

# A Methodological Approach to PER



Physics Education Research Conference

July 20 & 21, 2016

Sacramento, California

# PERC 2016: Schedule

## Wednesday, July 20

2:00pm	AAPT/PERC Bridging Session <i>Speakers:</i> <i>Kerrie Douglas (Purdue University)</i> <i>Jesper Bruun (University of Copenhagen)</i>	<i>Sheraton, Magnolia</i>
3:00pm	Set up First Timer/Undergrad poster session	Gardenia/Grand Ballroom Foyer
3:30pm	First Timer, Undergraduate Poster Session with Coffee	Gardenia/Grand Ballroom Foyer
4:30pm	Introduction	Magnolia/Camellia Ballroom
4:45pm	Plenary #1 Saalih Allie Methodology and theorizing in PER: The role of humble theories	Magnolia/Camellia Ballroom
5:30pm	Dinner on own	
7:30pm	Poster Session 1	Gardenia/Grand Ballroom Foyer
8:15pm	Poster Session 2	Gardenia/Grand Ballroom Foyer

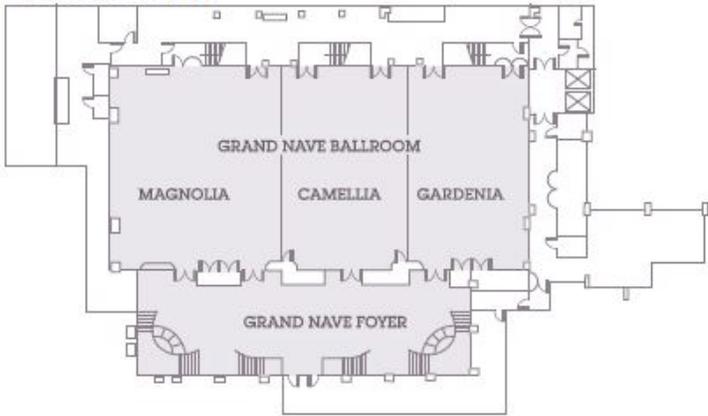
# PERC 2016: Schedule

## Thursday, July 21

8:30am	Plenary #2 - Peter Hewson On the Interaction of Physics with Physics Education Research	Magnolia/Camellia Ballroom
9:15am	Coffee	Grand Nave Ballroom Foyer
9:45am	Poster Session 3	Gardenia/Grand Ballroom Foyer
10:30am	Parallel Session 1	Room Name in Parallel Session Description
12:00pm	Lunch	Magnolia/Camellia Ballroom
12:30pm	Plenary #3 George Bodner	Magnolia/Camellia Ballroom
1:15pm	Parallel Session 2	Room Name in Parallel Session Description
2:45pm	Coffee	
3:15pm	Speaker Panel Summary Discussion with Eleanor Sayre	Magnolia/Camellia Ballroom
4:00pm	End of PERC	

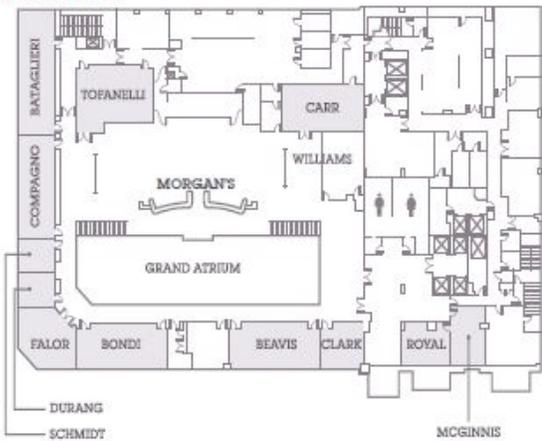
# PERC 2016: Hotel Floor Plan

Lower Level

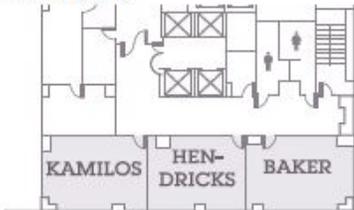


**Sheraton Grand Sacramento**  
HOTEL

Level 2



Level 3



**Lobby Level**  
Public Market Bar  
Glide's Event Space

**Level 4**  
Sheraton Fitness  
Swimming Pool  
Executive & Sales-Catering Office

# PERC 2016: Theme

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## A Methodological Approach to PER

Research methodology is often incorrectly used as a synonym for research method. Research methodology is about method in relation to the theoretical and epistemological aspects that underpin that method, which in turn collectively guide the research. Thus the chosen research methodology essentially is the research framework within which, and by which, a researcher will work. It is even accurate to consider it as the inception of the research. In PER contexts a researcher can choose to employ a particular methodology and this choice is guided by the research question, and as such the chosen methodology represents the concepts, assumptions, expectations, beliefs, and theory that will direct the data collection, analysis and conclusion and implication that gets drawn. In other words, giving due consideration to the appropriate choice of a research methodology is about paying attention to what kind of framework is needed to appropriately carry out all aspects of the research. The chosen methodology also underpins any theory that gets developed as a consequence of the study, and as such it provides a significant indication of its contextual credence.

The PERC 2016 conference is an invitation for the PER community to engage in debate and discussion about research methodology and its role in how we approach a research study. Whether it is a ten-week REU summer project or a multi-million dollar NSF study, developing a more insightful methodological awareness of research methodology can strengthen your research and your ability to answer the research questions you seek to answer. Speakers who are both internal and external to the PER community have been welcomed to share their perspective on research methodology with the hope that diverse contexts and examples will spark attendees to adopt or innovate research methodology for their future studies. Special focus will be given to innovative methodologies for, (1) informing research practice, (2) generating new understandings of learning and teaching experiences, (3) for predicting and generalizing learning outcomes, and (4) investigating other related areas of PER.

### *Organizers*

Paul Irving (Michigan State University)

Rebecca Lindell (Purdue University)

Cedric Linder (Uppsala University)

# PERC 2016: Plenary Speakers

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## **Kerrie A. Douglas, Purdue University**

Dr. Kerrie A. Douglas is Visiting Assistant Professor of Engineering Education at Purdue University. Dr. Douglas earned her PhD in Educational Psychology and studies methods of evaluation and assessment in STEM disciplines. Her areas of interest include assessment of engineering design competencies, what types of evidence constitute use for educational decision-making, and how multiple forms of data provide deeper levels to understand learning. She currently leads a research team to combine multiple forms of data (machine-generated and traditional assessment methods) to understand learners in highly technical nanotechnology-related open online online courses.

## **Jesper Bruun, University of Copenhagen**

Jesper Bruun is adjunkt (roughly equivalent to US assistant professor) at the University of Copenhagen, Denmark, where he completed his Bachelor and Master degrees in physics. His Master thesis was on the interplay between kinesthetic learning activities (KLAs) and computer simulations. For his PhD, also at University of Copenhagen, which specialized in PER, Jesper investigated the use of network analysis in physics education at upper secondary and university levels. Here, he worked on refining mixed methods approaches that integrate learning theories with network analysis. Jesper is currently continuing these lines of research at the Department of Science Education, where he is now involved in a diverse set of PER projects.

## **Saalih Allie, University of Cape Town, South Africa**

Saalih Allie is Associate Professor at the University of Cape Town, where he has held joint positions in the Department of Physics and in the Academic Development Programme since 1986. The broad spectrum of his activities, across the College of Science, includes issues of underrepresentation, access and throughput with regard to South African students from socially and educationally disadvantaged backgrounds. His teaching in the Physics Department has been directed primarily at such "non-traditional" students. More recently, as part of an equity initiative, he established, and directs, a postgraduate bridging program for Black physics B.S. graduates from across South Africa who wish to pursue studies in Astronomy and Space Science. He holds a PhD in experimental nuclear physics from UCT, but his main focus of research has been in PER, in particular with regard to the following areas: laboratory work and the teaching of measurement and uncertainty, writing in physics, and the role of context, language and socio-emotional factors with regard to "backstage cognition". He worked with the PER group at the University of Maryland during an extended sabbatical (2004-06) and was a Harvard-Mandela Fellow in 2000. He represented South Africa on the International Commission on Physics Education (2009-2011), and is presently a member of the editorial board of PRPER.

## **Peter W. Hewson, Stanford University**

Peter W. Hewson is Professor Emeritus of Science Education at the University of Wisconsin-Madison where he taught in the undergraduate science teacher education and graduate science education programs. A major focus of his scholarship was a conceptual change framework that informs the teaching and learning of science, science teacher education and teacher professional development. He played a major role in a dialogue between researchers in southern Africa and the United States. This led to the establishment of an annual Research School in southern Africa with particular emphasis on the professional development of new researchers in science and mathematics education. In 2009 he received the Distinguished Contributions to Science Education through Research Award from the National Association for Research in Science Teaching. Peter Hewson received his D.Phil. in theoretical nuclear physics from Oxford University, and taught physics and science education at the University of the Witwatersrand before moving to the United States. Today he remains one of the most influential founding members of the PER community in southern Africa.

# PERC 2016: Plenary Speakers

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## **George M. Bodner, Department of Chemistry, Purdue University**

George Bodner was born (3/8/46) and raised within a half-mile of Kodak Park in Rochester, New York. In spite of this, he entered the State University of New York at Buffalo as a history-philosophy major. At SUNY he found, much to his amazement, that chemistry was fun and he changed his major (under the mistaken impression that jobs were easier to find as a chemist).

After a mediocre career as an undergraduate (B.S., 1969) he entered graduate school at Indiana University (Ph.D., 1972), undoubtedly on the basis of letters of recommendation. He apparently did well enough in graduate school as a double major in inorganic and organic chemistry to gain an appointment as a visiting assistant professor at the University of Illinois (1972-75). His research interests at that time focused on the application of C-13 NMR spectroscopy to studies of the structure and bonding in organometallic complexes.

While at Illinois he made the mistake of professing total ignorance of biochemistry to one of his colleagues in that area. After a semester of intense study to relieve this obvious deficiency, he was asked to fill an appointment as a visiting professor in biochemistry for the summer of 1974. Having survived that, he was actually invited back for the summers of 1975 and 1976.

Two things became self-evident during his tenure at Illinois. He found that teaching was fun and he realized that his research could best be described as searching for definitive answers to questions that no one ever asked. When the time came to leave Illinois, he therefore took a job as two-thirds of the chemistry faculty at Stephens College - a women's college in Columbia, MO - where he lasted for two years (1975-1977), teaching general, organic, inorganic, and biochemistry.

In 1977, an opening in Chemical Education was advertised at Purdue University. He applied for the position and, much to their later chagrin, the faculty at that institution offered him the job. (They have since compounded their error by promoting him first to associate professor and then professor of chemistry and education.) He is the author of more than 80 papers and 30 books or laboratory manuals. He has been known to claim in public that his primary interest is in epistemology. His interests also include the development of materials to assist undergraduate instruction, research on how students learn, and the history and philosophy of science.

# PERC 2016: Parallel Session I

## **Conceptual blending as a theoretical framework in PER**

*Talk Symposium - Room Name: Bondi*

*Organizers:* Bor Gregorcic, Uppsala University; Jesper Haglund, Uppsala University

*Abstract:* Conceptual blending, as developed by Fauconnier and Turner, is an approach to analyze how cognition relies on individuals' drawing on and integrating several mental input spaces to spontaneously create so-called blends. Blending has recently received increasing attention in physics education research as a theoretical approach to study teaching and learning. In this symposium, we present conceptual blending as a theoretical framework, provide empirical examples of blending analyses, and, in an open panel-dialogue format following the presentations, explore how blending can be interpreted and applied in our field of study. The audience will get to know more about conceptual blending and how it can be applied in empirical analysis.

## **Investigating the impact of learning assistant model adoption on students and learning assistants**

*Talk Symposium - Room Name: Compagno*

*Organizers:* Leanne Doughty, University of Colorado Denver

*Abstract:* The number of physics departments utilizing undergraduate Learning Assistants (LAs) has been rapidly growing in recent years. This symposium brings together multiple research groups within the Learning Assistant Alliance that are investigating the impacts of Learning Assistant model adoption on both the students enrolled in LA-supported classes and the LAs themselves. Though the research goals of each of our groups are aligned in many respects, we are all focused on answering different research questions. As such, we are each using a set of research methods based on our respective theoretical perspectives on teaching and learning, and specific research questions. In our talks we will each describe our research methodology, along with presenting results from our individual projects. The discussion time will focus on the extent to which our theoretical perspectives and research methods overlap, the value in some of the differences, and how we might better converge for common goals.

## **Methodologies for Video-Based Research in PER**

*Talk Symposium - Room Name: Falor*

*Organizers:* Benedikt Harrer, San José State University; Luke Conlin, Stanford University

*Abstract:* More and more physics education researchers use audiovisual recordings of physics learning environments as their primary data source. Approaches to video-based analysis in the PER community encompass a wide range of methods, both qualitative and quantitative in nature. This symposium will provide an opportunity to closely examine a range of video-based research methodologies. We will reflect on methods and their theoretical framing with a focus on the different kinds of questions different approaches are particularly equipped to answer, how research design differs across methodologies, and what claims about knowledge and learning can look like.

# PERC 2016: Parallel Session I

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## **Expanding research questions by expanding quantitative analysis techniques**

*Poster Symposium - Room Name: Bataglieri*

*Organizers: Jacquelyn Chini, University of Central Florida*

*Abstract:* This poster symposium will highlight multiple quantitative methodologies that can allow physics education researchers to expand the type of research questions we can address by exploring the alignment between research design, research questions, data analysis and knowledge claims. As our guiding theoretical frameworks push us to examine our participants in richer detail, we must simultaneously adapt our research design and analysis methods to account for these multi-faceted data. Presenters in this session will highlight four distinct methodologies, requiring advanced quantitative analysis techniques, that allowed them to develop detailed quantitative descriptions of students' learning and attitudes. By comparing across presenters, participants will be able to trace how differences in each researchers' guiding theoretical framework led to specific decisions about research design and analysis, allowing them to answer different types of research questions.

## **Building Research Questions from Observational Data**

*Talk Symposium - Room Name: McGinnis*

*Organizers: Eleanor C Sayre, Kansas State University*

*Abstract:* This session is about how diverse research projects developed research questions and chose methodologies using observational data. The focus in the session is not particular populations, but rather on how access to observational data shapes the kinds of research questions and methods available to us. Projects include from an informal program that blends children and university students (Hinko); computational classrooms for grade schoolers (Hansen&Harlow); intensive lab experiences for incoming university students (Chase&Zwolak); and upper-division physics courses (Nguyen&Chari). Across all projects, we explore observational data gives affordances and constraints to the kinds of research available for us to do. More broadly, we explore questions of how methods and research questions co-evolve in light of access to particular kinds of data.

# PERC 2016: Parallel Session I

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## **Physics teaching for social justice: resource-sharing and co-thinking**

*Discussion Symposium - Room Name: Beavis*

*Organizers:* Amy D. Robertson, Seattle Pacific University; Abigail R. Daane, Seattle Pacific University; Moses Rifkin, University Prep

*Abstract:* This collaborative discussion session will provide opportunities for physics instructors and physics education researchers to co-think about what it would look like to "teach physics for social justice." We will explore what "physics teaching for social justice" means to participants; brainstorm, share resources and form collaborations around questions about what we should be reading, what we should be asking, what instructional approaches we should be trying, and how we can communicate our work to others; and close with a discussion across questions.

## **The PERC Proceedings: History, Publication Data, Writing, and Reviewing**

*Workshop - Room Name: Baker*

*Organizers:* Dyan L. Jones, Mercyhurst University; Lin Ding, Ohio State University; Adrienne L. Traxler, Wright State University; Alice D. Churukian, University of North Carolina at Chapel Hill

*Abstract:* This parallel session will begin by providing participants with a history and overview of the PERC Proceedings and some publication data including submission and acceptance rates. With this information in mind and considering the differences between the proceedings and other traditional journals, we will move into a discussion about the process of preparing and reviewing papers for the PERC Proceedings. Participants will have the opportunity to work with exemplar submissions and reviews and to get real-time feedback on their own current and future submissions.

# PERC 2016: Parallel Session II

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## **Methodologies using identity frameworks**

*Poster Symposium - Room Name: Bataglieri*

*Organizers:* Idaykis Rodriguez, Florida International University

*Abstract:* As a field, Physics Education Research (PER) has its place in the national initiatives to address the underrepresentation of minority and female students in STEM fields. Questions of how to recruit, retain and have underrepresented students persist in STEM fields leads researchers to explore much more than student performance, into exploring who our students are and how they participate in the sciences. Theories of identity help researchers interpret persistence trends and reasons that correlate with group underrepresentation in the sciences. In this invited poster symposia we discuss some design challenges such as choosing a theoretical framework of identity that informs the research question and analysis of data. We will also discuss how a design choice reflects the researchers' own beliefs, biases, and perceptions of knowledge and education. The poster symposia showcase identity theories within communities of practice, physics identity, critical race theory, intersectionality, and qualitative/quantitative data collection within these poster symposia showcase identity theories within communities of practice, physics identity, critical race theory, intersectionality, and qualitative/quantitative data collection within these frameworks.

## **Iteration, Ownership, and Emotions: Examining How Classroom Experiences in Physics Move Outside the Classroom**

*Talk Symposium - Room Name: Bondi*

*Organizers:* Leslie Atkins Elliott, Boise State University; Angela Little, Michigan State University

*Abstract:* An initial and enduring goal for PER has been understanding and improving students' content knowledge, an enterprise that has employed now-familiar methodologies of interviews, pre/post paradigms, and concept inventories. More recently, the field has extended its work to consider factors that influence how students learn content, and new methodologies have been employed. The speakers in this session have research goals that lie further from traditional content outcomes, and require methodologies that are less common in PER. Each speaker in this session will focus on: identifying our non-content goal (that is, how did we arrive at this goal as an outcome), characterizing these goals (that is, how are we making progress on articulating/operationalizing this goal), and developing/selecting methodologies to make progress on research related to this goal. A discussant will then lead a conversation on ways in which researchers can identify and engage in unfamiliar methodologies.

# PERC 2016: Parallel Session II

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## **Educating pre-service teachers**

*Talk Symposium - Room Name: Compagno*

*Organizers:* Shulamit Kapon, Technion - Israel Institute of Technology; Eugenia Etkina, Rutgers University

*Abstract:* This session brings together presenters that are involved in designing, teaching in, and studying different programs that aim to educate and prepare future physics teachers in the US and around the world. The session will focus on crucial aspects of physics teacher preparation programs and conceptual models that afford theoretical insights into their features. The session will conclude with a panel discussion with the audience.

## **Conceptual issues and content revisions in the introductory physics course for life science students**

*Talk Symposium - Room Name: Falor*

*Organizers:* Nancy Beverly, Mercy College; Dawn Meredith, University of New Hampshire

*Abstract:* The introductory physics for life science (IPLS) course presents an exciting, but challenging, opportunity to make physics an integral part of the professional development of biologists and health professions. Helping students develop physics perspectives and habits of minds (e.g. quantitative modeling) is essential, as well as focusing on physics content most relevant to biologists. Therefore, work in this area has focused on designing curriculum that includes authentic biological problems, promotes interdisciplinary scientific thinking, and builds coherence between physics and biology. These new pedagogical perspectives then must be joined with the already existing models of student learning for a comprehensive framework. The demands of this course are giving rise to the development of new theoretical frameworks, research-based transformations, and assessments. In this session, this PER work from diverse institutions will be presented, followed by discussion to explore common and divergent theoretical bases for curricular choices, pedagogies, and research strategies.

# PERC 2016: Parallel Session II

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## **NSF Education Programs for Physics & Astronomy**

*Workshop - Room Name: Beavis*

*Organizers: Kevin Lee*

*Abstract:* This workshop will focus on general guidance and specific suggestions aimed at increasing the number of high quality physics and astronomy education proposals submitted to NSF. The most important target for such proposals is the Division of Undergraduate Education's IUSE (Improving Undergraduate STEM Education) Program. We will provide a general overview of the program, the review process, an overview of the IUSE: EHR (Education and Human Resources Directorate) portfolio in physics and astronomy, and recommendations regarding working within the existing system for the maximum benefit of the physics and astronomy education community. We will also discuss recent developments in the S-STEM program. All S-STEM awards today are expected to be knowledge-generating and disseminate that knowledge to the broader STEM education community. This makes research projects possible in many areas including recruitment, retention, advising, and the efficacy of bridging programs, peer tutoring, and faculty mentoring for STEM majors. Information on other education programs in EHR (Noyce, ECR) and programs in other divisions (PHY, AST) will be briefly summarized as time allows. Pointers to numerous resources will be provided.

## **Network analysis in physics education research**

*Poster Symposium - Room Name: Tofanelli*

*Organizers: Adrienne Traxler, Wright State University; Jesper Bruun, University of Copenhagen*

*Abstract:* This poster symposium showcases recent applications of network analysis in physics and science education research. Approaches include a focus on individual students (ego networks), a time-evolving range of interaction types for an entire class (multiplex networks), and combinations with other tools such as text mining and discourse analysis. Social network analysis can complement qualitative methods in exploring the rich complexity of student participation, and is especially valuable for capturing the many student-student interactions that are an integral part of active learning environments. Other applications of network analysis, rather than approximating a social landscape, uncover hidden connections and themes in dense bodies of text such as interview transcripts. The research in this session highlights a variety of ways that the network data perspective extends the existing methodological toolbox of physics education research.

# PERC 2016: Abstracts

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## Talk Symposium

### [Conceptual Blending as a Theoretical Framework in Physics Education Research](#)

*Organizers: Bor Gregorcic | Discussant: Jesper Haglund*

#### 1) [Using conceptual blending to analyze student inquiry and embodied engagement in a technology-enabled collaborative learning environment](#)

Bro Gregorcic and Jesper Haglund, Uppsala University

With the help of digital technology, we can nowadays design inquiry-based learning materials on topics that were traditionally out of experimental reach. One example is using an interactive whiteboard and the software Algodoo to allow students to "create" and "throw" planets into orbits around the Sun. As students engage in this immersive exercise and make sense of what is going on, they intuitively draw on their everyday embodied experiences of throwing objects and using touch-screen devices, as well as their ideas about the universe, physics formalisms and computer simulations. The conceptual blending framework allows us to make better sense of what students bring into such a complex activity and how we can help them gain a physicist-like understanding of the relationships between the "universe out there", physics formalisms, computer simulations and their everyday world.

#### 2) [Exploring the nature of mental model blending in the context of sound propagation](#)

Zdeslav Hrepic, Columbus State University

Dean A. Zollman, Kansas State University

N. Sanjay Rebello, Purdue University

While constructing their understanding in various science areas, students go through transitional phases that may involve richly developed and consistently used mental models. These transitional models are unique cognitive structures composed of elements of both scientifically accepted and the commonly used initial alternative models. Such transitional models have been previously referred to as hybrid models or blend models. We will discuss the nature of model blending in the context of sound propagation and the issues that surface in their eliciting.

# PERC 2016: Abstracts

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## [Conceptual Blending \(continued...\)](#)

### [3\) Conceptual blending as a framework for modeling the coordinated use of ontological metaphors](#)

Benjamin W. Dreyfus, Ayush Gupta, Erin Ronayne Sohr, University of Maryland  
Jessica Hoy, University of Colorado Boulder

Intuitive reasoning and communication about abstract science concepts are often achieved through the use of ontological metaphors: metaphors about what kind of entity something is. Previous work has shown that both students and experts can productively coordinate multiple metaphors for energy, particularly energy as a substance and energy as a vertical location, and that this coordination can be modeled using the framework of conceptual blending. We apply this blending analysis to a group of students trying to understand the mechanism for atomic emission spectra. The students create a blended mental space that enables them to arrive at a conceptual resolution. The blended ontology is useful to these students in resolving their disagreement, and the blending framework is useful to researchers in understanding how the students did this.

### [4\) Conceptual blending as a tool for analyzing group discourse](#)

Jessica Hoy and Noah D. Finkelstein, University of Colorado Boulder  
Ayush Gupta, University of Maryland

While Fauconnier and Turner's theory of conceptual blending is a theory of the mind that focuses on the individual, we demonstrate that it can also be used as a tool for analysis of group discourse. Building on sociocultural theories that consider cognition a social process, we propose blending theory as a descriptive and analytic tool for use in examining the processes of collective reasoning. We present data from focus groups at CU Boulder in which Modern Physics students engage in reasoning about quantum phenomena and negotiate ontological conceptions of quantum entities such as electrons and photons (i.e. negotiating what kind of a thing an electron or photon is). We present a conceptual blending analysis of group discourse within this context, and show how conceptual blending theory can be used to describe both collectively constructed blends and more traditional individual blends.

# PERC 2016: Abstracts

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## [Conceptual Blending \(continued...\)](#)

### [5\) Blending mathematical formalism and gestures when separating variables in physics](#)

Michael C. Wittmann, University of Maine

When looking at learning on short time scales, we find evidence that students' gestures and words both play a role in how new ideas develop. We use the conceptual blending framework to describe the creation of new knowledge in the moment - perhaps fleetingly, never to be used again, perhaps more permanently. Regardless of the time scale of the effect, blending is a model that lets us describe meaning that is emergent in the moment. So, can blending help us answer questions about the definition of learning? Or is it a just-so story, one that doesn't provide a next step for our study of knowledge and learning?

# PERC 2016: Abstracts

## Talk Symposium

### [Investigating the Impact of Learning Assistant Model Adoption on Students and Learning Assistants](#)

*Organizers: Leanne Doughty | Discussant: Valarie Otero*

#### [1\) Examining LAs' self-concept and practice: What do they say, & what do they do?](#)

Eleanor W. Close, Jessica Conn and Hunter G. Close - Texas State University

The physics department at Texas State University has implemented a Learning Assistant (LA) program in our introductory course sequences. We use a blended theoretical framework of physics identity and communities of practice to examine the impacts of program participation. Previously we have reported evidence of physics identity development from analysis of interviews with LAs and written reflections. Our data now include video of weekly LA preparation sessions as well, which allows us to examine relationships between individual LAs' self-concepts and self-reported practices (in interviews) and their observed practices (in LA prep sessions), and to analyze the degree of alignment between the two. The processes of data collection and collaborative analysis are interspersed, with themes and questions emerging from analyses shaping interview questions. In this session, we will discuss affordances and constraints of this open-ended approach and of the data sources we have available, and findings of our study to date.

#### [2\) The Learning Assistant Survey of Practices \(LASP\): A Robust Tool for Understanding Learning Assistant \(LA\)-Student and Student-Student Interactions](#)

Hagit Kornreich-Lesham<sup>1</sup>, Rocio Benabentos<sup>1</sup>, Zahra Hazari<sup>2</sup>, Idaykis Rodriguez<sup>1</sup>, Geoff Potvin<sup>3</sup> and Laird Kramer<sup>3</sup>

<sup>1</sup>STEM Transformation Institute, Florida International University

<sup>2</sup>STEM Transformation Institute, Department of Teaching and Learning, and Department of Physics, Florida International University

<sup>3</sup>STEM Transformation Institute and Department of Physics, Florida International University

In this study, we investigate how Learning Assistant (LA)-student interactions are related to educational outcomes in active learning STEM courses. We use a retrospective survey methodology which relies on the natural variation in experiences and background of a large sample of college students in these courses. The Learning Assistant Survey of Practices (LASP) was administered in Fall 15' in collaborative classrooms supported with LAs in a large public Hispanic-Serving Institution. The survey study focuses on how classroom interactions with LAs are associated to academic performance, affective outcomes, and career aspirations. LA practices under examination include the frequency of interactions, types of conversations between LAs and students, discussion facilitation, conditions that encourage student participation, and positioning acts. In the current presentation, we will discuss the theoretical framework that guided the development of the instrument and preliminary results.

# PERC 2016: Abstracts

## [Investigating the Impact of Learning Assistant Model \(continued...\)](#)

### [3\) Developing an Observation Protocol to Investigate Factors That Influence Student Success](#)

Leanne Doughty<sup>1</sup>, Laurel Hartley<sup>2</sup>, Amreen Nasim<sup>1</sup>, Paul Le<sup>2</sup>, Jeff Boyer<sup>3</sup>, Hagit Kornreich-Leshem<sup>4</sup>, Laird Kramer<sup>5</sup>, Robert M. Talbot<sup>1</sup>

<sup>1</sup>School of Education and Human Development, University of Colorado Denver

<sup>2</sup>Department of Integrative Biology, University of Colorado Denver

<sup>3</sup>College of Science and Mathematics, North Dakota State University

<sup>4</sup>STEM Transformation Institute, Florida International University

<sup>5</sup>STEM Transformation Institute and Department of Physics, Florida International University

The goal of our work is to investigate how active learning methods and Learning Assistant support impact student outcomes. As part of this work, we are developing a classroom observation protocol that will allow us to identify features of active learning methods and its facilitation that are predictors of learning gains, achievement, retention, and persistence. By focusing on the active portions of a class we are making the assumption that it is in the co-construction of answers that meaningful learning and development occurs. Other protocol design decisions, like classification of the tasks that students are being asked to engage with and their level of engagement in those tasks, involve similar theoretical assumptions. In this presentation we will describe our theoretical framework and our resulting observation protocol design.

### [4\) Data, Variables, and Evidence: Specifying Theoretically Sound Predictive Models](#)

Robert M. Talbot<sup>1</sup>, Leanne Doughty<sup>1</sup>, Amreen Nasim<sup>1</sup>, Paul Le<sup>2</sup>, Laurel Hartley<sup>2</sup>

<sup>1</sup>School of Education and Human Development, University of Colorado Denver

<sup>2</sup>Department of Integrative Biology, University of Colorado Denver

In conducting large-scale research efforts which seek to determine the effect of active learning and Learning Assistant support on student outcomes, we routinely collect massive amounts of data from a variety of measurement instruments. Each of these data sources carries with it implicit assumptions about learning. For example, pre-post concept inventory and gain scores assume a cognitive theory of learning, where the latent construct resides in an individual's singular mind. On the other hand, characterizations of student interactions within a collective classroom network assume at least a socio-cognitive (if not sociocultural) view on learning, where interactions between individuals contribute to development of understanding or sophistication. Using different data sources such as these to define distinct variables within the same quantitative model requires theoretical justification and articulation of an explicit learning theoretical framework. In this presentation we describe our work in dealing with these issues.

# PERC 2016: Abstracts

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## [Investigating the Impact of Learning Assistant Model \(continued...\)](#)

### [5\) What Multi-Level Models Can Tell Us About Learning Assistants and Equity](#)

Ben Van Dusen and Jada-Simone White - Department of Science Education, California State University, Chico

The Learning Assistant (LA) Student Supported Outcomes (LASSO) project collects multi-disciplinary data from LA-using institutions across the country. The data falls into three categories: (1) student data (e.g. pre & post test scores, gender, and ethnicity), (2) course data (e.g. discipline, LA-uses, & instructor), and (3) institution data (e.g. institution type & term type). In this investigation, we develop a theoretical framework that is based in Critical Race Theory and Cultural Historical Activity Theory. To examine the dynamic interactions between varying components of the activity system, we develop Multi-Level Models that nest data within other sets of data. In our models student level data is nested within course level data, which is nested within institution level data. This allows us to measure and control for the complex interactions between various classroom and institutional contexts when analyzing student outcomes. In this sessions we will examine the impacts of LAs on diverse students and contexts.

# PERC 2016: Abstracts

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## Talk Symposium

### [Methodologies for Video-Based Research in PER](#)

*Organizers: Benedikt Harrer and Luke Conlin | Discussant: Rachel Scherr*

#### [1\) Designing for discovery in semi-structured clinical interviews](#)

Eric Kuo - Stanford University

There are two important affordances of interviews I take advantage of in my work. The first is the ability to respond adaptively to interviewee's ideas. Rather than setting activities and research questions in stone beforehand, clinical interviews afford a mix of preparation and adaptation. This allows me to, in-the-moment, probe interesting patterns of reasoning and understanding that might emerge unexpectedly. The second affordance of interviews is that they allow for focused video data collection. This allows me to capture an interview without needing to pre-define what aspects of student reasoning I want to capture. To illustrate these points, I'll provide an example of how I designed, performed, and analyzed interviews around quantitative approximations in math and physics problems.

#### [2\) On moral stances and perspective-taking through video analysis](#)

Ayush Gupta - University of Maryland

Video analysis of students engaged in physics discussions has led to many insights into how students think about and participate in explanation-building and problem-solving in physics. However, analysis of video-records of students' discussions on topics beyond physics content can illustrate expansive uses of video-analysis tools, while simultaneously expanding our toolbox for analyzing students' understanding of physics. I present our ongoing analysis of video-records of engineering students engaged in discussions of socio-scientific issues in clinical focus-group settings, focused on the shifting moral and epistemic stances adopted by students in the discussion. Merging their stance-taking dynamic with fine-grained attention to the content of their talk provides insights into characterizing what perspectives students adopt in their utterances and how these might (or might not) align with stakeholders in the socio-scientific issue. The analysis highlights the role of attending to word choice, gestures, postures, talk sequences, and register changes in making claims about students' stances and perspectives.

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## [Methodologies for Video-Based Research in PER \(continued...\)](#)

### [3\) "I have a good idea!": Insights from video analysis that count even if they cannot be counted](#)

Luke Conlin - Stanford University

Instructors often use engineering design projects to provide students with opportunities to make sense of physics concepts, but do students take them up in this way? I will report on research that approached this question via two contrasting methods: a code-oriented approach based on a classroom observation protocol as well as an insight-oriented approach based on video analysis (Scherr, 2009). The code-oriented approach revealed a rare moment of scientific sense-making during a 6th-grade pneumatics project in which a vocal male student reported having a "good idea." The insight-oriented approach of this good idea revealed that the idea was not Roger's alone – a quieter female student had made a subtle yet substantive contribution that went uncounted. This case illustrates how code-oriented approaches can complement insight-oriented video analysis, while highlighting how some insights can emerge more readily from video data than code counting, with implications for equity in engineering and science classrooms.

### [4\) Multimodal analysis of the interactional work of transforming participation structures in a middle-school classroom](#)

Benedikt W. Harrer - San Jose State University  
Virginia J. Flood

Participation frameworks in classrooms are co-constructed and co-maintained by the interactional work of teachers and students. We show how sequential, multimodal analysis of video records can reveal the embodied resources participants enlist to achieve transformations in participation frameworks during group-work when a teacher has been called over to help in a middle school Project-Based Inquiry Science (PBIS) course. Our ethnomethodological analysis traces the process of how an epistemically asymmetrical, teacher-led Initiation, Response, Evaluation (IRE) sequence is re-negotiated into an epistemically symmetrical, student-led inquiry sequence that eventually excludes the teachers' contributions. Our multimodal analysis is able to show how students' sensitivity and responsiveness to prosodic cues enable them to differentiate known-answer questions from felicitous, information-seeking questions. Creating opportunities for and sustaining student-led inquiry sequences are interactional achievements rather than solely the achievement of curricular design and therefore require fine-grained video analyses of classroom interaction.

# PERC 2016: Abstracts

## Poster Symposium

### [Expanding Research Questions by Expanding Quantitative Methodologies](#)

Organizers: Jacquelyn Chini

#### [1\) Finding groups in student-level data: Utilizing the Profile Approach](#)

Jarrad W. T. Pond and Jacquelyn J. Chini - University of Central Florida

Individual students bring their own motivations and self-regulated study strategies to the classroom. When interested in characterizing students, one can turn to the Profile Approach. At the core of this approach is a theoretical framework that considers the interactions of different motivational and strategic self-regulatory constructs and describes the various, distinct patterns that exist across these constructs as Learning Profiles. The Profile Approach relies on individuals' characteristics; thus, accompanying research designs must incorporate collecting student-level data on various motivational and strategic self-regulatory constructs. Also, analyses must consider patterns across these constructs. Cluster analysis is such a technique, allowing identification of coherent groups (Learning Profiles) based on patterns in the data. Resulting Profiles are useful for exploring hypotheses about student characteristics, guiding instructors to better understand their students, and follow-up statistical analyses. I present--from start to finish--applying the Profile Approach to identify Learning Profiles among algebra-based, studio-mode physics students.

#### [2\) Using structural equation modeling to test the physics identity framework](#)

Robynne M. Lock - Texas A&M University - Commerce

Zahra Hazari - STEM Transformation Institute, Department of Teaching and Learning, and Department of Physics, Florida International University

Geoff Potvin - STEM Transformation Institute and Department of Physics, Florida International University

Jennifer Cribbs - School of Teacher Education, Western Kentucky State University

Fully modeling the complex relationships between multiple factors in a theoretical framework requires connecting several statistical techniques. Structural equation modeling (SEM) combines confirmatory factor analysis (CFA), path analysis, and multiple regression. Rather than providing a form of exploratory data analysis, SEM is a confirmatory technique that involves testing and modifying a hypothesized model. Specific tests indicate ways to improve the model, and a variety of fit indices are used to assess the model fit. The implementation of SEM will be shown through the example of testing the physics identity theoretical framework. This includes performing the initial CFA to verify the identity dimensions and assessing model fit. Additionally, the method of modeling multiple groups will be demonstrated by comparing the physics identity model for males and for females. Examples of implementation will be shown in R. Furthermore, the types of research questions to which SEM is most applicable will be described.

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## [Expanding Research Questions by Expanding Quantitative Methodologies \(continued...\)](#)

### [3\) Addressing Relational Data in Students' Representation Use with Network Analysis](#)

Daryl McPadden - Florida International University  
Jesper Bruun - University of Copenhagen  
Eric Brewe - Florida International University

Network analysis is aligned with a theoretical framework that values relational questions and connection between quantities. One of the problems of using frequentist statistics in education is that most statistical analyses (such as t-tests and analysis of variance) require normally distributed data set, with observations that are independent of one another; however, when studying students in a classroom, these assumptions are often violated. Students interact with each other, instructors, and course material, allowing ideas to be transferred in a variety of ways. Learning is embedded in these interactions and can be an exciting area to research but fundamentally requires a research design that captures relational data. This poster will present an example from our work on students' use of representations to demonstrate the types of questions that network analysis can answer, highlight a variety of the analyses that can be run with relational data, and address some of the challenges we faced in using this methodology.

### [4\) A Multi-faceted Approach to Measuring Student Understanding](#)

Trevor I. Smith, Ian T. Griffin and Nicholas J. Wright - Rowan University

Data from the FMCE support findings that students' understanding of graphs impacts their abilities to express their understanding of the relationships between and among forces and various quantities of motion. We approach the current study with an assumption that measurements of student understanding of a particular topic depend not only on the student but also on the instrument used to make the measurement. Multiple measurements are needed to build a more complete picture of what the student actually "knows." We compare individual student responses to 12 specific questions on the FMCE from three question clusters. Each cluster provides students with four identical descriptions of object velocities. In one cluster students choose a description of an accompanying force, in the others students choose a graph of force or acceleration vs. time. We use Cohen's  $w$  to report the correlation between the clusters and consistency plots to show the impact of instruction.

# PERC 2016: Abstracts

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## Talk Symposium

### [Building Research Questions from Observational Data](#)

Organizers: Eleanor C. Sayre

#### [1\) From rich points to research questions: A design-based research approach](#)

Danielle B. Harlow and Alexandria K. Hansen, University of California, Santa Barbara

Design based research assumes a complex learning system and allows for researching cognition in context. Such research designs involve systematically observing and understanding learning while also designing curriculum, pedagogy, or contexts. The goal of design-based research is not to improve a specific context (though it may do so); the goal is to contribute to models and theories of how learners think. In our work, we create curricular modules based on research and then observe the curriculum in practice, paying special attention to instances when what happens in the classroom deviates from what we anticipate. We call these "rich points" after Agar's work (2000). Such events may indicate that elementary school students misinterpreted the activity goals (a local problem) or struggled to complete tasks we expect to be trivial (which may have implications for how children learn). Identifying such events through observations and discussion uncover new research questions and directions.

#### [2\) Rich interactions in an informal learning environment](#)

Katie Hinko, PISEC and JILA

Informal physics learning environments are often highly complex and can vary widely in terms of format, goals, and participants. Effective assessments of informal settings need to align with the rules and norms of the environment in order to accurately reflect students' knowledge and experiences. In the case of informal learning that is exploratory and self-directed, formalized assessments such as concept inventories with multiple choice or Likert-style questions may not be appropriate. Observational data is one means of capturing the dynamics of such informal environments. We have spent the past three years collecting video from afterschool sessions where K-8 children and university students work together on open-ended, hands-on physics activities. In our afterschool program, many independent activities take place simultaneously; to capture a sample of these activities, we have structurally embedded and normalized daily video/audio recording for participants. Based on the recorded interactions between participants, we have developed research questions by applying a socio-cultural lens. We analyze moments of "rich" interaction using an activity theoretic framework and have characterized the pedagogical moves by university student volunteers, the response of K-8 students to these moves and the generation of scientifically creative ideas by K-8 students. These research findings inform our own program design and contribute to the broader understanding of teaching and learning physics in informal environments.

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## [Building Research Questions from Observational Data \(continued...\)](#)

### [3\) Network analysis of student collaboration](#)

Annie Chase - San Jose State University

Justyna Zwolak - Florida International University IMPRESS Education Research Squad (IMPRESSERS)

How does student collaboration, both within small groups and between these groups, change in an intensive lab setting? We answer this research question by studying the IMPRESS (Integrating Metacognitive Practices and Research to Ensure Student Success) summer experience - a bridge program for first generation college and deaf/hard of hearing students designed to teach them how to reflect on, evaluate, and change their own thinking. The research team collected video data for the entire two week period, capturing small group and group to group interactions from a variety of angles. We apply social network analysis (SNA), a well suited approach for studying individual student integration into a group as well as the dynamics of the group as a whole, to the video data. SNA uses the notion of nodes and ties to represent students and interactions between them. This method of analysis gives us a way to describe the IMPRESS students' collaboration quantitatively and visually in order to answer our research question.

### [4\) Instructor's framing affects students' framing in upper-division physics problem solving](#)

Hai Nguyen and Deepa Chari - Kansas State University

Problem solving is an important part of learning physics at all levels. In our work, we study students' in-class problem solving in upper-division physics courses. We are particularly interested in how students interact with each other and with the instructor to use mathematics and build meaning in solving physics problems.

In our Electromagnetic Fields course, students spend the majority of class time solving problems in small groups; the instructor occasionally interrupts or assists them. From video data of students' problem solving, we abstract the students' and instructor's epistemological frames and frame shifts. We look for trends in how students shift between frames during problem solving, and how the instructor's framing affects the students'. From this quantitative work on framing trends comes new theory at the junction of framing and interaction analysis.

# PERC 2016: Abstracts

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## Talk Symposium

### Methodologies Using Identity Frameworks

Organizers: *Idaykis Rodriguez*

#### 1) Making Sense of Different Generalization and Selection Practices in PER

Amy D. Robertson, Rachel E. Scherr and Sarah B. McKagan - Seattle Pacific University

In this poster, we will unpack the claim that different ways of generalizing and selecting in PER are tied to different assumptions about knowledge, our social world, and our reasons for knowing it. In particular, we will compare and contrast the assumptions made by two different research paradigms: what we call case-oriented PER – which seeks to refine and develop theory by linking that theory to cases – and what we call recurrence-oriented PER – which seeks to inform instructional predictions by discerning reproducible, representative patterns and relationships. We will discuss how the different assumptions instantiated within these two paradigms can help us make sense of differences in generalization and selection practices in PER.

#### 2) Development of physics identity in self-concept and practice: analysis of the Learning Assistant experience

Eleanor W. Close, Jessica Conn and Hunter G. Close - Texas State University

The physics department at Texas State University has implemented a Learning Assistant (LA) program in our introductory course sequences. We are interested in how participation in the LA program influences LAs' identity both as physics students and as physics teachers; in particular, how being part of the LA community changes participants' self-concepts and their day-to-day practice. Our analytic lens is a blended theoretical framework informed by the physics identity framework developed by Hazari et al., which relies on self-report of experiences and self-perception; and Lave and Wenger's theory of Communities of Practice, which focuses on the ways in which identity is enacted and negotiated. We describe the two theories and build a correspondence between factors in the physics identity framework and community of practice theory. This blended theory is used to analyze video of LA interviews and written artifacts for evidence of shifts in LA identity.

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## [Methodologies Using Identity Frameworks \(continued...\)](#)

### [3\) Emergent Attitudinal Profiles of Introductory Engineering Students](#)

Jacqueline Doyle - Florida International University

Geoff Potvin - STEM Transformation Institute and Department of Physics, Florida International University

Traditionally, education studies that explicitly or implicitly examine differences between normative and non-normative groups have based their analysis by choosing a particular pre-defined normative group (e.g. majority race students), and then draw comparisons against that group. The researcher thus imposes a priori definitions of both what is important and how to group students for comparisons. This can put the research at odds with an intersectional approach to understanding individuals. A quantitative topological data analysis (TDA) allows us to answer research questions in a way that respects the intersectional diversity of the students. Using only quantitative affective data, including a spectrum of attitudes, beliefs and identity measures, but not student demographic information, we allow student responses to form emergent attitudinal profiles that define the normative characteristics of our sample of introductory engineering students.

### [4\) Scientific identity formation in black women physicists: A methodological approach](#)

Katemari Rosa - Universidade Federal de Campina Grande

When we look at underrepresented groups in science, Black women have particular experiences in the field. In this presentation we bring the perspectives of Black women in Physics in regards to the construction of scientific identity. Stemming from notions of identity as performance and using a Critical Race Theory (CRT) framework, we look at scientists' life trajectories to talk about how they develop their identity as physicists. Specifically, we will focus on the methods used to both unveil these narratives and analyze them. First, we will address interviewing as a method to collect data in Physics Education Research (PER). Then, we discuss the use of the qualitative analysis software Atlas.ti to help searching for emergent themes when dealing with interview transcripts as data. In addition, we talk about how qualitative analysis software can be an aid in reducing bias in qualitative research, which is rich and dense with information. With this work, we hope to bring CRT perspectives to the PER community and contribute with discussions around underrepresented groups in Physics.

# PERC 2016: Abstracts

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## Talk Symposium

### [Iteration, Ownership, and Emotions: Examining How Classroom Experiences in Physics Move Outside the Classroom](#)

*Organizers:*

*Leslie Atkins Elliott, Boise State University*

*Angela Little, Michigan State University*

*Discussant: Rosemary Russ - University of Wisconsin*

#### 1) Reducing the "real world"/classroom divide

Leslie Atkins Elliott - Boise State University

Angela Little - Michigan State University

What does it look like to create educational spaces that reduce barriers between the classroom and the "real world"? We report on two research strands (Transformative Experiences (TE) and Definitional Ownership (DO)) that examine related goals: students use ideas constructed in class (a concept or a definition) to "see" their everyday world in new and meaningful ways. (E.g. "I am now constantly thinking about how light rays travel" and "I see thresholds everywhere now!") Research on these strands require methodological innovations; we will discuss novel analysis methods as well as our ongoing efforts to connect with existing methodologies and research strands. For instance, the following shared theme has emerged from our joint work: positioning students as accountable authors (Greeno, 2006) of scientific concepts plays a role in an expansive framing (Engle, 2006; Engle, et al, 2012) of classroom activity; such framing, we hypothesize, fosters both TE and DO. Research supported through NSF Grant #1140785 and Spencer Foundation Grant #201100101.

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## [Iteration, Ownership, and Emotions \(continued...\)](#)

### 2) Articulating Problems

Anna Phillips, Jessica Watkins and David Hammer - Tufts University

"The formulation of a problem is often more essential than its solution, which may be merely a matter of mathematical or experimental skill. To raise new questions, new possibilities, to regard old questions from a new angle, requires creative imagination and marks real advance in science." (Einstein & Infield, 1938) We present results from a project, The dynamics of learners' engagement and persistence in science, funded by the Gordon and Betty Moore Foundation (#3475). In this work, we first identify exemplars of students' doing science, working with a team of scientists to vet candidate episodes from existing data as well as new data collected in undergraduate courses. We then analyze each case, to understand what we can of its particular dynamics. Finally, we look across the cases for patterns. In this presentation, we discuss one finding: Six of the nine cases involve students working to articulate and motivate problems, where by "problem," we mean an inconsistency or gap in understanding. This work of problematizing, we contend, reflects disciplinary practices in science: Doing science involves having and expressing uncertainty and confusion, and working within realms of uncertainty to pin down what, precisely, is not understood. We argue for valuing students' attempts at articulating a problem as scientific activity, and the articulation of a problem as a scientific achievement in its own right. Drawing on our analysis, we present responsive teaching moves and strategies that can support students' problematizing.

### 3) Meta-affective learning

Jen Radoff and David Hammer - Tufts University  
Lama Jaber - Florida State University

We present an analysis of interview data and written work from a freshman engineering student, Marya, to illustrate the substantive role of affect in her learning experiences within a reformed introductory physics course. Marya described how, through this course, she shifted from being intimidated by physics to feeling excited about and empowered to do physics. We claim that at the heart of Marya's transformation is a shift in her attitudes and dispositions with respect to struggle, confusion, and uncertainty in the doing of science. We see this shift as an example of meta-affective learning-- i.e., the development of productive feelings and dispositions for navigating intellectual challenges. Marya described how she came to see physics as a pursuit of understanding rather than being about absolutes. Correspondingly, she shifted from feeling anxious about "being wrong" to taking pleasure in exploring ideas and making discoveries. Marya's transformation invites us to attend carefully to the role of meta-affect in science, and to foster students' productive dispositions with respect to struggle, confusion, and uncertainty as an important target in science education.

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## [Iteration, Ownership, and Emotions \(continued...\)](#)

### [4\) Defining Professional STEM Practice](#)

Anne Leak and Ben Zwickl, Rochester Institute of Technology

We examine how math, physics, communication skills and other relevant ideas from undergraduate physics get utilized in optics and photonics workplaces by entry-level employees who have recently finished school. Nearly all of our research interests lie beyond content learning goals and emphasizes the context, goals, representations, and tools that define professional STEM practice. Our methodology involves a large scale ( $N = 100+$ ) qualitative study with in-depth (1 hour long) semi-structured interviews. Challenges include identifying appropriate samples across diverse contexts (even a limited field like optics has very diverse workplace practices), triangulating views on workplace skills (entry-level employee perspectives vs managers vs HR), making personal connections with a wide range of industry folks despite being an outsider from academia, organizing and analyzing large scale qualitative data, and trying to conduct and communicate research that both academically trained physicists and industrial physicists and engineers find relevant.

# PERC 2016: Abstracts

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## Talk Symposium

### Educating Pre-service Physics Teachers

Organizers:

*Shulamit Kapon - Technion, Israel Institute of Technology*

*Eugenia Etkina - Rutgers University*

#### 1) Strong introductory courses + professors who care about teaching = physics teachers

Gay Stewart and John Stewart, West Virginia University

Previously at the University of Arkansas (UA), and now at West Virginia University (WVU), we have led physics teacher preparation programs as part of the Physics Teacher Education Coalition (PhysTEC). Our invitation to apply as one of the first primary program institutions was initiated by our NSF program officer, based on his familiarity with our reformed introductory course. Years of student interviews supported that it was both the opportunity to engage in an environment supporting real learning with their peers and having professors who felt education was important that empowered students to choose a teaching career. 15 years after having its first PhysTEC graduate, UA remains in the 5+Club. At WVU, we are also seeing significant impact from these factors. We will discuss the characteristics reported by the students as most impactful on their decision to teach, and shown by our research to have strong correlation with improved learning.

#### 2) Project lab course for first year students: Cutting the Gordian knot in physics teacher preparation

Gorazd Planinsic - University of Ljubljana, Slovenia

One of the major problems in training of future teachers is finding an authentic environment where they can practice new approaches to teaching and learning. Ideally, you want to place your students with reformed in-service teachers but unfortunately often this is not possible. In our department we took a different approach. We created Project lab course which pre-service physics teachers take twice: first time as students (in their first year of studies) and second time as future teachers (in their 4th or 5th year). As first year students they work on open-ended experimental projects. During their second time, already enrolled in the Physics Teacher preparation program, they design project tasks for first year students, observe groups of students solving problems and evaluate their reports using scientific abilities rubrics. I will describe logistical details of such clinical experience and present examples of pre-service teacher work and their reflections on the experience.

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## [Educating Pre-service Physics Teachers \(continued...\)](#)

### 3) Changing the landscape of physics teaching – Helping engineers become effective physics teachers

Shulamit Kapon - Technion, Israel Institute of Technology

Avraham Merzel - Technion, Israel Institute of Technology and The Hebrew University of Jerusalem

In 2011, the Technion – Israel Institute of Technology launched a special program, Views, whose objective is to help alleviate the shortage in high-quality high school STEM teachers in Israel. Views invites Technion graduates to study towards an additional bachelor's degree in STEM education. In its first year, 60 students enrolled in the program; this year, the program has attracted over 300. The increase in the number and quality of students enrolling necessitated substantial reform of the teacher preparation courses. We will review the theoretical underpinning of the reformed program of the physics education track; discuss in detail the design of one of the physics teaching methods courses; and present preliminary findings from a study that followed the students throughout this course, focusing on challenges these pre-service teachers experienced in the design and teaching of engaging lessons in physics, and on our support of the students in this process.

### 4) [A theory-guided research agenda for physics teacher education](#)

Eugenia Etkina - Rutgers University

Bor Gregorcic - Uppsala University

Stamatis Vokos - Seattle Pacific University

The authors have recently proposed a theoretical perspective to guide the development and improvement of physics teacher education (PTE) programs. According to the Development of Habits through Apprenticeship in a Community (DHAC), the primary role of PTE programs is to help novice teachers to develop the requisite habits of mind and habits of practice through apprenticeship in a community centered around master teachers and veteran teachers, all of whom share a similar framework for what physics learning consists of and how it can be realized. This conceptual model explains features of effective PTE programs and makes testable predictions. In this session, the authors will describe briefly the DHAC theoretical perspective and propose a research agenda to test it, refine it, and build on it.

# PERC 2016: Abstracts

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## Talk Symposium

### [Conceptual Issues and Content Revisions in the Introductory Physics Course for Life Science Students](#)

*Organizers: Nancy Beverly - Mercy College*

#### 1) Authenticity as a Lens for UMD's NEXUS/Physics IPLS Course

Kim Moore - Department of Physics, University of Maryland  
Deborah Hemingway - Biophysics Program, University of Maryland

Life Science students in required Introductory Physics courses pose an intriguing challenge to the PER community. This talk explores UMD's response to the pedagogical issues of and content revisions needed in IPLS courses, as life science students often are resistant to and question the biological relevance and authenticity of the subject matter. To address this student response, we advocate for the creation of course revisions built on a theoretical framework that encompasses biological authenticity; authentic scientific practice; student-centered, active learning; and attention to affect--all coupled to iterative revision with experience. We do this through a discussion of how prior and current PER work can be used to form a theoretical framework for content revision and course development, providing both existing illustrative examples from the UMD NEXUS/Physics project ([www.nexusphysics.umd.edu](http://www.nexusphysics.umd.edu)) and newly-developed examples from the Understanding and Overcoming Barriers to Using Mathematics in Science project as context.

#### 2) Assessment of a multimedia IPLS course

Ralf Widenhorn and Elliot Mylott - Portland State University  
Warren Christensen, North Dakota State University

We will present the preliminary results of an assessment of student attitudes toward an introductory course for pre-health students that focuses on the physics of biomedical technologies. The course follows a partially flipped classroom model and incorporates multimedia elements including video interviews with biomedical experts, an online homework system, and original texts. Student attitudes were measured using the Colorado Learning Attitudes about Science Survey, additional survey questions specific to the course, and student interviews. Students' conceptual understanding of the physics material and its application in biomedical technology was also assessed. The results of the IPLS course will be compared to those of the traditional course, which was taught concurrently and covered similar physical concepts.

This work was supported by grants (DUE-1141078 and DUE-1431447) from the National Science Foundation.

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## [Conceptual Issues and Content Revisions in the IPLS Students \(continued...\)](#)

### [3\) The Need For New Instruments: Assessing Interdisciplinary Thinking](#)

K. K. Mashood, Vashti Sawtelle, Charles W. Anderson, Rebecca L. Matz, Emily E. Scott, Sonia M. Underwood - Michigan State University

Interdisciplinary thinking and reconciliation is integral to developing a coherent understanding of science. Significant research has gone into addressing this problem, particularly in the context of biology and physics. Projects like NEXUS resulted in the development of courses and materials that are meaningful to students across the disciplines and can serve as prototypes for similar endeavors. The development of these research-based courses has created a need for new assessment tools. We outline the preliminary stages of development of an instrument to assess how students connect essential ideas across introductory science disciplines and how students expect the disciplines to relate. Semi-structured interviews were conducted with 12 biology majors enrolled in a physics course. The students were asked to explain everyday interdisciplinary phenomena as well as to describe their attitudes toward different disciplines and making connections between them. An analysis of these interviews is a first step toward developing a framework for an interdisciplinary assessment.

### [4\) The source of student engagement in IPLS](#)

Benjamin D. Geller and Catherine H. Crouch - Swarthmore College  
Chandra Turpen, Department of Physics, University of Maryland

Effectively teaching an Introductory Physics for the Life Sciences (IPLS) course means engaging life science students in a subject matter for which they may not have considerable preexisting interest. While we have found that the inclusion of topical examples of relevance to life-science students can help to engage students whose initial interest in physics is less developed, we have found that the inclusion of biological content is just one of several dimensions supporting student engagement in IPLS. When describing what is salient to them about their IPLS experiences, students are just as quick to cite particular pedagogical structures and supports as they are to cite issues relating directly to content choices. In this talk we begin to unpack this complex interplay of content and pedagogy in fostering student engagement in the IPLS classroom. We also describe the role that explicit messaging around disciplinary coherence may play in students' experiences.

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## [Conceptual Issues and Content Revisions in the IPLS Students \(continued...\)](#)

### [5\) Examining the implementation of a new IPLS course at UNC-CH](#)

Alice D. Churukian, Duane L. Deardorff, David P. Smith, Colin S. Wallace, Laurie E. McNeil  
- University of North Carolina at Chapel Hill

At the University of North Carolina at Chapel Hill, we have completed the implementation of our redesigned introductory physics course for life science (IPLS) majors. The new course aligns introductory physics concepts with authentic biological applications. We were influenced by cognitive theories of learning to reform the pedagogy to confront or build upon students' prior knowledge and intuitions in order to develop more expert-like understandings. This reformed pedagogy, implemented in the lecture/studio format [1,2], fosters student participation and enculturation into the practices of the discipline, as advocated by situated models of learning. We will present data on the effectiveness of this course, including results from well-known concept inventories such as the FCI and CSEM, and student performance on exam questions. We will make comparisons to data collected prior to the course transformation and present a review of student survey data, C-LASS results, and comments from faculty teaching the course.

1. C.M. Sorensen, A.D. Churukian, S. Maleki, and D.A. Zollman, "The New Studio format for instruction of introductory physics," *Am. J. Phys.* 74, 1077-1082 (2006).
2. T. Furtak and T. Ohno, "Installing studio physics," *Phys. Teach.* 39, 11-15 (2001).

This work has been supported in part by the National Science Foundation under Grant No. DUE-1323008.

# PERC 2016: Abstracts

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## Poster Symposium

### Network Analysis in Physics Education Research

Organizers:

*Adrienne Traxler - Wright State University*

*Jesper Bruun - Institut for Naturfagenes Didaktik*

#### 1) Students' progress during an assignment in computational physics: mental models and code development

Madelen Bodin - Umeå University

Solving physics problems in university physics education using a numerical approach requires knowledge and skills in several domains, for example, physics, mathematics, programming, and modeling. In this study students' mental models are monitored using interviews at several occasions during an assignment in computational physics. The interview data was analysed using a network analysis approach. Interview transcripts were coded according to the context dependent concepts that were used to define the particular context and situation of this assignment. The adjacency of concepts in the transcripts was assumed to reflect the associations between them made by students, and thus representing students' mental models of the problem solving situation at the time of the interview. For each student a network was built where the concepts were nodes and their adjacency formed the links between them. The changes in students' mental models between the interview occasions gave important information about what the students were focusing on at different stages of the solution process. What students focused on at the different interview occasions was assumed to be an indication of what they believed was useful in solving the task. The visualization of the mental models showed that at the beginning students were concerned about how to deal with writing the Matlab code that was needed to model the problem. As students got more comfortable with the coding process, the physics needed to assure that their simulation was following physics principles, such as energy conservation, became more and more central in their narratives. This study gives important contribution to how networks can be used to model students' thinking in a particular context and provides important knowledge about students' progress in a task in computational physics.

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## [Network Analysis in Physics Education Research \(continued...\)](#)

### [2\) Ego network analysis of upper division physics student survey](#)

Eric Brewe, Justyna Zwolak, Remy Dou, and Eric Williams - Florida International University

We present the analysis of ego networks derived from a survey of upper division physics students. Analysis of ego networks are somewhat different than network analyses that are becoming more common in PER. Ego networks focus on the connections that center on one person (the ego). The ego networks in this poster come from a survey that is part of an overall project focused on understanding student retention and persistence. The theory underlying this work is that social and academic integration are essential components to supporting students continued enrollment and ultimately graduation. This work uses network analysis as a way to investigate the role of social and academic interactions in retention and persistence decisions. We focus on student interactions with peers, on mentoring interactions with physics department faculty, and on engagement in physics groups and how they influence persistence. Our results, which are preliminary, will help frame the ongoing research project and identify ways in which departments can support students.

### [3\) Investigating physics learning with layered student interaction networks: Combining time and modes of interaction](#)

Jesper Bruun - Institut for Naturfagenes Didaktik

Network analysis has previously been employed to show that centrality in student interaction networks can predict future grades. However, previous analyses have only been employed on isolated categories of student interactions which have been summed over time. In this study we use multiplex (layered) networks to relax these constraints. Within a week, we now allow bidirectional links between the same student as represented in two different layers, for example a layer representing problem solving interactions and another representing conceptual discussion, to model how these layers may interact. Likewise, we allow links from a student as represented in a network at time,  $t$ , and the same student in the network for time,  $t+1$ . The nature of links between network layers is different from the original links and thus need a theoretically based model. These models may yield insights into the interplay between categories of interaction into the significance of time development.

# PERC 2016: Abstracts

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## [Network Analysis in Physics Education Research \(continued...\)](#)

### [4\) Integrating text-mining, network analysis and thematic discourse analysis to produce maps of student discussions about sustainability](#)

Mats Lindahl - Linnaeus University  
Jesper Bruun - Institut for Naturfagenes Didaktik  
Cedric Linder - Uppsala University

We use a combination of network analysis (NA), text-mining (TM) techniques, and thematic discourse analysis (TDA) to characterise and compare student discussions about sustainable development. Three student groups at three different times were analysed. The analysis entails an iterative design where NA, TM, and TDA continuously inform each other to produce a rich and coherent picture of the discussions. The output of such an analysis is a set of maps of these discussions, which have both qualitative and quantitative uses. Qualitatively, the maps show how thematic patterns in the discussions are related for each group, and we can see how discourses differ between groups as well as over time. Quantitatively, we use network motif analysis, entropy based measures, and degree distributions to distinguish between discussions.

### [5\) CourseNetworking and community: Linking online discussion networks and course success](#)

Adrienne L. Traxler - Wright State University  
Andy Gavrin - Indiana University-Purdue University Indianapolis  
Rebecca Lindell - Purdue University

We report on connections between student participation in an online course forum and their grades in an introductory physics class. Discussions started before the semester, ended after finals, and continued well beyond the level incentivized by extra credit. We collect all posts and replies and construct a bipartite network of actors (students) and events (threads) in the forum. The actor projection of this two-mode network is a weighted representation of students' mutual participation in discussion threads, and shows whether they are central or peripheral participants in the semester-long discussion community. We look for significant links between network centrality and final grades, as part of a larger investigation of the CourseNetworking software as an online community-building tool. These questions are especially relevant for institutions with many commuter and non-traditional students, where asynchronous forum talk is a key way for students to engage with their peers outside of class time.

# PERC 2016: Contributed Posters

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## First Timer, Undergraduate Poster Session

1) Self-Perception of Teaching Fellows and Learning Assistants in Introductory Physics Classes  
Becker, Alexander P., Boston University

2) Relevance and Responsibility: Preliminary Results from the Implementation of a Cooperative Problem-Solving in a Large Introductory Physics Course  
Burgasser, Adam, UC San Diego

3) Argumentation during active learning strategies in a SCALE-UP environment  
Campos, Esmeralda, Tecnologico de Monterrey

4) Classroom-Based Field Experiences in High School STEM Academies: Opportunities to Observe and Participate in High-Leverage Science Teaching Practices  
Carpenter, Stacey, University of California, Santa Barbara

5) Students' identification of Newton's third law's force pairs in the presence of gravitational force  
Castro, Eduardo, Tecnologico de Monterrey

6) Decreased failure rates across all ethnicities in UC Davis CLASP  
Chessey, Mary, University of California, Davis

7) Role-plays for preparing physics teaching assistants and learning assistants  
Cook, Monica K., Georgia State University

8) The impact of metacognitive activities on student attitudes towards experimental physics  
Eblen-Zayas, Melissa, Carleton College

9) Introducing Coarse-Graining: From Molecular Dynamics to Random Walks  
Edri, Haim, Weizmann Institute of Science

10) Investigating student ability to follow and evaluate reasoning chains  
Ferm Jr., William N., University of Maine

11) Examining student engagement with activity theory in an afterschool physics program  
Franco, Nevil, University of Colorado - Boulder

12) Traditional physics vs IPLS: Comparing student experiences  
Franklin, Max, Swarthmore College

13) Differential Impacts of Aligning Expectations in Introductory Physics Labs  
Funkhouser, Kelsey, Michigan State University

14) Students' Social Media Participation is Positively Correlated with Homework Effort  
Gavrin, Andy, IUPUI

# PERC 2016: Contributed Posters

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## First Timer, Undergraduate Poster Session

15)The Creation {and Annihilation} of Quantum Mechanics Exam Questions Using ACER  
Green, Chrystin, California State University Fullerton

16)Exploring the Role of Design Problems in the Physics Classroom  
Hamerski, Paul, Michigan State University

17)Making and Breaking Bones: Learning Physics through Engineering Design  
Hansen, Alexandria, University of California

18)Exploring Optimal Learning Moments at Physics Tutorial Sessions  
Hendolin, Ilkka, University of Helsinki

19)Gender, Network Analysis, and Conceptual Gains in Introductory Physics  
Hierath, Sarah, Wright State University

20)Analysing discourse and identity in physics education: Methodological considerations  
Johansson, Anders, Uppsala University

21)The Sundial Project: Building Equity and Community Through Science  
Johnson, Kali, Arizona State University

22)Improving student understanding of degenerate perturbation theory in quantum mechanics  
Keebaugh, Christof, University of Pittsburgh

23)Examining Gender Biases Within the Physics Learning Assistant Program  
Kim, Lauren, California Polytechnic University, Pomona

24)Faculty expectations of dimensional analysis  
Lenz, MacKenzie, Oregon State University

25)Measuring Problem Solving Skill Gains in a Flipped Cooperative Problem-Solving Model  
Introductory Physics Course at UC San Diego  
Lopez, Mike Albert, UC San Diego

26)Adapting AAPT Lab Recommendations to Meet Local Conditions: DATA Lab  
Martinez, William, Michigan State University

27)Pedantic and Unnecessary - Student Use of Units in Physics Problems Involving Integrals  
Mays, Mikayla, California State University Fullerton

28)Student response to a grading approach based on gaming  
McColgan, Michele, Siena College

29)"This sounds like science": The impact of epistemological framing  
Monaghan, Isabel, Grinnell College

# PERC 2016: Contributed Posters

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## First Timer, Undergraduate Poster Session

30) [Examining the relationship between Career Outcome Expectations and Physic Identity](#)  
Monsalve, Camila, Florida International University

31) [Teaching experimental and data analysis skills in online labs](#)  
Moosvi, Firas, University of British Columbia

32) [Investigating student learning with accessible interactive physics simulations](#)  
Morgan, Elise C., University of Colorado Boulder

33) [Middle division students' reasoning while "coordinatizing" coordinate independent integral equations.](#)  
Mulder, Gregory, Oregon State University

34) [Promoting student engagement in scientific practice in an introductory laboratory](#)  
Nair, Abhilash, Michigan State University

35) [Extending psychometric analysis of gender differences on the FCI](#)  
Papak, Alexis, University of Illinois at Urbana-Champaign and Purdue University

36) [Modeling Instruction: Optics](#)  
Pendas, John K., Florida International University

37) [CU-Prime: Empowering Students to Build Inclusive Physics Communities](#)  
Pollard, Benjamin, CU Boulder

38) [Improving representation in physical sciences using a Departmental Action Team](#)  
Rainey, Katherine, University of Colorado at Boulder

39) [Developing a Competency Based Introductory College Physics Curriculum for Non-Physics Majors](#)  
Rajapaksha, Ajith, Purdue University

40) [A Pedagogical Method of Advanced Laboratory Writing: Letters Home Project](#)  
Ramey, II, Charles L, Texas Tech University

41) [Thinking about Thinking: Preliminary Analysis of Students' Metacognitive Reflections in Lecture versus Cooperative Problem-Solving Introductory College](#)  
Rodrigues, Isabela Abreu, University of California, San Diego

42) [A comparison of students' written explanations and CLASS responses](#)  
Rowe, Gabriel, Clark University

43) [Non-Traditional Student Status, Conceptual Gains and Centrality in Introductory Physics](#)  
Sandt, Emily, Wright State University

# PERC 2016: Contributed Posters

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## First Timer, Undergraduate Poster Session

44) Students' understanding of the magnetic force exerted on a charged particle

Sanchez-Mata, Oscar, Tecnologico de Monterrey

45) Physics Teacher's Questioning Patterns and the Reasoning Behind Them

Santangelo, Brianna, The College of New Jersey

46) Developing the Next Generation of Computer Coach Tutorials

Santiago, John R., Cal Poly Pomona

47) Introductory Physics Students' Epistemological Resources

Scanlon, Erin, Texas State University

48) Probing Student Ability to Construct Reasoning Chains: A New Methodology

Speirs, J. Caleb, University of Maine

49) The Effects of Laboratory Redesign on Conceptual Learning and Learning Attitudes

Topdemir, Zeynep, Georgia State University

50) A Cross-sectional Study of Students' Use of Mathematics

Turnbull, Anna, Michigan State University

51) Student understanding of unit vectors and coordinate systems beyond cartesian coordinates in upper division physics courses

Vega, Marlene

52) Epistemic Games and Activity Theory: A Multi-Layered Task Analysis

Vignal, Michael, Oregon State University

53) Assessing Student Learning and Improving Instruction with Transition Matrices

Walter, Paul J., St. Edward's University

54) Student Understanding of Period in Introductory and Quantum Physics Courses

Wan, Tong, University of Washington

55) Comparing Students' performance in quantum mechanics between China and the US

Wang, Jue, East China Normal University

56) Students' writing reflects varied solution schemata on homework problems in upper division physics courses

Weliweriya, Nandana, Kansas State University

57) National Assessment Impact of Learning Assistants on Physics Students' Learning

White, Jada-Simone S., California State University, Chico

58) Improving Student Understanding of Vector Fields in Junior-Level E&M

Xue, Bert, University of Washington

# PERC 2016: Contributed Posters

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## First Timer, Undergraduate Poster Session

59) Exploring the Role of Gender and Expertise in CLASS Responses through Graduate Students

Zamarripa-Roman, Brian, University of Central Florida

60) Learning Progression of Mental Models on Conductor and Dielectric

Zhang, Jing, Yangtze university

## Poster Session I

1) Investigating Student Pathways at a Research University

Aiken, John M., Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences

2) Classroom Instruction Promotes Posterior Medial Cortex Brain Activity During Problem-Solving

Bartley, Jessica E, Florida International University

3) Algebra-Based Students & Vectors: Assessing Physical Understanding in Arrow vs  $ijk$

Buncher, John B., North Dakota State University

4) Analysis of student performance on the Mechanics Reasoning Inventory

Chen, Zhongzhou, Massachusetts Institute of Technology

5) Teleology as Placeholder: The Coordination of Teleology and Mechanism In Experts' and Novices' Physics Explanations

Conlin, Luke, Stanford University

6) Impacts of teaching style and on retention of underrepresented groups in STEM

Dancy, Melissa, University of Colorado

7) Active Learning and Learning Assistant Support Predictors of Student Success

Doughty, Leanne, University of Colorado Denver

8) Fostering Transfer through Intercontextuality

Elliott, Leslie Atkins, Boise State University

9) Understanding the impact of institutional structures and cultural practices on university informal physics programs

Fracchiolla, Claudia, University of Colorado - Boulder

10) A conceptual blending analysis of student immersive engagement with an interactive whiteboard

Gregorcic, Bor, Uppsala University

# PERC 2016: Contributed Posters

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## Poster Session I

11) [The Effect of Themed Learning Community on Physics Students' Performance](#)

Hashimoto, Wataru, Northern Illinois University

12) [University physics students' attitudes and experiences in informal physics programs](#)

Hinko, Kathleen, University of Colorado Boulder

13) [Understanding connections between physics and racial identities through recognition and relational resources](#)

Hyater-Adams, Simone, University of Colorado Boulder

14) [The Effects of Formative Feedback in Introductory Physics](#)

Irving, Paul, Michigan State University and CREATE for STEM Institute (MSU)

15) [Examining Student Participation in Collaborative Exams through Video Analysis](#)

Ives, Joss, University of British Columbia

16) [Applying Business Literature to Product Development in STEM Education](#)

Khatri, Raina, Western Michigan University

17) [Contextualizing problem-solving strategies in physics-intensive PhD research](#)

Leak, Anne E., Rochester Institute of Technology

18) [Deltas, differentials, and derivatives: navigating the mathematics of change](#)

Loverude, Michael, California State University Fullerton

19) [Design and evaluation of campus-wide professional development program in STEM](#)

McInerny, Alistair, North Dakota State University

20) [Effect of Animated Solution Videos on Physics Learning](#)

Morphew, Jason, University of Illinois at Urbana-Champaign

21) [Using phenomenography to better understand student development with computational physics](#)

Obsniuk, Michael J., Michigan State University

22) [Student Self-Assessment and Reflection in a Learner Controlled Environment](#)

Phillips, Jeffrey A., Loyola Marymount University

23) [Attending to Scientific Practices within Undergraduate Research Experiences](#)

Quan, Gina, University of Maryland, College Park

24) [Comparing Two Activities' Effectiveness Improving Reasoning with Multiple-Variable Information](#)

Rosenblatt, Rebecca J, Illinois State University

# PERC 2016: Contributed Posters

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## Poster Session I

25) Spin First vs. Position First instructional approaches to teaching introductory quantum mechanics

Sadaghiani, Homeyra, Cal Poly Pomona

26) Student use of symbolic forms when constructing differential vector elements

Schermerhorn, Benjamin, University of Maine

27) Cognitive wrappers: Learning how to learn physics

Soto, Patricia, Creighton University

28) Large-scale Assessment Yields Evidence of Minimal Use of Reasoning Skills

Thacker, Beth, Texas Tech University

29) Linking workshop design to how faculty engage in professional development

Turpen, Chandra, University of Maryland

30) A Taxonomy of Conceptions About Buoyancy

Wagner, DJ, Grove City College

31) Performance and Active Engagement through the Lens of Classroom Networks

Williams, Eric A., Florida International University

32) How Did End-Of-Chapter Problems Change Over 30 Years?

Xiao, Bin, North Carolina State University

33) Characterizing problem types and features in physics-intensive PhD research

Zwickl, Benjamin, Rochester Institute of Technology

## Poster Session II

34) Challenging engineering students to think critically in a new flipped, design-based introductory physics laboratory

Ansell, Katherine, University of Illinois at Urbana-Champaign

35) Can Analogical Reasoning Help Students Learn to Solve Synthesis Problems?

Badeau, Ryan, The Ohio State University

36) Self-directed learning in the introductory university physics classroom

Barker, Brent, Roosevelt University

37) Developing valid assessments of group effectiveness

Brookes, David, California State University, Chico

# PERC 2016: Contributed Posters

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## Poster Session II

38) National survey of the uses of, resources for, and attitudes toward computation  
Caballero, Marcos, D., Michigan State University

39) Exploring Student Thinking on Non-Cartesian Coordinate Systems  
Christensen, Warren, North Dakota State University

40) Student discourse about equity in an introductory college physics course  
Daane, Abigail, Seattle Pacific University

41) Differentiated Self-Efficacy within Physics, Science, Mathematics, and Engineering  
DeVore, Seth, West Virginia University

42) "Nothing works the first time": An experimental physics epistemology  
Dounas-Frazer, Dimitri, R., University of Colorado Boulder

43) Investigating Effects of Reformed Laboratories on Student Motivation and Attitude  
Evans, William R., University of Illinois at Urbana-Champaign

44) Drawing Energy: Evidence of NGSS for Energy in Learners' Diagrams  
Gray, Kara, E., Seattle Pacific University

45) Managing Frustration in a Semester-Long Mastery-Style Homework Course  
Gutmann, Brianne, University of Illinois at Urbana-Champaign

46) Incorporating Research-Based, Biologically-Authentic Physics Problems in IPLS  
Hemingway, Deborah, University of Maryland

47) Graduate teaching assistants use different criteria when grading introductory physics vs. quantum mechanics problems  
Henderson, Charles, Western Michigan University

48) Preliminary development and validation of a diagnostic of critical thinking for introductory physics labs  
Holmes, Natasha, Stanford University

49) Authentic research experience in high school physics: Learning, mentorship, and social infrastructure  
Kapon, Shulamit, Israel Institute of Technology

50) Understanding and Supporting Faculty Use of Large Educational Data  
Knaub, Alexis, V., Western Michigan University

51) Pretest and Gain in Assorted Concept Inventories  
Lieberman, David, Queensborough Community College

# PERC 2016: Contributed Posters

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## Poster Session II

52) Student Difficulties with Quantum Operators Corresponding to Observables

Marshman, Emily, University of Pittsburgh

53) Open-ended Design and Peer Review in NEXUS/Physics IPLS

Moore, Kim, University of Maryland

54) Design and assessment of multimedia modules for physics instruction in a flipped classroom course for pre-health and life science majors

Mylott, Elliot, Portland State University

55) Student understanding of time-dependence in spins-first Quantum Mechanics

Passante, Gina, California State University Fullerton

56) STEM Ambassadors: An undergraduate-powered outreach program

Price, Edward, California State University San Marcos

57) Exploring the Role of Content Knowledge in Responsive Teaching

Robertson, Amy, D., Seattle Pacific University

58) Multiple-Choice Assessment for Upper-division Electrodynamics

Ryan, Qing, Cal Poly Pomona

59) A Design Research Project for an IPLS Course

Sawtelle, Vashti, Michigan State University

60) Sense-making with Inscriptions in Quantum Mechanics

Sohr, Erin Ronayne, University of Maryland College Park

61) Relationship between students' affect and their sense of ownership of upper-division lab projects

Stanley, Jacob, T., University of Colorado - Boulder

62) Using Spaced Recall to Encourage Expert Practice

Torigoe, Eugene, Thiel College

63) Impact of reformed pedagogy students' epistemologies about experimental physics

Wilcox, Bethany, R., University of Colorado at Boulder

64) "Collectively, we're a genius": Teachers discussing student difficulties\*

Wittmann, Michael, C., University of Maine

65) University students' understanding on generalized work-energy principle in introductory physics courses: a study in two countries

Zavala, Genaro, Tecnológico de Monterrey

# PERC 2016: Contributed Posters

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## Poster Session II

66)Effect of Active Learning on Student Attitudes towards Learning Physics

Zeng, Liang, The University of Texas-Rio Grande Valley

## Poster Session III

1)Influence of Sensorimotor Experience on Understanding Center of Gravity

Agra, Elise, University of Chicago

2)Problematizing "cold" with K12 Science Teachers

Alvarado, Carolina, University of Maine

3)Can middle school students reasoning abilities be enhanced?

Aubrecht, Gordon, J., Ohio State University

4)Exploring Student Difficulties with Introductory Cosmology

Baily, Charles, University of St. Andrews

5)Conceptual Survey of Electricity and Magnetism: Analysis of the items and recommendations

Barniol, Pablo, Tecnologico de Monterrey

6)Evaluation of Student Self-Assessment in a Competency-based IPLS Course

Beverly, Nancy, Mercy College

7)Using lab reports to help students develop scientific abilities

Bugge, Danielle, Rutgers University

8)Better Questions for Peer Instruction

Cao, Ying, Oregon State University

9)Assessment with purpose: Evaluation of the New Faculty Workshop experience

Chasteen, Stephanie, Sciencegeekgirl enterprises LLC

10)Investigating the evolution of partnerships between physics faculty at Two-Year Colleges and Four Year Universities

Cochran, Geraldine L., Rutgers University

11)Sleep and Test Performance

Coletta, Vincent P., Loyola Marymount University

12)How Can Asynchronous Communication Support Virtual Faculty Learning Communities?

Corbo, Joel C., University of Colorado Boulder

13)Investigating students' understanding of ac biasing networks\*

De Bogart, Kevin L. Van, University of Maine

# PERC 2016: Contributed Posters

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## Poster Session III

14) Successful STEM Student Pathways: A two- and four-year partnership

DeLeone, Charles J., California State University San Marcos

15) Transformative Experience in Introductory Physics

Donnelly, David, Texas State University

16) Peer and Expert Evaluations of Students' Video Lab Reports

Douglas, Scott, Georgia Institute of Technology

17) Drawing physical insight from mathematics via extreme case reasoning

Eichenlaub, Mark, University of Maryland

18) Student Understanding of Superposition: Vectors, Waves, and Wave Functions

Emigh, Paul J., University of Washington

19) Longitudinal study of RTOP scores in a cohort of teachers in high need schools

Falconer, Kathleen, Buffalo State College

20) The source of student engagement in IPLS

Geller, Benjamin, Swarthmore College

21) Project Accelerate: A Scalable University – HS Partnership Bringing AP® Physics 1 to Underserved Students

Greenman, Mark D., Boston University

22) Utility of the Cognitive Reflection Test in research on student reasoning in physics\*

Grosz, Nathaniel, North Dakota State University

23) Drawing Attention to Details: How sketching and problem-solving frameworks support student thinking

Hallinen, Nicole R., Temple University

24) Investigating Student Understanding of Vector Calculus in Junior-Level E&M

Hazelton, Ryan., University of Washington

25) Social Positioning and Consensus Building in “Board” Meetings With Disagreements

Hinrichs, Brant., Drury University

26) Exploring the relationship between exam performance and lecture/recitation attendance

Hirsch, Andrew, Purdue University

27) Incorporating experiments into epistemology: Views from introductory-level to PhD students

Hu, Dehui, Rochester Institute of Technology

28) Synthesis physics problem solving with varying mathematical complexity

Ibrahim, Bashirah, The Ohio State University

# PERC 2016: Contributed Posters

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## Poster Session III

29) [In-class vs. Online Administration of Concept Inventories and Attitudinal Assessments](#)  
Jariwala, Manher, Boston University

30) [Text Mining Social Media in an Introductory Physics Course](#)  
Kelley, Patrick, Indiana University-Purdue University Indianapolis

31) [AP Chemistry Content Knowledge and Guided Inquiry Lab Instructional Strategies](#)  
Knapp, Emily, University of Colorado Boulder and Longmont High School

32) [Concept Inventories and the Next Generation of Assessment](#)  
Laverty, James T., Michigan State University

33) [Using contrasting cases to develop student metacognitive knowledge about salient distracting features in physics problems](#)  
Le, Thanh K., University of Maine

34) [Being a Supplemental Instruction Leader: More than Just a Job](#)  
Li, Sissi L., California State University Fullerton

35) [Context Dependent Mindset: Building New Frameworks and Measurement Methodologies](#)  
Little, Angela, Michigan State University

36) [Attitudes of Life Science Majors Towards Computational Modeling in Introductory Physics](#)  
Lunk, Brandon, Texas State University

37) [The impact of students' epistemological framing on a task requiring representational consistency\\*](#)  
Maries, Alexandru, University of Cincinnati

38) [Role of Group Dynamics in Analysis of Attitudes towards Metacognitive Physics Problem Solving](#)  
Mason, Andrew J., University of Central Arkansas

39) ["Pulling out" as a procedural resource when solving partial differential equations](#)  
Modir, Bahar, Kansas State University

40) [Student Difficulties in Graduate-Level Quantum Mechanics](#)  
Porter, Christopher D., The Ohio State University

41) [Using RealTime Physics with different instructional technologies in a circuits lab](#)  
Quezada-Espinoza, Monica, Tecnologico de Monterrey

42) [Argumentation Prompts Mediating Student Resource Use on Conceptual Problems](#)  
Rebello, Carina M., Purdue University

43) [TheFlippedClassroom.com](#)  
Ross, Jerry, East Stroudsburg University

# PERC 2016: Contributed Posters

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## Poster Session III

44) [Leveraging the expertise of the urban STEM student in developing an effective LA Program: LA and Instructor Partnerships](#)  
Sabella, Mel, Chicago State University

45) [Using a parachute class to retain students in introductory physics classes](#)  
Saul, Jeff, Tiliadal STEM Education Consulting

46) [The impact of peer interaction on the responses to clicker questions in upper-level quantum mechanics](#)  
Sayer, Ryan T., University of Pittsburgh

47) [Education Metaphors We Live By](#)  
Scherr, Rachel, Seattle Pacific University

48) [Student difficulties with expectation values in quantum mechanics](#)  
Singh, Chandralekha, University of Pittsburgh

49) [Active learning in pre-class assignments: Exploring the use of interactive simulations to enhance reading assignments](#)  
Stang, Jared, University of British Columbia

50) [A methodology for developing physics activities utilizing cutting edge topics in planetary science](#)  
Steckloff, Jordan, Purdue University

51) [Developing student attitudes in the first-year physics lab](#)  
Strubbe, Linda, University of British Columbia

52) [CourseNetworking and community: Linking online discussion and networks and course success](#)  
Traxler, Adrienne L., Wright State University

53) [The "revisiting" strategy in physics tutorials](#)  
Von Korff, Joshua, Georgia State University

54) [Characterizing Studio Physics Instruction Across Instructors and Institutions](#)  
Wilcox, Matthew, University of Central Florida

55) [Group Formation on Physics Exams](#)  
Wolf, Steven, East Carolina University

56) [Eye movements on Conceptual Physics Tasks: Effects on Multimedia Hints](#)  
Wu, Xian, Kansas State University

57) [Life Science Students' Productive Reasoning about Ideal Gasses](#)  
Young, Daniel, Gustavus Adolphus College

# PERC 2016: Contributed Posters

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## Poster Session III

58)The challenges of changing TAs' grading practices: Shifting the burden of proof from the instructor to the student

Yerushalmi, Edit

59)Investigating Students Understanding Early Atom models via Model-Based Inquiry

Yuksel, Tugba, Purdue University

60)What can assignments and assessments tell us about instruction in physics?

Zisk, Robert, Rutgers University

61)Effect of Visual Cues and Video Solutions on Students' Eye-gaze pattern

Zu, Tialong, Purdue University

# PERC 2016: Restaurant Guide

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In an attempt to reduce the registration costs for PERC 2016 there will be no banquet this year. Listed below are links to various food orientated apps and a similar search for the area surrounding the convention center and Sheraton hotel. These links are clickable via the pdf version of the program, however, for your convenience, there is also a small section indicating a variety of restaurants in the area with maps to their locations from the hotel. We hope that attendees will see this as an opportunity to invite people into our community. Dinner could be the opportunity to start a new collaboration, so if you are having an interesting conversation with someone you have never met before, please do invite them to dinner with you.

[TripAdvisor]

[https://www.tripadvisor.com/RestaurantsNear-g32999-d1419963-Sacramento\\_Convention\\_Center-Sacramento\\_California.html](https://www.tripadvisor.com/RestaurantsNear-g32999-d1419963-Sacramento_Convention_Center-Sacramento_California.html)

[GoGoBot]

<https://www.gogobot.com/sacramento-ca/things-to-do/sacramento-convention-center/nearby-restaurants>

[YELP]

[http://www.yelp.com/search?find\\_desc=Restaurants+Near+Convention+Center&find\\_loc=Sacramento%2C+CA](http://www.yelp.com/search?find_desc=Restaurants+Near+Convention+Center&find_loc=Sacramento%2C+CA)

[OpenTable]

<http://www.opentable.com/landmark/restaurants-near-sacramento-convention-center>

# PERC 2016: Restaurant Guide

## Mother

★★★★☆ 457 reviews [Details](#)

\$\$ · Vegetarian, American (New) [Edit](#)

"The squash **latkes** were crispy & nicely paired w/ a variety of glazed vegetables & creme fraiche." in 25 reviews

"I ordered the fried mushroom **po'boy** and roasted brussel sprouts to-go and man, did that hit the spot!" in 11 reviews

"The Lychee Sage Zeal Kombucha, I have never tried **Kombucha** before, to me it tasted like beer, I had to ask if this was an alcoholic beverage." in 11 reviews

**Get directions**

Start from [Swap start/end points](#)

1230 J street

**Mother**  
1023 K St, Sacramento, CA 95814

**Get directions**

**Walking directions**

Walking directions are in beta. Use caution – This route may be missing sidewalks or pedestrian paths.

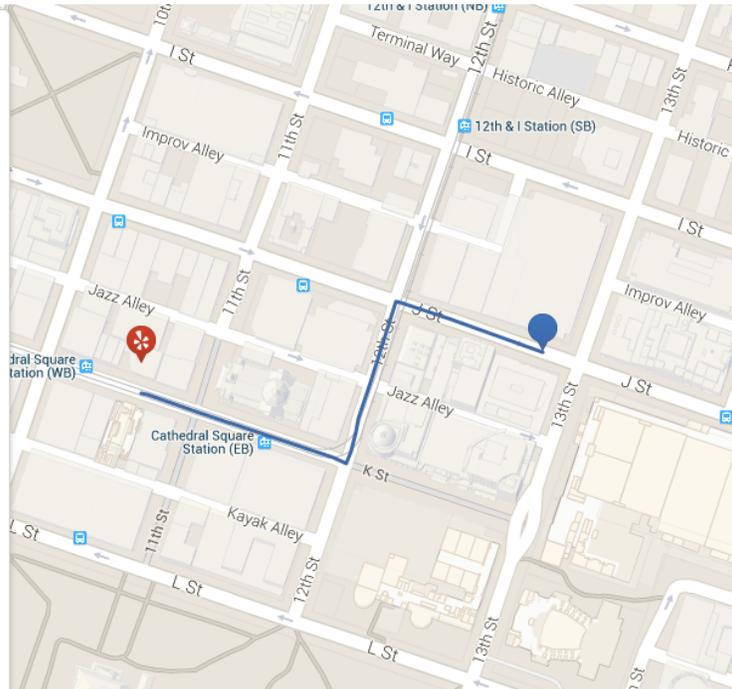
1230 J St, Sacramento, CA 95814, USA

0.3 mi. About 5 mins

1. Head **west** on **J St** toward **12th St** 394 ft
2. Turn **left** onto **12th St** 430 ft
3. Turn **right** onto **K St** 0.1 mi

1065 K St, Sacramento, CA 95814, USA

Map data ©2016 Google



## Chaise Lounge

★★★★☆ 95 reviews [Details](#)

\$\$ · Lounges, Asian Fusion [Edit](#)

"For my dinner, I ordered the **Korean Loco Moco**, which was bulgogi, vegetables, and a fried egg over rice." in 14 reviews

"My friends and I ordered the **taro fries**, beef skewers, cheese burger eggrolls, and the lollipop wings." in 12 reviews

"Was still a little hungry as the portion wasn't humungous so I ordered the **cheeseburger egg rolls** and they too were delectable." in 11 reviews

**Get directions**

Start from [Swap start/end points](#)

1230 J street

**Chaise Lounge**  
1330 H St, Sacramento, CA 95814

**Get directions**

**Driving directions**

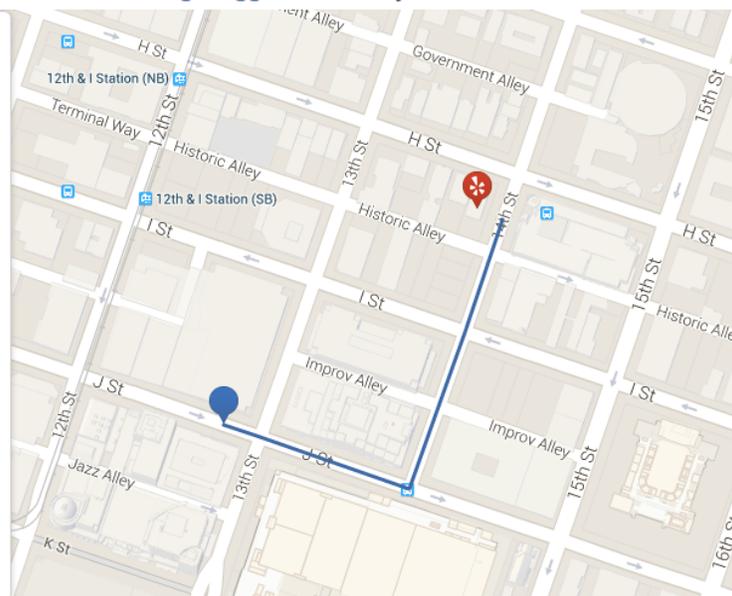
1230 J St, Sacramento, CA 95814, USA

0.2 mi. About 2 mins

1. Head **east** on **J St** toward **13th St** 495 ft
2. Turn **left** onto **14th St** 0.1 mi  
Destination will be on the left

816 14th St, Sacramento, CA 95814, USA

Map data ©2016 Google



# PERC 2016: Restaurant Guide

## Darna



169 reviews

Details

\$\$ · Mediterranean, Middle Eastern, American (New)

"The **lunch buffet** has a lot of variety, and everything I've had on the buffet has tasted great." in 35 reviews

"Lentil soup, **spicy eggplant**, falafel, chicken and goat kabobs, beef ribs, and 2 types of rice among other things." in 7 reviews

### Get directions



#### Start from

Swap start/end points

1230 J Street

#### Darna

925 K St, Sacramento, CA 95814

Get directions

### Walking directions

Walking directions are in beta. Use caution – This route may be missing sidewalks or pedestrian paths.

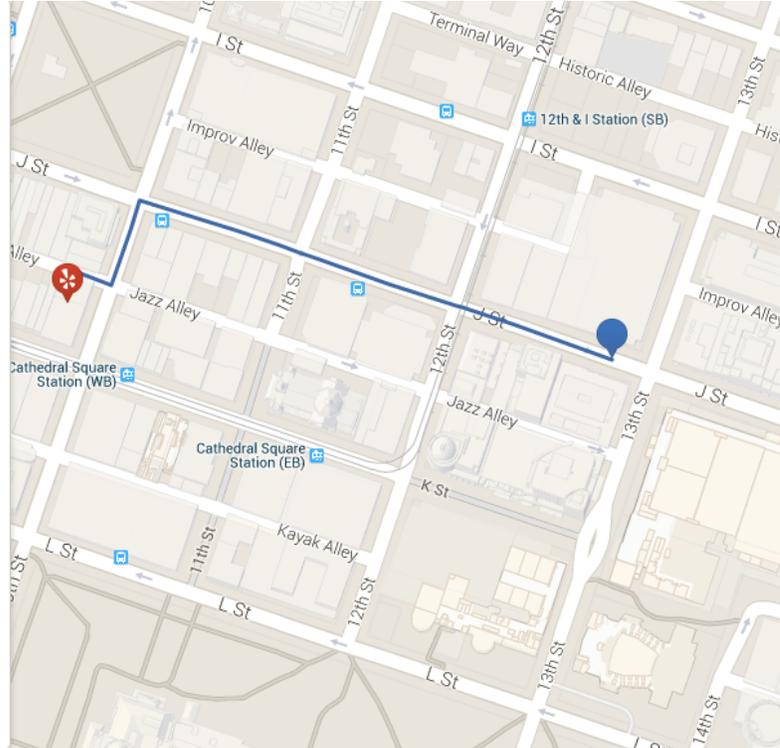
1230 J St, Sacramento, CA 95814, USA

0.3 mi. About 6 mins

1. Head **west** on **J St** toward **12th St** 0.2 mi
2. Turn **left** onto **10th St** 210 ft
3. Turn **right** onto **Jazz Alley** 85 ft  
Destination will be on the left

1020 10th St, Sacramento, CA 95814, USA

Map data ©2016 Google



## Petra Greek



633 reviews

Details

\$\$ · Greek, Vegetarian, Mediterranean

"We ordered 3 things: **Triple dip plate**, Petra fries, and Mediterranean Pirilia Platter...well, everything was delicious!" in 12 reviews

"My usual go-to's are their Petra fries and plain pita bread with a side of **fry sauce** (similar to thousand island but **BETTER!**)." in 23 reviews

### Get directions



#### Start from

Swap start/end points

1230 J Street

#### Petra Greek

1122 16th St, Sacramento, CA 95814

Get directions

### Walking directions

Walking directions are in beta. Use caution – This route may be missing sidewalks or pedestrian paths.

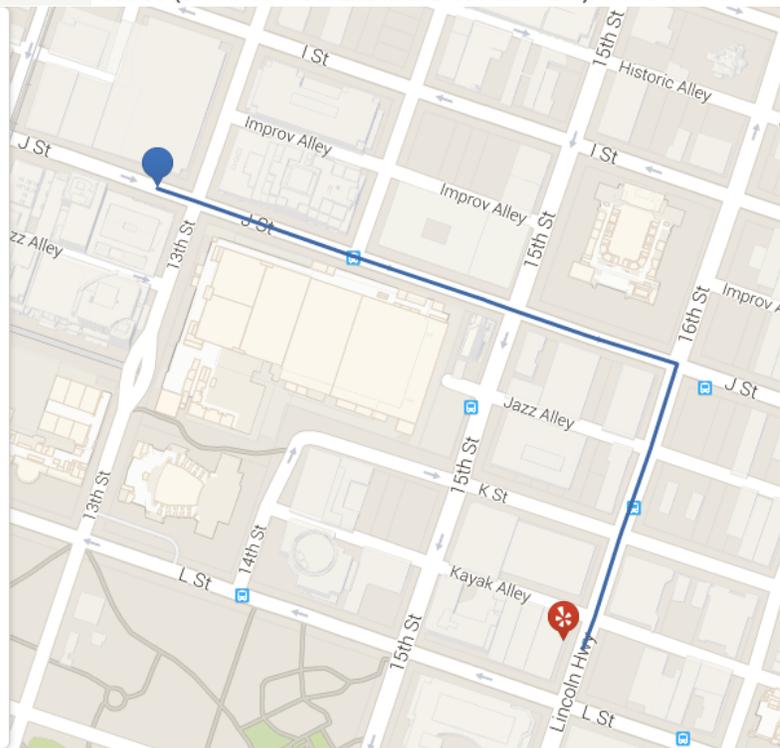
1230 J St, Sacramento, CA 95814, USA

0.4 mi. About 8 mins

1. Head **east** on **J St** toward **13th St** 0.2 mi
2. Turn **right** onto **16th St** 0.1 mi  
Destination will be on the right

1150-1198 Lincoln Hwy, Sacramento, CA 95814, USA

Map data ©2016 Google



# PERC 2016: Restaurant Guide

## Cafeteria 15L

★★★★☆ 1207 reviews [Details](#)

\$\$ · [American \(Traditional\)](#), [Breakfast & Brunch](#)

"Cafeteria was formerly known as Mason's. I frequented [Mason's](#) in the past and liked it but I LOVE the concept of Cafeteria." in 39 reviews

"They do tend to focus on the "cafeteria comfort foods" of yesteryear with some contemporary additions or "comfort with a twist." in 45 reviews

### Get directions



Start from [Swap start/end points](#)

1230 J street

**Cafeteria 15L**  
1116 15th St, Sacramento, CA 95814

[Get directions](#)

### Walking directions

Walking directions are in beta. Use caution – This route may be missing sidewalks or pedestrian paths.

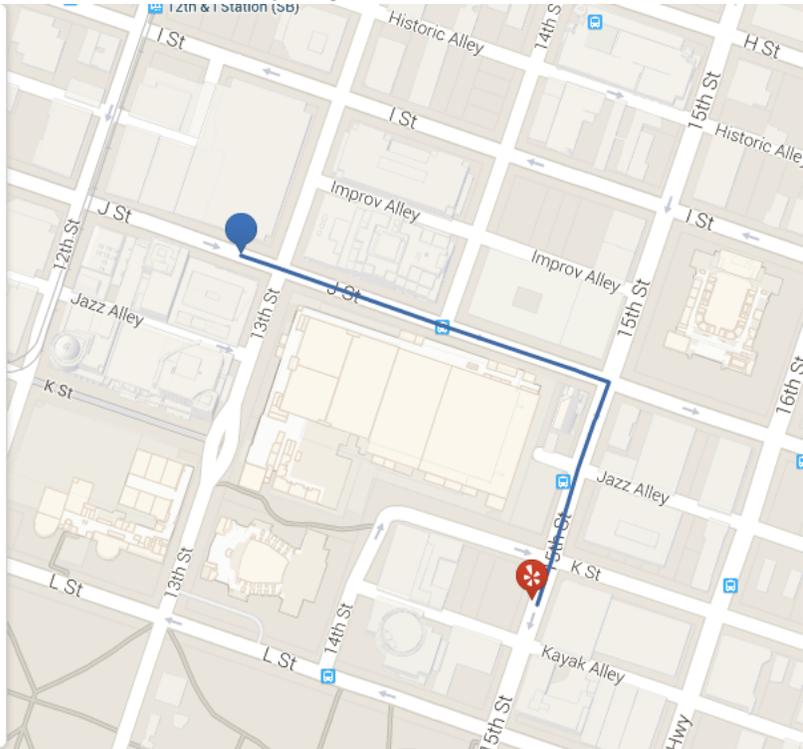
1230 J St, Sacramento, CA 95814, USA

0.3 mi. About 5 mins

1. Head east on J St toward 13th St 0.2 mi
2. Turn right onto 15th St 0.1 mi  
Destination will be on the right

1112 15th St, Sacramento, CA 95814, USA

Map data ©2016 Google



## Station 16

★★★★☆ 17 reviews [Details](#)

\$\$ · [Seafood](#), [Cajun/Creole](#), [Bars](#) [Edit](#)

Such a wonderful addition to downtown Sacramento! This place reminds me of Hog Island/Crustaceans. Asian Cajun with a modern twist. The interior was sleek and cool. It was bright and open. They even have a oyster bar where guest can sit around. Very nice touch.

### Get directions



Start from [Swap start/end points](#)

1230 J Street

**Station 16**  
1118 16th St, Sacramento, CA 95814

[Get directions](#)

### Driving directions

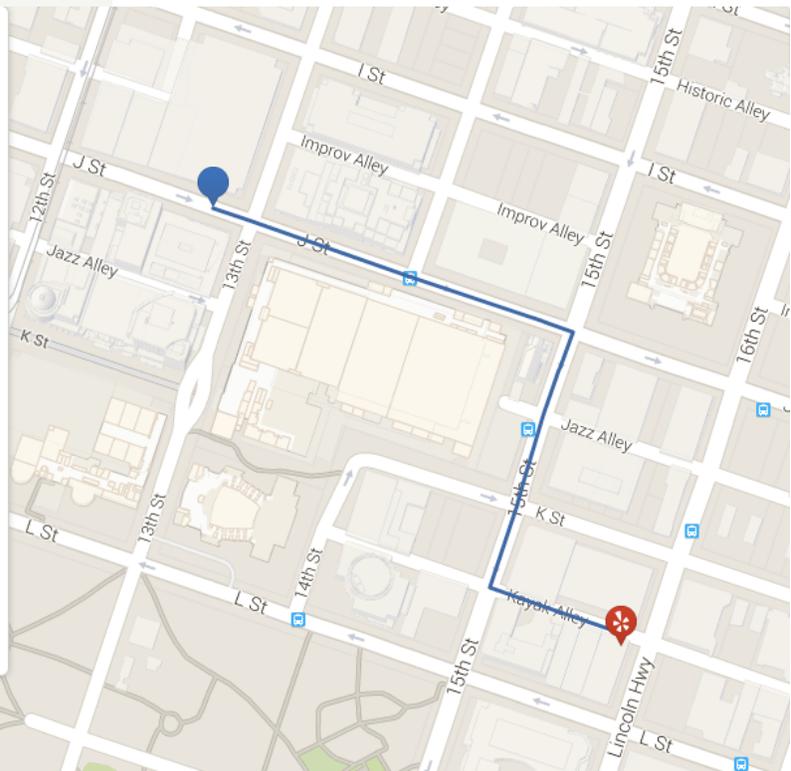
1230 J St, Sacramento, CA 95814, USA

0.4 mi. About 3 mins

1. Head east on J St toward 13th St 0.2 mi
2. Turn right onto 15th St 0.1 mi
3. Turn left onto Kayak Alley 338 ft  
Destination will be on the right

Kayak Alley, Sacramento, CA 95814, USA

Map data ©2016 Google



# PERC 2016: Restaurant Guide

## Firestone Public House

★ ★ ★ ★ ☆ 1032 reviews [Details](#)

\$\$ · [American \(New\)](#), [Pubs](#), [Sports Bars](#) [Edit](#)

“Happy Hour includes half off select starters and pizzas, \$2 off select wines, \$1 off large drafts, and \$4.50 well drinks.” in 224 reviews

Happy Hour: Yes

“She was busy but still spent the time showing us the menu and expertly answering my questions about **brunch** the next day.” in 115 reviews

Good For: Brunch

### Get directions



Start from [Swap start/end points](#)

1230 J Street

**Firestone Public House**  
 1132 16th St, Sacramento, CA 95814

[Get directions](#)

### Walking directions

Walking directions are in beta. Use caution – This route may be missing sidewalks or pedestrian paths.

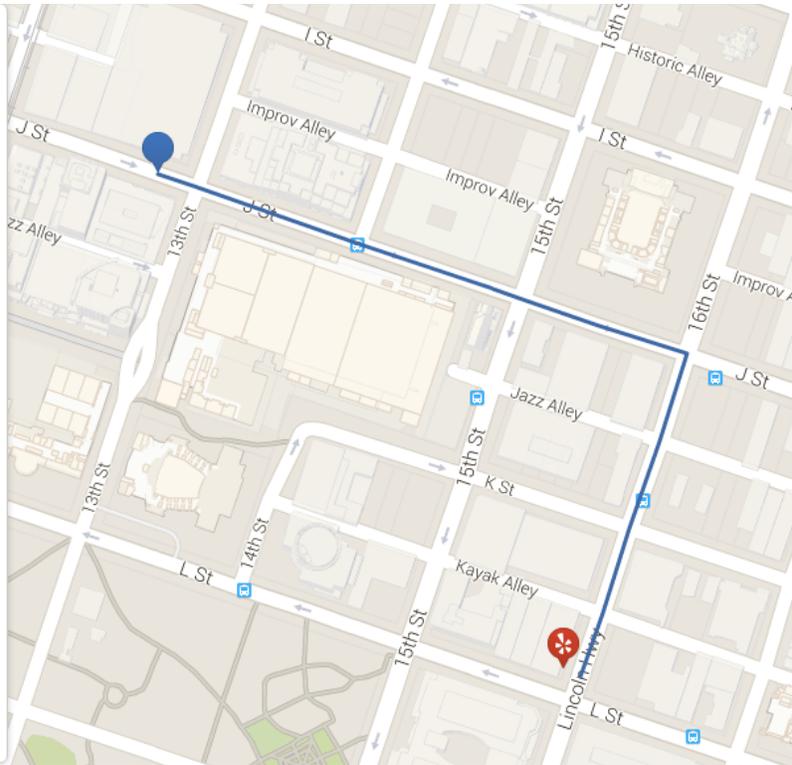
1230 J St, Sacramento, CA 95814, USA

0.4 mi. About 8 mins

- Head **east** on **J St** toward **13th St** 0.2 mi
- Turn **right** onto **16th St** 0.1 mi  
Destination will be on the right

1151-1199 Lincoln Hwy, Sacramento, CA 95814, USA

Map data ©2016 Google



## Aura Korean & Japanese Restaurant

★ ★ ★ ★ ☆ 355 reviews [Details](#)

\$\$ · [Japanese](#), [Korean](#) [Edit](#)

“The korean food here is all excellent especially the soondubu and the hot stone **bi bim bap**, also the service is impeccable which is always a plus.” in 25 reviews

“We used thegroupon and tried their Kim chee soup, glass noodle #30( the best n flavorful) n the **hot stone** .” in 16 reviews

### Get directions



Start from [Swap start/end points](#)

1230 J Street

**Aura Korean & Japanese Restaurant**  
 1401 G St, Sacramento, CA 95814

[Get directions](#)

### Walking directions

Walking directions are in beta. Use caution – This route may be missing sidewalks or pedestrian paths.

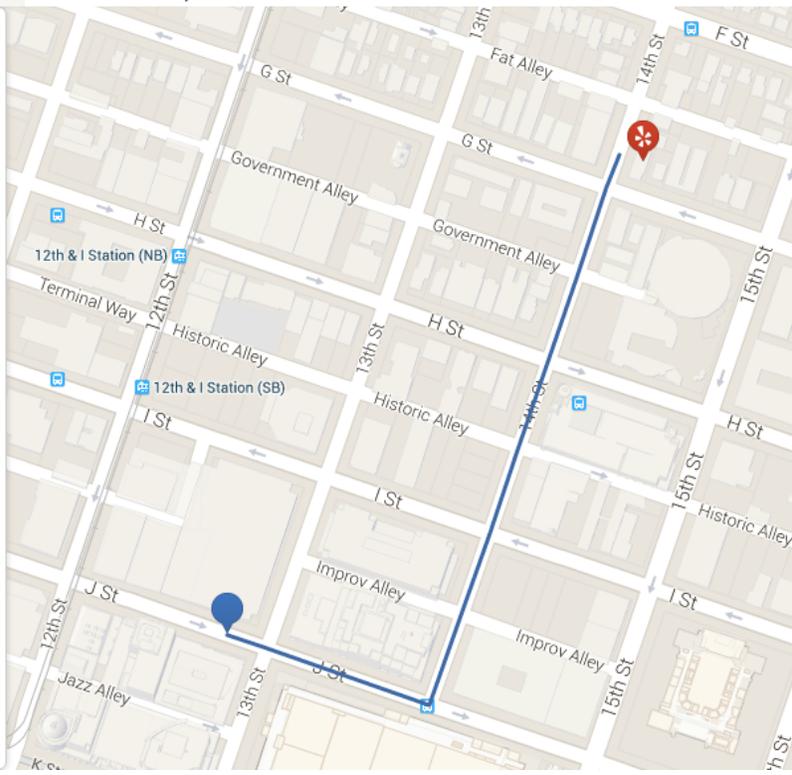
1230 J St, Sacramento, CA 95814, USA

0.3 mi. About 7 mins

- Head **east** on **J St** toward **13th St** 495 ft
- Turn **left** onto **14th St** 0.3 mi  
Destination will be on the right

625-699 14th St, Sacramento, CA 95814, USA

Map data ©2016 Google



# PERC 2016: Restaurant Guide

## Kim's Vietnamese

★★★★☆ 192 reviews [Details](#)  
\$ - Vietnamese [Edit](#)

### Get directions



Start from [Swap start/end points](#)

1230 J Street

**Kim's Vietnamese**  
1008 J St, Sacramento, CA 95814

[Get directions](#)

### Walking directions

Walking directions are in beta. Use caution – This route may be missing sidewalks or pedestrian paths.

1230 J St, Sacramento, CA 95814, USA

0.2 mi. About 4 mins

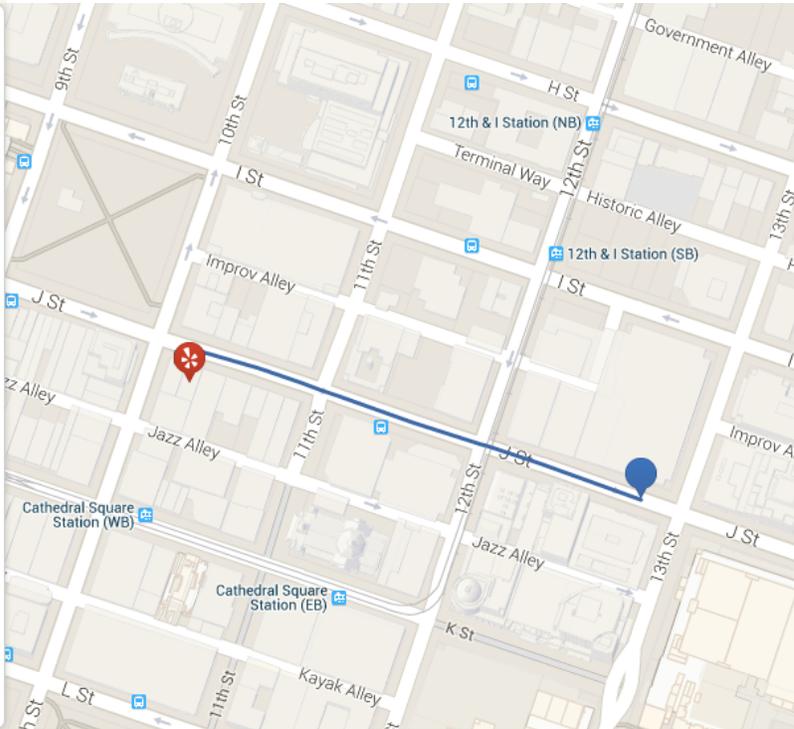
1. Head **west** on **J St** toward **12th St** 0.2 mi  
Destination will be on the left

1001-1009 J St, Sacramento, CA 95814, USA

Map data ©2016 Google

"Its a hidden gem on J street, lately its not so hidden anymore as at noon it is packed and no place to sit." in 9 reviews

"I have also been intending to try the Bhan Mi but every time the picture of the Pho above the register changes my mind, someday..." in 10 reviews



## Pieology Pizzeria

★★★★☆ 454 reviews [Details](#)  
\$ - Pizza [Edit](#)

### Get directions



Start from [Swap start/end points](#)

1230 J Street

**Pieology Pizzeria**  
1020 16th Street, Sacramento, CA 95814

[Get directions](#)

### Walking directions

Walking directions are in beta. Use caution – This route may be missing sidewalks or pedestrian paths.

1230 J St, Sacramento, CA 95814, USA

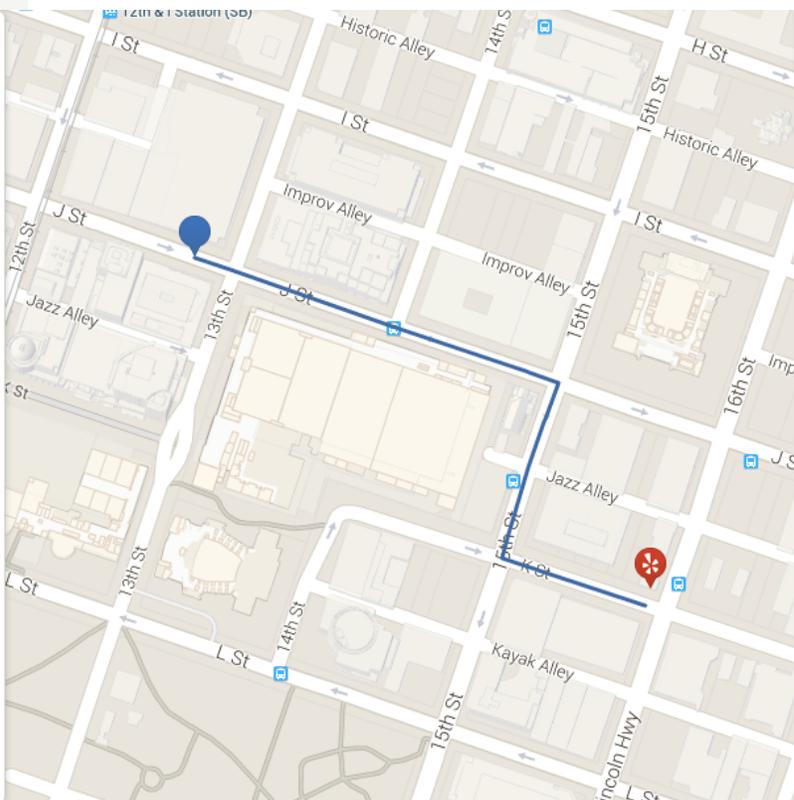
0.3 mi. About 6 mins

1. Head **east** on **J St** toward **13th St** 0.2 mi
2. Turn **right** onto **15th St** 430 ft
3. Turn **left** onto **K St** 348 ft  
Destination will be on the left

1531-1599 K St, Sacramento, CA 95814, USA

Map data ©2016 Google

"Ideology is similar to Chipotle, except they allow you to choose **unlimited toppings** for the same price of \$7.95!" in 45 reviews



# PERC 2016: Restaurant Guide

## Bangkok @12 Thai Restaurant

★★★★☆ 539 reviews [Details](#)

\$\$ · Thai [Edit](#)

"I might try something new some day, if I can ever pull myself away from the delicious yellow/**avocado curry**..." in 39 reviews

"And there's no better way to cleanse the palate at the end of the meal than with fried plantains served with **coconut ice cream** and cinnamon." in 7 reviews

**Get directions**

Start from [Swap start/end points](#)

1230 J Street

**Bangkok @12 Thai Restaurant**  
900 12th St, Sacramento, CA 95814

**Get directions**

**Walking directions**

Walking directions are in beta. Use caution – This route may be missing sidewalks or pedestrian paths.

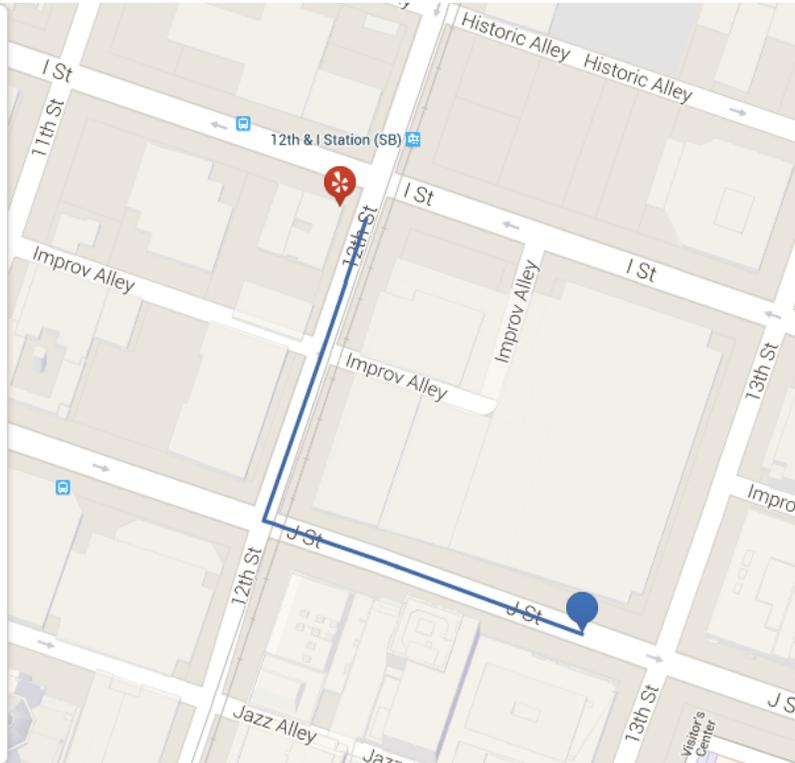
1230 J St, Sacramento, CA 95814, USA

0.1 mi. About 3 mins

- Head **west** on **J St** toward **12th St** 394 ft
- Turn **right** onto **12th St** 374 ft  
Destination will be on the left

901-909 12th St, Sacramento, CA 95814, USA

Map data ©2016 Google



## Tequila Museo Mayahuel

★★★★☆ 588 reviews [Details](#)

\$\$ · Mexican, Bars, Vegetarian [Edit](#)

"EVERYTHING is excellent from the food, to drinks, to service, to entertainment (**best mariachi**), to decor." in 21 reviews

**Get directions**

Start from [Swap start/end points](#)

1230 J Street

**Tequila Museo Mayahuel**  
1200 K St, Sacramento, CA 95814

**Get directions**

**Walking directions**

Walking directions are in beta. Use caution – This route may be missing sidewalks or pedestrian paths.

1230 J St, Sacramento, CA 95814, USA

0.2 mi. About 4 mins

- Head **west** on **J St** toward **12th St** 394 ft
- Turn **left** onto **12th St** 0.1 mi  
Destination will be on the left

1109 12th St, Sacramento, CA 95814, USA

Map data ©2016 Google

