the community of their chosen discipline. In the process of completing a major, students transition their identity towards being a member of their field. In Wenger's community of practice framework, community membership is built on alignment of common goals, participation in social interactions, and perception of belonging in the community. But what does it mean to be a chemist or physicist from the students' perspective? In this study, we examine junior-level chemistry and physics majors' ideas about their science identity through semi-structured interviews and prompted reflective journals. We compare and contrast how chemistry and physics students negotiate their identity as members in their disciplinary field in terms of practice, qualifications, attitude, and in relation to other STEM communities.

Cultural Influences on Physics Teaching: Identifying Factors, Implementing Change

Instructional Changes Based on Cogenerative Physics Reform

Natan Samuels, Eric Brewe, and Laird Kramer, Florida International University

Abstract: We describe changes in a physics teacher's pedagogy and cultural awareness that resulted from her students' involvement in reforming their classroom. For this case study, we examined a veteran high school teacher's semester-long use of CMPLE (the Cogenerative Mediation Process for Learning Environments) in her Modeling Instruction classroom. CMPLE is a formative intervention designed to help students and instructors collaborate to change classroom dynamics, based on how closely the environment matches their learning preferences. Analysis of classroom videos, interviews, and other artifacts indicates that adapting the environment to align with the preferences of that shared culture affected the instructor in complex ways. We will trace her teaching practices and her self-

described awareness of the culture of learning, to highlight notable changes. The teacher espoused deeper understanding of her students' physics learning experience, which she gained from including students in responding to their own individual and collective learning preferences.

Cultural Toolkits in the Urban Physics Learning Community
Mel Sabella and Andrea G. Van Duzor, Chicago State University
Abstract: Chicago State University has been involved in curriculum development, teacher preparation, and education research that target urban physics learners on the south-side of Chicago. Through this work we have begun to recognize specific cultural norms that our students bring to the classroom. These cultural norms appear to help our students establish strong communities in classes. Because of the homogeneity of our population, with most students coming from within a five-mile radius of our campus, there are a set of shared experiences that help establish a level of trust and sense of community that manifests itself in the science learning environment. Aspects of community also play a major role in the preparation of teachers. In this talk we discuss our understanding of CSU student culture, its importance in the development of community, and its role in our physics classrooms as well as its role in the preparation of future physics teachers.
Footnotes: Supported by the NSF Noyce Program (DUE # 0833251) and a PhysTEC Grant from the American Physical Society.

Building Classroom and Organizational Structure Around Positive Cultural Values
Joel Corbo, Dimitri Dounas-Frazer, and Anna Zaniewski, University of California, Berkeley
Abstract: The Compass Project is a self-formed group of graduate and undergraduate students in the physical sciences at UC Berkeley. Our goals are to improve undergraduate physics education, provide opportunities for professional development, and increase retention of students--especially those from populations typically underrepresented in the physical sciences. Compass fosters a diverse, collaborative student community by providing a wide range of services, including a summer program and fall/spring seminar courses. We describe Compass's cultural values, discuss how community members are introduced to and help shape those values, and demonstrate how a single set of values informs the structure of both our classroom and organization. We emphasize that all members of the Compass community participate in, and benefit from, our cultural values, regardless of status as student, teacher, or otherwise.

Critical Classroom Structures for Empowering Students to Participate in Science
Shelly Belleau, University of Colorado at Boulder and Mapleton Expeditionary School of the Arts
Abstract: We compared contextual characteristics that impacted the nature and substance of "summarizing discussions" between a physics and a chemistry classroom in an Hispanic-serving urban high school. Specifically, we evaluate structural components of curricula necessary to develop a culture of critical inquiry. Through implementing the Physics and Everyday Thinking (PET) curriculum in the physics course, we found that students' participation in summarizing discussions demonstrated critical thinking, critical evaluation, and use of laboratory evidence to support ideas. We then implemented a model similar to PET in the chemistry course. However, chemistry students' participatory statements lacked evidence, opposition and critical evaluation, and required greater teacher facilitation. We hypothesize that the designed laboratories and the research basis of PET influenced the extent to which physics students verbalized substantive scientific thought, authentic appeals to evidence, and a sense of empowerment to participate in the classroom scientific community. Classroom data and teacher reflections will be discussed.
Footnotes: Supported by the NSF Noyce Program (DUE # 937941)

Reading of scientific texts as means of exposing students to authentic disciplinary practices

Constructing conceptual meaning from a popular scientific article – The case of E=mc^2
Shulamit Kapon, Tel Aviv University
Abstract: Although Israeli high school physics students solve problems using the expression E=mc2, the origin of this expression and its deep conceptual meaning are hardly ever discussed due to students' limited prior knowledge. In 1946, a year after the atomic bombs were first dropped, Albert Einstein published a popular scientific article explaining the equivalence between mass and energy to the general public and the implications of this principle for our daily lives. This paper describes the utilization of Einstein's article in a high school physics lesson. It discusses the instructional affordances of exemplary popular scientific texts through an analysis of students' learning, in comparison to previous studies on the instruction and learning of the equivalence of mass and energy, and in relation to features of exemplary popular scientific writing reflected in Einstein's article. The research is supported by a Marie Curie International Outgoing Fellowship within the 7th European Community Framework Program.

Using scientists' notebooks to foster authentic scientific practices
Leslie J. Atkins and Irene Y. Salter, California State University, Chico
Abstract: Scientific Inquiry is an introductory undergraduate course for preservice elementary teachers that aims to engage students in authentic scientific practices where these practices are not viewed as a mere course requirement, but are understood as essential practices for constructing knowledge in the discipline. Many of these practices (e.g., representational practices, control-of-variables) evolve over the course of the semester as we work to answer complex questions. However, we hoped to have students- from the start of the term- keep detailed scientific notebooks. In this presentation, we describe an activity designed to foster practices related to the use of scientific notebooks, detail how we use images from scientists' notebooks, discuss the rubrics students create for their own notebooks, and share outcomes, including images of students' notebooks and students' reactions to the activity. Funding provided by NSF #0837058.

Reading computational code to inform predictions of time-varying computational models
Shawn Weatherford, Saint Leo University and Ruth Chabay, North Carolina State University
Abstract: Computational code is a different type of scientific text, where code defining physics quantities and principles is commingled with functions defined by the programming language. In a recent study, physics students were asked to read through computational code and draw a prediction of the visual output produced by short example programs written in VPython. These example programs strategically omit key lines of code representing fundamental physics principles. Student drawings and discussions reveal how students worked together to interpret the lines of code that constrain the motions of 3D objects in the visual output. Student predictions blend together information from the computational code with knowledge about the motion of real-world physical systems. We will present the example program code, some select student data, and the modifications to the instructional task that incorporate these findings.

Students' comprehension of a research article adapted for an interdisciplinary high school program
Elon Langbeheim, Sam Safran, and Edit Yerushalmi, Weizmann Institute of Science
Abstract: We present a study of the introduction of Adapted Primary Literature (APL) as part of a high school course on soft matter. APL is a text genre that allows students to comprehend a scientific article, while maintaining the core features of the communication among scientists, thus representing an authentic scientific discourse. We describe the adaptation of a research paper by Nobel Laureate Paul Flory on phase equilibrium in polymer-solvent systems. The adaptation followed two design strategies: a) Making the interplay between the theory and experimental evidence explicit. b) Re-structuring the text to map the theory onto the students' prior knowledge. Specifically, we map the modeling of polymer-solvent system onto a model for binary mixtures of small molecules that was already studied in class. We then present findings regarding the students' comprehension of the APL and its purpose and discuss their ability to extract features of theoretical modeling embedded in it.

Social Hierarchies and Accessibility in Physics

Obscuring power structures in the physics classroom: Implications for student engagement and physics identity development
Zahra Hazari, Clemson University, Robynne M. Lock, Cheryl A. P. Cass, and Carrie Beattie
Abstract: Many students are disempowered in physics classes finding them to be more difficult, unpleasant, narrow, and masculine when compared to other subjects. Such disempowerment can lead students to limit their engagement and rely on rote learning strategies. This study explores how physics teachers can help students engage with the material and develop their physics identities by obscuring traditional classroom hierarchies. Employing a positionality lens on case studies of four high school physics teachers, we coded teachers' behavioral cues that contributed to the relationship structure in the classroom. Our findings suggest that teachers' physical cues (space and hierarchical stance occupied), structural cues (dynamic nature of the classroom allowing alternating roles), contextual cues (including students' thoughts and experiences), and social cues (obscuring traditional boundaries between teacher and student) affect the social distance between the teacher, students, and content. This social distance can moderate students' level of engagement and ultimately their physics identity development.

Measuring the impact an instructor's words has on student engagement and responses
Dedra Demaree, Oregon State University, Saalih Allie, and Sissi Li
Abstract: From fall 2008 to fall 2010 extensive data were collected within the large-lecture introductory calculus-based physics course at Oregon State University for the purpose of measuring the efficacy of course reform and studying student identity development in learning communities. Simultaneously, data were collected at the University of Cape Town in a completely un-related study, also within a large-lecture introductory course, but for understanding how students make sense of measurements in the laboratory. Trends seen in both of these settings led to an in-depth analysis of the wording used by the instructor to introduce in-class activities or phrase questions to probe student understanding. We found strong correlations between authoritativeness of statements and a reduction in student

engagement in both environments. This poster briefly presents the results of these studies, proposes a model for understanding this effect from a cognitive perspective, and ties the findings to the literature on identity and community.

Welcome to America, Welcome to College: Comparing the effects of immigrant generation and college generation on physical science career intentions

Florin Lung, Clemson University, Geoff Potvin, Gerhard Sonnert, Philip M. Sadler

Abstract: Students enter college with social, cultural, and economic resources (well described by Bourdieu's concepts of habitus and capital) which significantly impact their successes, goals, and actions. Two such sociocultural dimensions are students' immigrant generation and college generation status. The two principal conceptualizations of immigration are: a bottom-up model in which new immigrants start at society's lowest echelons and work their way upwards, and an "immigrant advantage" model, which posits that immigrants have specific values, skills, and beliefs which provide social advantages. Our prior research found first generation immigrants were significantly more likely to choose physical science and engineering majors. Here, drawing on a national sample of 7505 freshmen enrolled in college English, we compare and contrast the effects of immigrant generation with college generation status to explore some of the challenges faced by the first in the family to become an American and/or go to college.

Research on the learning and teaching of Thermodynamics: Insight from many perspectives

An Expert Path Through a Thermo Maze

Mary Bridget Kustusch, Corinne Manogue, David Roundy, and Tevian Dray, Oregon State University

Abstract: There have been several studies in recent years that have demonstrated that upper-division students struggle with partial derivatives and the complicated chain rules ubiquitous in thermodynamics. We asked several experts (primarily faculty who teach thermodynamics) to solve a challenging and novel thermodynamics problem to understand how they navigate through this maze. What we found was a tremendous variety in solution strategies and sense-making tools, both within and between individuals. This case study focuses on one particular expert: his solution path and use of sense-making tools. This expert was also asked to work the same problem using differentials (an approach taught in the Paradigms in Physics: Energy and Entropy course). This presentation will also discuss his reflections on how a differential method compared to his own approach and on the utility of using differentials in teaching undergraduates.

Conserving energy in physics and society: Creating an integrated model of energy and the second law of thermodynamics

Abigail Daane, Stamatis Vokos, and Rachel E. Scherr, Seattle Pacific University

Abstract: Entropy is typically not a central focus either in introductory university physics textbooks or in national standards for secondary education. However, entropy is a key part of a strong conceptual model of energy, especially for connecting energy conservation to energy degradation and the irreversibility of processes. We are developing a conceptual model of entropy and the second law of thermodynamics as they relate to energy, with the goal of creating models and representations that link energy and entropy in a meaningful way for learners analyzing real-life energy scenarios. We expect this model to help learners better understand how their everyday experiences relate to formal physics analyses. Our goal is to develop tools for use with elementary and secondary teachers and secondary and university students.

Identifying Student Difficulties with Conflicting Ideas in Statistical Mechanics

Trevor I. Smith, Dickinson College, John R. Thompson and Donald B. Mountcastle, University of Maine

Abstract: In statistical mechanics there are two quantities that directly relate to the probability that a system at a temperature fixed by a thermal reservoir has a particular energy. The density of states function is related to the multiplicity of the system and indicates that occupation probability increases with energy. The Boltzmann factor is related to the multiplicity of the reservoir and indicates that occupation probability decreases with energy. This seems contradictory until one remembers that a complete probability distribution is determined by the total multiplicity of the system and its surroundings, requiring the product of these two functions. We present evidence from individual and group interviews that students knew how each of these functions relates to multiplicity but did not recognize the need to combine the two to characterize the physical scenario.

They still remember what I never taught them

Michael Loverude, California State University Fullerton

Abstract: 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 the current poster, we present student responses from a set of interviews completed 1-2 years after students had completed the thermal physics course. Students gave a variety of responses, but most students gave answers that did not correspond to the models that they had been taught in the course.

LA Model Variation and Emulation: Toward a National Research Agenda

Learning assistants in University Physics: Initial replication results and effect on underrepresented populations
Paul M. Miller, Jeffrey S. Carver, Aniketa Shinde, Betsy Ratcliff, and Ashleyn N. Murph, West Virginia University
Abstract: During the 2011-2012 academic year, West Virginia University began a learning assistants (LA) program in its introductory calculus-based physics course targeted at increasing course effectiveness and recruiting future STEM teachers. The LA program was modeled after the Colorado Learning Assistant model. This poster describes the setting and initial results from the implementation including changes in learning gains (measured with the FMCE) and attitudes (measured with the CLASS). These data are combined with demographic data about the individual students and compared to baseline data collected during the spring semester of 2011. Particular attention is paid to whether the changes in the modified course have affected under-represented populations in physics any differently from the overall effect in the course.

A Framework for Assessing Learning Assistants' Reflective Writing Assignments
Geraldine L. Cochran, David T. Brookes, Eric Brewe, and Laird H. Kramer, Florida International University
Abstract: At Florida International University we have implemented a learning assistant program (LAP) based on the Colorado Learning Assistant Model.[1] As a part of this program, students take a course on science and mathematics education theory and practice in which they are required to submit written reflections. The purpose of this study is to determine if students' writing assignments provide evidence that they are reflecting on their teaching experiences and to characterize the different ways in which they reflect on those experiences. In our investigation we adapted a rubric from Hatton and Smith[2]. We show how this rubric helps us to categorize the depth of student reflections and provide them with constructive feedback.

Understanding the Learning Assistant Experience with Physics Identity
Eleanor Close, Hunter Close, and David Donnelly, Texas State University–San Marcos
Abstract: Learning Assistants (LAs) have been shown to have better conceptual understanding and more favorable beliefs about science than non-LAs, and are more likely to choose a career in K-12 science teaching [1]. We propose that connections between elements of identity, persistence, and participation in an LA program can be explained using the concept of the community of practice and its intimate relationship to identity [2]. In separate work, Hazari et al. found that physics identity was highly correlated to expressed career plans in physics [3]. We hypothesize that a thriving LA program has many features of a well-functioning community of practice and contributes to all four elements of physics identity: personal interest, student performance, competence, and recognition by others. We explore how this analysis of the LA experience might shape decisions and influence outcomes of adoption and adaptations of the LA model.
[1] Otero, Pollock, & Finkelstein, Am. J. Phys. 78 (11), 1218-1224 (2010).
[2] Wenger, Communities of Practice: Learning, Meaning, and Identity. (Cambridge Univ. Press, 1998).
[3] J. Res. Sci. Teach. 47 (8), 978-1003 (2010).

Impact of the Learning Assistant model on DFW rates in Introductory Physics Courses
George Ortiz and Valerie Otero, University of Colorado at Boulder
Abstract: The Colorado Learning Assistant (LA) model transforms large-enrollment undergraduate courses using talented undergraduate STEM majors to facilitate small-group interaction among enrolled students. The Colorado LA model has proven to be effective in increasing learning gains in LA-supported transformed courses and LAs themselves have been shown to outperform their peers in upper division courses. The LA model has also proven to be successful in recruiting talented physics majors to teaching careers and positively impacting their K-12 instruction. In this study we evaluate the impact of the LA model on the percentage of students who receive a final grade of D, final grade of F, or withdraw (DFW) from introductory physics courses at the University of Colorado-Boulder. Results will be reported and discussed.

Teaching to Learn: Exploring the Experiences of First-Time Learning Assistants
Kara E. Gray and Valerie Otero, University of Colorado at Boulder
Abstract: This paper explores, from the participants' perspective, the Colorado Learning Assistant program. Case studies of four first-time physics LAs are analyzed to understand the expansion and evolution of their views on good teaching, and their understanding of student learning. Findings suggest that through participating in teaching activities, LAs tend to move toward of view of teaching and learning focused on students' construction of physics content, and teaching strategies that are adapted to individual students. We conclude that the repetition of thinking about how students learn, constructing interventions, and reflecting on the results of their actions leads LAs to converge on certain ways of behaving and talking that are more closely aligned with the goals of the LA program. We hypothesize that pedagogical concepts such as formative assessment and dialogic discourse made available through the pedagogy course assist greatly in students' convergence on desired practices.

When Former LAs Teach the LA Pedagogy Course: An insider's perspective

Ian Her Many Horses and Valerie Otero, University of Colorado at Boulder

Abstract: At the University of Colorado Boulder, the LA program has grown to the point that we now run 3 sections of the LA pedagogy course. This poster is presented by a former LA, now a doctoral student in Computer Science Education, who is now teaching and modifying the LA pedagogy course at CU Boulder. As one of the first LAs for the Applied Mathematics department, a unique perspective is brought to the LA pedagogy course which was initially designed by a physics education researcher and a high school physics teacher. Since the pedagogy course reaches diverse STEM student majors, the course must continually be made relevant for all students. Here we present a unique perspective from two angles: (1) from the angle of a computer science/math major teaching in what was a physics-centric LA pedagogy course and (2) the perspective of a former LA who is now taking action toward educational change. Finally, we discuss this final measure of success of the LA program that is rarely discussed in the literature: the recruitment of LAs into advanced doctoral programs in STEM education as they establish their agenda for educational change.

Finding a Home for All of Myself: Intersectionality in Identity Formation for Women of Color in Physics

Identity and Belonging: Experiences of a Black Woman Physicist

Katemari Rosa, Columbia Teachers College

Abstract: Physics is a collaborative scientific endeavor where the community decides not only what physics is but who physicists are. This community has a set of rituals and traditions that allow those who pass and learn them to be considered a peer. These practices were forged in a fashion that traditionally excluded women, in particular women of color. However, there are women of color who managed to make part of the world of physics, either by learning the rules or breaking them, creating new ones, and contributing to a new physics. Through storytelling, this work focuses on the trajectory of a Black woman towards the construction of her identity as a physicist and how she became part of this community.

Authoring Identity Amidst the Treacherous Terrain of Physics: A Multiracial Feminist Examination of the Journeys of Women of Color

Angela Johnson, St. Mary's College of Maryland; Jaweer Brown, EngenderHealth; Heidi Carlone, University of North Carolina at Greensboro; and Azita Cuevas, New York University School of Medicine

Abstract: The study of the identity processes of women of color in science-based fields helps us (a) find ways to support similar women, and (b) study the dynamics of inequity, within and beyond science. Participants in this study (a Black woman, a Latina, and an American Indian woman) survived inadequate high schools and discouraging college science departments to win formal recognition (fellowships, publications). Qualitative methods were designed around multiracial feminist theory and Black feminist precepts of caring and personal accountability, the use of concrete experience and of dialogue. Participants reported conflicts between their identities as women of color and as credible science students, and having racist, sexist identities ascribed to them. All became more adept at fending off negative ascription and all found settings with less identity conflict; their ability to read a situation and quickly adjust helped them survive. But the fact that they needed to do this is unjust.

Narratives of the Double Bind: Intersectionality in Life Stories of Women of Color in Physics, Astrophysics and Astronomy

Lily Ko and Maria Ong, TERC

Abstract: This paper presents themes on the life stories of women of color in physics, astronomy and astrophysics. Drawing from our NSF-sponsored project, Beyond the Double Bind: Women of Color in STEM, we share findings from 10 interviews and 41 extant texts (covering 23 women in varied life stages). Employing interactional theory and narrative analysis, our study contributes a critical analysis of how the intersection of gender and race affects performance, identity, achievement and overall career and education experiences in the physical sciences. Our findings both support the literature on women of color in STEM, as well as bring to light unique issues, such as the importance of outside activism and outreach, and career-life balance issues. This research will add to the knowledge base about strategies for retaining women of color--widely considered an untapped source of domestic talent that could fill the country's scientific workforce needs.

Dispatches from the Front Lines: Evidenced Takeaways for Politics and Policy

Rachel Kachchaf, TERC; Apriel K. Hodari, Council for Opportunity in Education; and Lorelle Espinosa, Abt Associates

Abstract: Traditionally, many programs and policy interventions focused on improving the academic success of women and minorities in STEM are grounded largely in the good intentions and social justice motivations of program leaders and policymakers. Meanwhile, research on effective intervention strategies has been meager, as are evidence-based policy prescriptions or legislative actions. In this paper, we will discuss how research such as the papers presented in

this session can be (and recently have been) applied during the current STEM-focused education policy context, often in unexpectedly political ways. While we applaud both the political energy and growing opportunities directed toward STEM education and careers, including considerable focus on broadening participation in these fields, we observe greater increases of linguistic sophistication than in substantive and progressive policy intervention. We will provide examples of evidenced takeaways for politics and policy which promote success for all participants in the STEM education and careers.

Contributed Poster Locations

Presenter	Location	Contributed Poster Title
Wendy Adams	P20	Student Conceptual Understanding of Electrostatic Potentials and Views About Learning
John M. M. Aiken	J11	Understanding Student Computational Thinking with Computational Modeling
John M. M. Aiken	J12	Integrating Numerical Computation in the Modeling Instruction Curriculum
Jasmine Angelie V. Albelda	K1	Difficulties of Selected Physics and General Science Students of Philippine Normal University in Electricity and Magnetism
Patricia E. Allen	N3	Can laboratory reform survive the economic downturn?
Patricia E. Allen	P5	The Pre-Health iCollaborative Project: How can AAPT and PER help?
Maria Paula Angarita	O1	Instructor Prompting Mechanisms and Student Participation in a Reformed Classroom
Bijaya Aryal	J16	Investigating Patterns and Use of Students' Self-Created Equation Sheets
Leslie J. Atkins	N2	Representing Energy for a Physics of Processes & Causation
Gordon J. Aubrecht, II	D3	Learning about anthropogenic climate change
Charles Baily	F1	Research-Based Materials and Assessments for Upper-Division Electrodynamics
Rabindra R. Bajracharya	J3	Investigating students' understanding of the Fundamental Theorem of Calculus
Brent W. Barker	N1	Assessing student learning of error propagation in the undergraduate lab
Kimberley Barnes	P9	Evidence of Change in Teacher Pedagogy Observed Through a Cogenerative Process
Pablo Barniol	K8	Students' Difficulties Interpreting the Torque Vector in a Physical Situation
Alex Barr	B10	Conceptual Blending in Physics Problem Solving
Azael Barrera	K12	Introduction of Physics Studio Teaching in Panama

Contributed Poster Locations

Presenter	Location	Contributed Poster Title
Ramón S. Barthelemy	D10	The Research Subfield Choice of Women in Academic Physics: A Pilot Study
Stephen Bartos	M4	Do You Show What You Know? An Examination of Physics Teachers Subject Matter Structures and Their Classroom Practices
Ian D. Beatty	K13	Improving physics instruction by analyzing video games
Yoav Bergner	E11	Multidimensional Student Skills from Collaborative Filtering
Jennifer Blue	D9	Self-Efficacy in Introductory Physics in Students at Single-Sex and Coeducational Colleges
Scott Bonham	P3	Evaluation of a multiple goal revision of a physics lab
David T. Brookes	P1	Using collaborative group exams to measure students' ability to learn
Timothy Brown	E6	Changes in students' epistemologies
Juan R. Burciaga	F8	Textbook Design: An Exploration of Pedagogical Properties
Marcos D. Caballero	J2	Towards a framework on the use of mathematics in physics
Tom Carter	C10	Winter Break Effect in CLASS
Deepa Chari	L7	Postgraduate researchers experiences of nanotechnology research - a phenomenological examination
Norma M. Chase	F10	Does requiring online Mastering Physics homework improve student learning?
Evan Chase	G26	Evidence of Embodied Cognition via Speech and Gesture Complementarity
Zhongzhou Chen	G32	The impact of visual representation on knowledge activation during problem solving
Ying Chen	B3	An epistemic game for answer making
Jacquelyn J. Chini	A1	Alignment of TAs' Beliefs with Practice and Student Perception

Contributed Poster Locations

Presenter	Location	Contributed Poster Title
Ximena Cid	G26	Is There a Relationship Between Students' Spatial Ability and Success in STEM Courses?
Jessica W. Clark	I5	Comparing Student Conceptual Understanding of Thermodynamics in Physics and Engineering
Hunter G Close	G25	Nested coordinates in graphical representations in physics
Eleanor Close	A8	Understanding the Learning Assistant experience with Physics Identity
Kim Coble	L9	The Big Ideas in Cosmology: Investigating Student Understanding and Developing a Research-Based Curriculum
Geraldine L. Cochran	A7	A Framework for Assessing Learning Assistants' Reflective Writing Assignments
Vincent Coletta	C6	Motivation and Learning
Abigail Daane	L2	Conserving energy in physics and society: Creating an integrated model of energy and the second law of thermodynamics
Melissa Dancy	O4	The influence of students on the practices of new faculty implementing research-based instructional strategies
Dedra Demaree	C5	Leveraging nanotubes to tackle low student motivation in vectors and coordinate systems in intro physics
Lin Ding	C9	A Cross-grade Comparison of Student Views about Learning Physics
Jennifer Docktor	G19	Eye-gaze patterns while interpreting kinematics graphs
David Donnelly	B7	Factors Contributing to CLASS Shifts in a General Education Physics Course
Robyn Donnelly	D12	Role of Assessment Type on Gender Disparity in Undergraduate Physics Performance
Andrew W. Dougherty	G30	Effect of Online Pretests on Performance in Inquiry Based Physics
Scott S Douglas	C1	Computational Modeling as a Promoter of Cognitive Transfer: Pilot Study
Jason E. Dowd	P17	Exploring design in the introductory physics laboratory

Contributed Poster Locations

Presenter	Location	Contributed Poster Title
Benjamin W. Dreyfus	I6	Students' Interdisciplinary Reasoning about "High-Energy Bonds" and ATP
Archana Dubey	K2	Investigation of Students' Understanding of Magnetic Forces and Problem-Solving Skills
Michael Dugdale	P13	Oops, I think I've Flipped my Classroom
Jared Durden	P12	Pilot Testing of the Modeling Instruction Curriculum
Ben Van Dusen	G29	Using Screencasting on iPads to Alter High School Student Roles
Jennifer L. Esswein	M3	Effect of Science Professional Development Program on Classroom Instruction
Gerald Feldman	D1	Is Conceptual Understanding Compromised by a Problem-Solving Emphasis in an Introductory Physics Course?
Brian W Frank	P7	Building knowledge for teaching: Three cases of physics graduate students
Scott Franklin	P18	Diversity of Faculty Practice in Workshop Classrooms
Amber Frazier	J9	Do Common Exam Question Scores Vary Significantly Between Different Modes of Instruction?
Jon D. H. Gaffney	M6	How an active-learning class influences physics self-efficacy in pre-service teachers
Ross Galloway	B5	The effect of research-based instruction in introductory physics on a common cognitive bias
Alejandro Garza	L12	Contrasting students understanding of electric field and electric force
Benjamin Geller	I7	Students' Reasoning about Interdisciplinarity
Elizabeth Gire	B12	Arrows as Anchors: Conceptual Blending and Student Use of Electric Field Vector Arrows
Matthew Goszewski	F4	Exploring Student Difficulties with Pressure in a Fluid
Kara E. Gray	A10	Teaching to Learn: Exploring the Experiences of First-Time Learning Assistants

Contributed Poster Locations

Presenter	Location	Contributed Poster Title
Ayush Gupta	C7	Coupling Identity and Epistemology to Explain Differences in Learning Experiences
Nicholas Hall	E4	The Effects of Autonomy on the Student Experience In Introductory Physics
Nicole R. Hallinen	B2	A Comparison of Two Instructional Models Using Contrasting Cases
Benedikt W. Harrer	H6	Student-teacher interactions for bringing out student ideas about energy
Jeffrey Hawkins	G3	Students├ Response Patterns to Research Tasks With Alternative Questioning Formats
Ryan L Hazelton	K3	Investigating student ability to apply basic electrostatics concepts to conductors
Ian Her Many Horses	A11	When Former LAs Teach the LA Pedagogy Course: An insider's perspective
Paula Heron	G2	Variation Of Pretest Results From Dozens Of Classes And Thousands Of Students
Kathleen Hinko	D2	Impacting University Physics Students Through Participation in Informal Science
Brant Hinrichs	C3	A Student-Led Whole-Class Discussion Reconciles Friction with the System Schema
Andrew S, Hirsch	G12	Developing Pre-flight Tutorials for Matter & Interactions
George Wesley Hitt	K10	Cultural perspectives on curriculum design for Gulf Arab students using PER-based instructional strategies.
Theodore Horton	G37	Doing it wrong the first time: effectiveness of incorrect solution steps in video based problem solving examples
Zdeslav Hrepic	G34	Methodology and/or Technology: Making Difference in Improving Students' Problem Solving Skills
Dehui Hu	J6	Characterizing students' use of resources in physics integration problems
Michael M. Hull	J14	A conceptual physics class where students found meaning in calculations
Paul Hutchison	E7	Evidence of epistemological framing in survey question misinterpretation

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Presenter	Location	Contributed Poster Title
Bashirah Ibrahim	L6	Students' Categories of Mental Representations and Handling of Multiple External Representations
Paul Irving	E5	Upper level physics students conceptions of understanding
Abdel F. Isakovic	K11	Challenges and opportunities in incorporating PER-based science instruction in engineering-focused curricula in Gulf Arab environment
Joss Ives	G4	Group Work and Immediate Feedback in Assessments
Lama Jaber	H8	The role of affect in stabilizing inquiry
Ignatius John	F7	Effect of contextual variations on student responses to questions about an open DC circuit comprising a battery and a single resistive element
Dyan Jones	J1	Comparing Physics and Mathematics Problems
Adam Kaczynski	G11	Student Expectations in a Group Learning Activity on Harmonic Motion
Thomas James Kassebaum	G40	POOLkits: Applying Object-Oriented Principles to Physics Object-Oriented Learning
Neelam Khan	G35	Comparing the Use of Animations and Written Solutions in Facilitating Problem Solving
Raina Khatri	K14	Increasing the Impact of Educational Innovations: PI and PD views of Successful Dissemination
Patrick B. Kohl	G17	Engagement of clicker users in introductory and upper-division physics courses
Antje Kohnle	G36	Evaluation work for QuVis: The Quantum Mechanics Visualization project
Mila Kryjevskaia	C4	Investigating inconsistencies in student reasoning approaches
Mila Kryjevskaia	F9	Probing utility of Bloom's taxonomy in physics
Eric Kuo	J8	Considering factors beyond transfer of knowledge across disciplines
Mary Bridget Kustusch	M8	An Expert Path Through a Thermo Maze

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Presenter	Location	Contributed Poster Title
Nathaniel Lasry	G33	Easier to redesign a classroom than an instructors' pedagogy
James T. Laverty	G21	Teaching Graphs in Introductory Physics: Interpretation vs. Construction
Daniel Laverty	P8	Preliminary investigations of physical science teacher content knowledge and PCK
May Lee	P15	Students' Affective and Conceptual Shifts in the Transformation of an Electric Potential Lab
Heather Lewandowski	P11	A Framework for Adopting Modeling in Upper-Division Lectures and Labs
Sissi L Li	E1	Physics learning identity of a successful student: a plot twist
Yuhfen Lin	P10	Motivating students to take the less-travelled road to deep learning
Shih-Yin Lin	G20	Student Difficulties in Translating between Mathematical and Graphical Representations in Introductory Physics
Beth Lindsey	C12	Assessing Students' Metacognitive Calibration with Knowledge Surveys
Angela Little	D7	What Do We Really Mean By That Word? Identifying Skills in the Work of Categorizing and Defining
Robynne M. Lock	D11	Physics career intentions: The effect of physics identity, math identity, and gender
Michael Loverude	L1	They still remember what I never taught them
Brandon Lunk	B4	Computationally Native Epistemic Games
Robert B Lynch	I3	A Qualitative Look at The Long Term Effects of Early Enrollment in Physics
Adrian Madsen	G22	Do perceptually salient elements in physics problems influence students' eye movements and answer choices?
Jonathan Mahadeo	G6	Regression analysis exploring teacher impact on student FCI post scores
William Mamudi	A5	Instructor's Goals for Using Example Solutions for Introductory Physics

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Presenter	Location	Contributed Poster Title
Seth Manthey	I4	Towards Modeling Instruction — Biology: Adapting curricular frameworks from physics to biology
Alexandru Maries	G24	To Use or Not to Use Diagrams: The Effect of Drawing a Diagram in Solving Introductory Physics Problems
Mathew Martinuk	E8	Students' Use Of Real-World Knowledge During Collaborative Physics Problem Solving
Jeffrey Marx	D5	Developing student's scientific literacy
Andrew Mason	G39	Adaptation of Introductory Physics Computer Coaches: Applications and Design
Frances Mateycik	B1	Assessing students' epistemic logic using clause topics during problem comparison
Brinkley Mathews	C11	What Do Students Think "Thinking Like A Physicist" Means
Timothy McCaskey	J15	Using student notecards as an epistemological lens
Sarah B. McKagan	D6	Defining "research validation" for PER users and researchers
Daryl McPadden	J5	Vectors in the time of scalar instruction
David Mendez	H7	Effect of cooperative learning according to the capability of the students
Brendon Mikula	J7	Sines and Signs - Student difficulties with trigonometric vector component problems
Paul M. Miller	A6	Learning assistants in University Physics: Initial replication results and effect on underrepresented populations
Kelly Miller	G13	Switching Behavior in the Peer Instruction Classroom
Alexander Moncion	G9	Student interactions leading to learning and transfer: A participationist perspective
Jayson Nissen	E10	Investigating Students' Affective Experience in Introductory Physics Courses
Victoria Nwosu	K16	A study of postgraduate students in an astrophysics bridging year: Identifying Contradictions in a complex system

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Presenter	Location	Contributed Poster Title
Christopher Oakley	P6	Instructor Expectations of Undergraduate Students Entering Quantum Mechanics
George Ortiz	A9	Impact of the Learning Assistant model on DFW rates in Introductory Physics Courses
Eric Page	G14	Leadership and Followership in Cooperative Group Development
Bruce R Patton	M5	Impact of Inquiry PD on In-service Teaching
Ariel Paul	H4	What can middle school students teach us about effective simulation design?
Andrew Pawl	B6	A Major- and Gender-Dependent Self-Confidence Decline in CLASS Data from MIT Introductory Physics
Rachel E. Pepper	F6	Tapping into sophomores' understanding of classical mechanics: The Colorado Classical Mechanics/math methods Instrument (CCMI)
Julia Plummer	P4	Dimensions of a learning progression for the formation of the Solar System
Noah Podolefsky	O3	Affordances of Play for Student Agency and Student-centered Pedagogy
Steven Pollock	P14	Impacts of curricular change: 8 years of conceptual survey data from introductory physics.
Wendell H Potter	I2	Additional Evidence of Far Transfer of Scientific Reasoning Skills Acquired in a Reformed Physics Course
Edward Price	G10	Supporting scientific writing and evaluation in a conceptual physics course with Calibrated Peer Review
Gina Quan	C2	Characterizing Consensus about the Definition of a Physics Model
Kathleen Quardokus	M1	Department-Level Change Initiatives: Using Social Network Analysis to Understand the Hidden Structure of Academic Departments
Jennifer Radoff	H5	Isaac's theory of wheels: A third-grade class's stability in doing science
Heather A. Rave	G15	Matching the context of learning and assessment
N. Sanjay Rebello	K5	Probing Students' Conceptions About Rolling in Different Contexts

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Presenter	Location	Contributed Poster Title
Carina M. Rebello	M7	Transfer of Argumentation Skills in Physics Problem Solving
AJ Richards	B9	Students' Use of Resources in Understanding Solar Cells
Jennifer Richards	E2	Coupling epistemology and identity in explaining student interest in science
Reni Roseman	H3	Utilization of Hands-on and Simulation Activities for Teaching Middle School Lunar Concepts
Rebecca Rosenblatt	K6	Student distinctions between 'force-of-motion' and net force in various contexts
Mike Ross	C8	Challenging Traditional Assumptions of Secondary Science through the PET Curriculum
Amy Rouinfar	K7	Scaffolding Students' Understanding of Force in Pulley Systems
Alexander L. Rudolph	K9	Interactive Learning in French University Physics Classrooms
Todd Ruskell	G31	The North American Network of Science Labs Online (NANSLO)
Homeyra Sadaghiani	H1	It Is Never Too Early: Exposing First Graders To Physical Science
Homeyra Sadaghiani	J13	Mathematical vs. Conceptual Understanding in Introductory Physics: Where do we draw the line?
Irene Salter	D4	Surveys Fail to Measure Grasp of Scientific Practice
William Sams	P2	Developing a Comprehensive, Multifaceted Assessment for Laboratory Courses
Choojit Sarapak	H2	Nanotechnology in Science Club
Vashti Sawtelle	I8	An Examination of Expert/Novice Positional Identities in the Disciplines
Eleanor C Sayre	B11	Effortful and Effortless Conceptual Blending
Thomas M. Scaife	K4	The Dependence of Instructional Outcomes on Students' Individual Differences: An Example from Simple DC Circuits

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Presenter	Location	Contributed Poster Title
David R Schmidt	G27	Effect of Paper Color on Physics Exam Performance
Bill Schmitt	G1	Helping American middle & high school science teachers to change to formative assessment
Matthew Semak	G5	Predicting FCI Gain with a Nonverbal Intelligence Test
Chandralekha Singh	E9	Core graduate physics courses: A missed learning opportunity?
Trevor I. Smith	L3	Identifying Student Difficulties with Conflicting Ideas in Statistical Mechanics
Philip Southey	L10	Students' Understanding of Density: A Cognitive Linguistics Perspective
Benjamin T. Spike	A3	Applying a Framework for Characterizing Physics Teaching Assistants' Beliefs and Practices
Brian M Stephanik	G7	Development of an inquiry-based module on energy for precollege teachers
John Stewart	F5	Using Cluster Analysis to Identify Intellectually Similar Groups of Students
Sean Stewart	G16	"Learning Arc": The Process of Resolving Concerns through Student-Student Discourse
Antoinette Stone	G23	Students Use of Diagrammatic Representations as Sense-making Tools
Jane Stout	G18	How a Gender Gap in Belonging Contributes to the Gender Gap in Physics Participation
Enrique Suarez	D8	"Because it hibernates faster": 3rd grade English Language Learners making sense of sound
Anne Tabor-Morris	N4	Quest in the Physics Classroom
Chandra Turpen	I1	Research on students' coherence-seeking across disciplinary boundaries
Andrea G. Van Duzor	E12	Science Education Internships for the Professional Development of Noyce Scholars at Chicago State University: Affordances and Constraints
Arnaldo M. Vaz	K15	Old Philosophy for New Research: John Dewey's ideas and deliberations in PER

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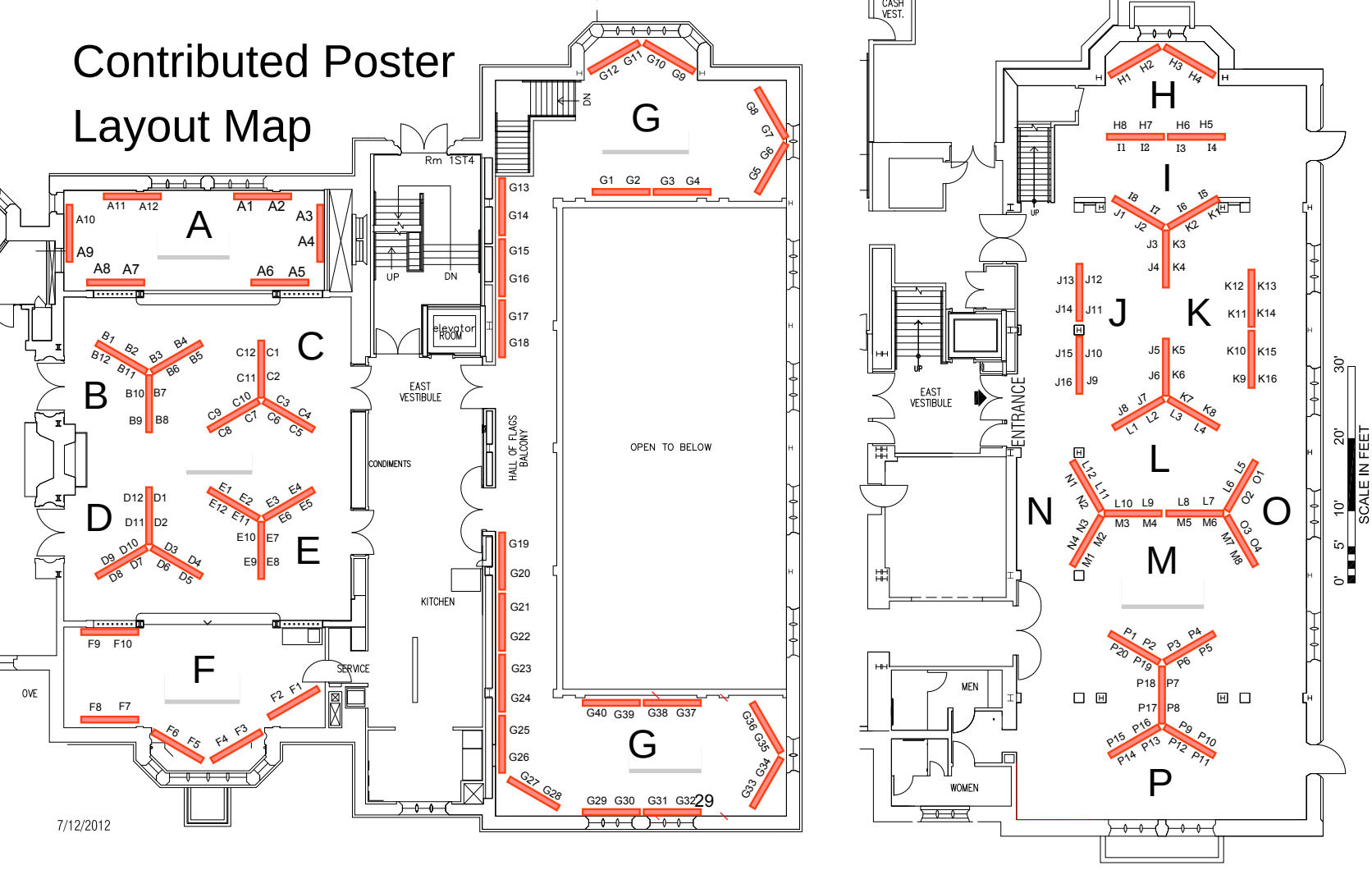
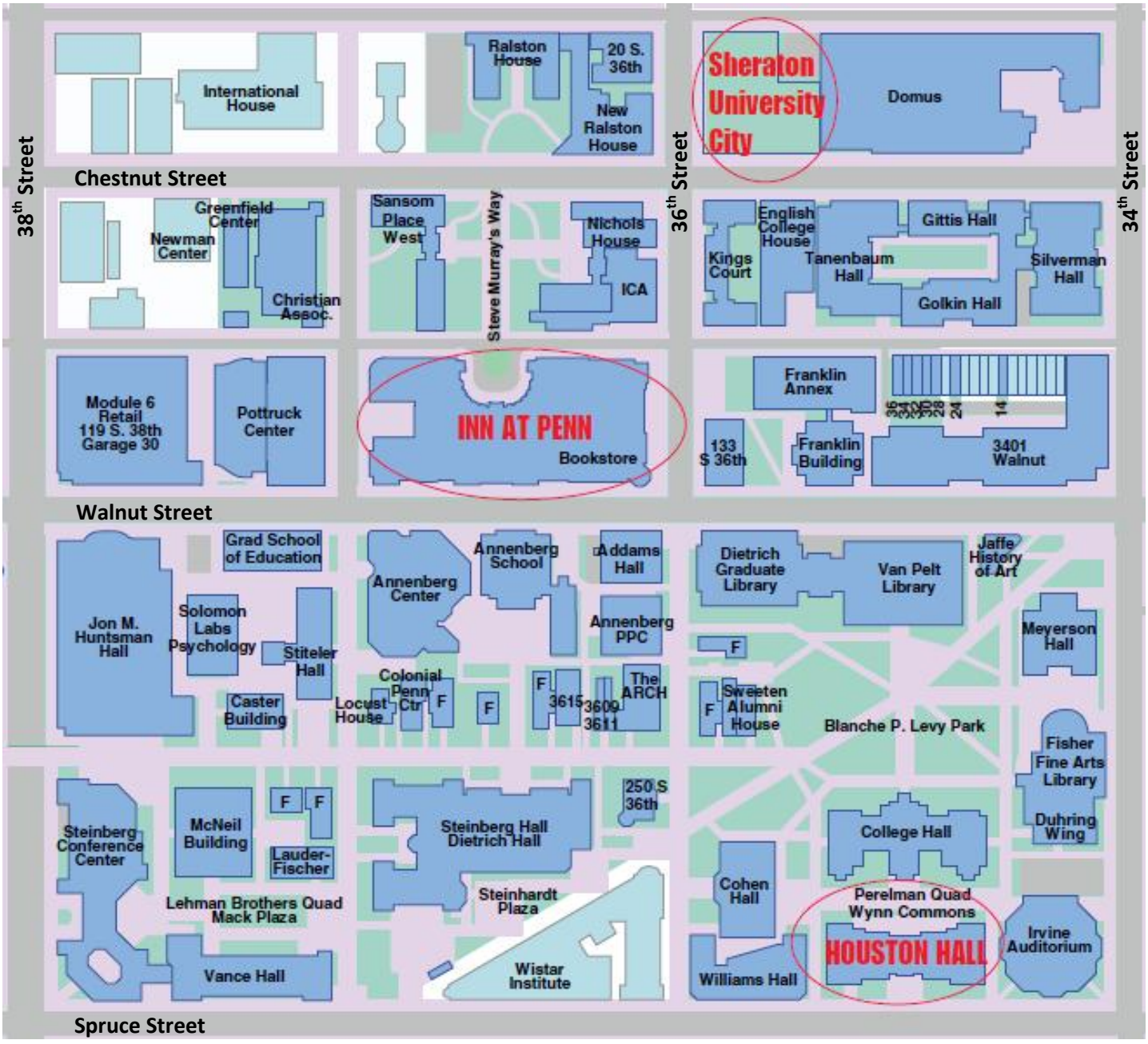
Presenter	Location	Contributed Poster Title
DJ Wagner	F3	Exploring Student Difficulties with Buoyancy
Wendi Wampler	O2	Reflective Discourse Techniques: From in-class discussions to out-of-classroom problem solving
Jing Wang	J10	Learning Mathematics in Physics Context
Jessica Watkins	L5	Examining the integration of physics equations in students├ biological reasoning
Meghan J Westlander	A2	Teaching assistants' interactions with their students: Examining methods for data analysis
Bethany Wilcox	J4	Upper-division student understanding of Coulomb's Law: Difficulties with continuous charge distributions
Michael C. Wittmann	L11	New ways of investigating the canonical ball toss problem
Steven Wolf	F2	Rigging your Card Games - Differentiating Expert from Novice
Krista E. Wood	P19	Revealing Students' Preconceptions in DC Circuits: A Preliminary Study
Rosemary Wulf	E3	Promoting Student Agency and Communication in an Informal Science Program
Qing Xu	G38	Using internet based computer coaches for introductory physics problem-solving
Edit Yerushalmi	A4	Instructors' Use of Specific Design Features in Example Solutions
Philip W. Young	P16	Correlation between FCI Gains and the Level of Interactive Engagement in the Calculus-Based Mechanics Course
Tugba Yuksel	L8	The Next Generation Science Standards: To What Extent are Modern Physics Concepts Included?
Genaro Zavala	G8	Students' Understanding of Dot Product as a Projection in No-context, Work and Electric Flux Problems
Robert Zisk	M2	Why is This Sentence True: A Study of Learning to Read a Textbook
Benjamin Zwickl	B8	Development and Validation of the Colorado Learning Attitudes about Science Survey for Experimental Physics

Contributed Poster Layout Map



7/12/2012

MAP OF VENUE LOCATIONS



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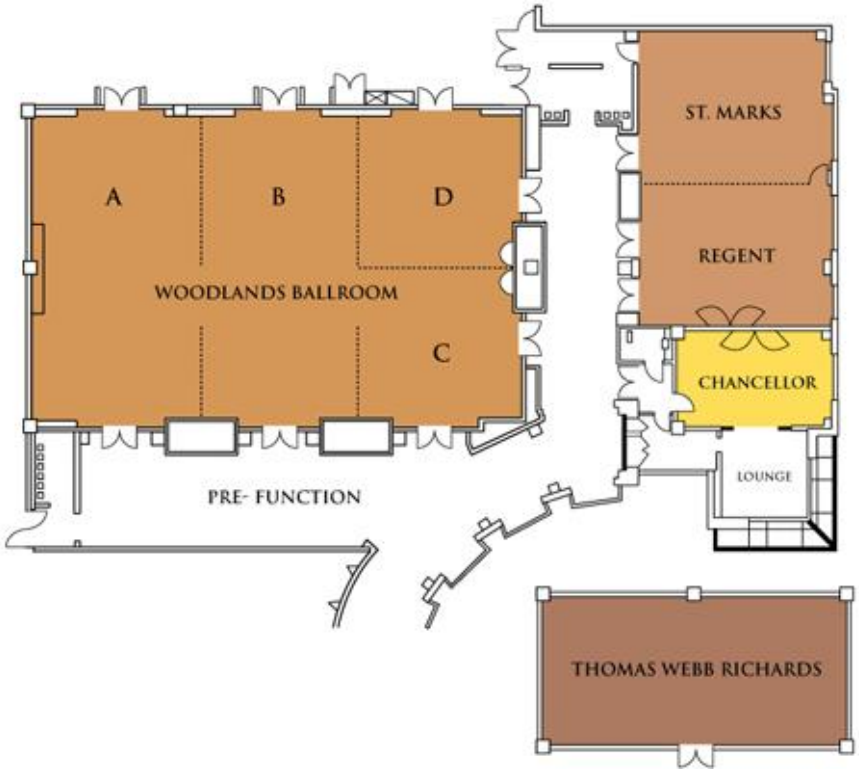

Sheraton Floor Plan