Physics Education Research Conference (PERC) 2018

Having Wonderful Ideas: Connecting the Content, Outcomes, and Pedagogies of Physics

Many physics instructors have educational goals for their students that go beyond understanding physics concepts and problem-solving approaches. These goals can include understanding how physics knowledge is generated, understanding how to learn difficult concepts, learning more general problem-solving skills, developing confidence in physics/science, and developing a physics identity. Our conference theme is inspired by an educational goal articulated by Eleanor Duckworth, a goal connected to the ones just mentioned but different in flavor: "The having of wonderful ideas is what I consider the essence of intellectual development. And I consider it the essence of pedagogy to give [students] the occasion to have [their] wonderful ideas and to let [them] feel good about [themselves] for having them." What does "having wonderful ideas" mean in physics courses and other physics learning environments?

Sessions at PERC 2018 will explore this question by focusing on both learners (including students and teacher-learners) and classrooms.

- At the student level: What are the various ways in which students' ideas in physics are wonderful? In what ways can students' ideas challenge our sense of what "counts" as physics? How do our assessments capture wonderful aspects of student thinking?
- At the classroom level: How do the learning outcomes we identify help us articulate what is wonderful about physics? What are the different ways in which our classrooms are wonderful places to be?

Discussing these questions can help us better refine and articulate our goals as physics educators and physics education researchers.

August 1-2, 2018
Renaissance Washington, DC Downtown Hotel

Organizing Committee:
Amy Robertson, Leslie Atkins Elliott, Andrew Elby, Jennifer Richards

Wifi Info
Network: Renaissance_Conference
Password: SM2018

Online Questions Board
www.slido.com
Code: #PERC

At-a-Glance Schedule and Table of Contents

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5:00 PM	**Poster Session I**: *First Timer/Undergraduate*	Grand South	pp. 3-6
6:00 PM	**Dinner** ("Dine & Discuss" groups or on your own), Poster Session II setup		
8:00 PM	**Poster Session II** (+ dessert): *First 45 min odd-numbered, last 45 min even-numbered*	Grand South	pp. 7-10

Thursday, August 2, 2018

8:00 AM **Parallel Sessions Cluster I**	People of Color Discussion & Writing Space	Meeting Room 2	p. 11
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	Encouraging Wonderful Ideas about Functions of Several Variables in Multiple Physics Contexts	Grand Central	p. 15
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9:45 AM	**Poster Session III** (+ coffee), PERLOC office hours	Grand South	pp. 18-20
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12:15 PM	**Lunch Plenary Talk**: *Déana Scipio*	Renaissance Ballroom	pp. 28-29
1:30 PM **Parallel Sessions Cluster III**	Introducing Computation in High School Physics	Meeting Room 2	p. 30
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3:15 PM **Closing Activities**	Plenary Panel	Renaissance Ballroom	p. 38
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Hotel maps can be found on p. 39.

Rosemary S. Russ, University of Wisconsin, Madison

Teachers as Learners: Seeing "wonderful ideas" in preservice teacher thinking

We are in a time of science education research, and in PER specifically, when nearly all scholars enthusiastically embrace a constructivist perspective on learning. At the heart of that perspective is the assumption that people construct new knowledge from existing knowledge. Duckworth's notion of learners having "wonderful ideas" elucidates and extends constructivism by explicitly reminding researchers that the old knowledge learners build from, while potentially used incorrectly, is in-and-of itself valuable and productive. That is, learner's existing knowledge is wonderful, and indeed must be wonderful, if they are to build their new knowledge from it. Although researchers and educators have embraced constructivism for our students across K-16, the field has yet to apply that same perspective to our understanding of teachers. It continues to be commonplace to treat teachers either as blank slates who come to our undergraduate courses with no useful knowledge, or as novices characterized predominantly by deficits we need to fix. In this talk, I suggest that supporting teachers in their own learning – both of physics and of pedagogy – must involve seeing them first as learners with wonderful ideas. I will argue for this (seemingly obvious yet not actualized in research!) theoretical stance by presenting data that illustrates teachers' wonderful ideas across several contexts and settings. I will also demonstrate the continuity between those existing wonderful ideas and those the field considers to be sophisticated and desirable. Finally, I will explore implications of this stance for our work with physics teachers both in practice and research.

About Rosemary

Dr. Rosemary S. Russ is an Assistant Professor of Science Education in the Department of Curriculum and Instruction in the School of Education. Dr. Russ' background straddles the worlds of STEM and Education; she completed her graduate work in the Physics Department at the University of Maryland, College Park and became Research Faculty in the Learning Sciences Program in the School of Education and Social Policy at Northwestern University. Her research examines students' and teachers' tacit understandings of knowledge and knowing in science, and explores the impact of those understandings on K-16 classroom teaching and learning. Specifically, she examines the interplay of personal epistemological knowledge and conceptual knowledge in science teaching and learning. Recently, her work has shifted to explore whether and how students' and teachers' understandings of what and whose knowledge counts in the classroom enacts and perpetuates systemic, societal inequity. The contexts of her research include elementary, middle, and high school science classrooms; interviews with K-12 students and teachers; and undergraduate student coursework in the disciplines of physics and teaching.

Benedikt W. Harrer, San Jose State University

The multimodal interactional work of Having Wonderful Ideas

Learning physics is socially organized through interactions with peers and more competent others. Instructors' and peers' assessment of and responsiveness to learners' ideas in the moment is critical for the collaborative construction of knowledge in physics. However, we still know little about how instructors and learners negotiate the value and productiveness of ideas. While to an outsider, some of the ideas physics learners discuss do not seem immediately valuable or productive for the problem being solved, Duckworth encourages us to pursue an 'insider's view' on how a learner experiences their ideas. Building on Duckworth, I pursue an 'insider's view' to better understand how peers and teachers experience each other's ideas. In particular, I examine the interactional methods and resources participants use to express ideas and to mark their own or others' ideas as wonderful or not-so-wonderful. I demonstrate how participants rely on a variety of multimodal communicational tools, including speech, words, gestures, and whiteboard inscriptions to negotiate wonderfulness, extending our current understanding of how peers and instructors are responsive to physics ideas in the moment.

About Benedikt

Benedikt is an Assistant Professor of Physics at San José State University (SJSU). He earned his Ph.D. in physics at the University of Maine, and he holds a graduate degree in physics and mathematics with a concentration in teaching and education from the Ludwig-Maximilians University in Munich, Germany. Before joining the Department of Physics and Astronomy at SJSU, Benedikt taught in the Cal Teach program at the University of California, Berkeley and co-directed the Berkeley Engineering Research Experiences for Teachers program. In his dissertation work, Benedikt investigated the nature of productive classroom interactions for learning about energy. Inspired by ethnomethodological conversation analysis and responsive teaching, Benedikt's current research focuses on understanding how students and instructors achieve productive interactions in physics learning encounters, from peer talk in laboratory investigations to large lecture discussions.

Poster Session I — Grand South

Wednesday, August 1, 5:00pm

Abrashkin, Ariel	Students modeling of thermal contact - From particle diffusion to Energy Spreading	A1
Akinyemi, Abolaji	Introductory student interpretation of validity checks of expressions: Different analytical perspectives	A2
Alfson, Jonathan W.	Student use and coordination of computerized and tangible visualization tools	A3
Amadeu Filho, Joao R.	Learning physics on YouTube: what is available for students?	A27
Arruda, Anthony	Transitioning from Dirac to Function Notation in Spins-first Quantum Mechanics	A4
Becker, Sebastian	Promoting Students' Conceptual Knowledge and Representational Competence using Video Analysis on Tablet Computers	A5
Bender, Lydia G.	Transforming to Three-Dimensional Learning Across Institutions	A6
Bretland, Dean	Adapting Tutorials in Introductory Physics for new populations and environments	A7
Castillo, Steven	The Intersection of Physics and Computing Identities: Examining boundary spanning amongst marginalized groups in physics	A8
Cermak, Jacob	Comparative Experiments: Investigating student reasoning with pictorial and graphical data.	A9
Chang, Sheh Lit	Curriculum development to improve student understanding of rolling motion	A10
Cheng, Hemeng	The Structure of Student Physics Identity Development through Two High School Interventions	A11
Coghlan, Virginia	Investigating Student Perceptions of Learning Assistants	A12
Colborn, Christopher	Student understanding of principles of superposition in introductory calculus-based electricity and magnetism	A13
Corrales, Adriana	Conversational norms in faculty communities enable and constrain opportunities to learn	A14
Cothrel, Helen Mae	Modern Physics Laboratory Students' Ideas about Physics	A15
Crouch, Taylor	Effect of peer-review on development of students' problem-solving abilities	A16
De Grandi, Claudia	Strategies for building a welcoming STEM classroom environment for all students	A17
De Winter, James	The views of pre-service physics teachers on the role of mathematics in the teaching and learning of physics	A18
Deich, Aaron	Writing Physics Books Like Harry Potter: How to Make Physics Textbooks More Enjoyable	A19
Doty, Constance M.	Graduate Teaching Assistants' Perspectives on Leading Student-centered Classes in Physics and Chemistry	A20
Elliott, Thomas	Service Learning in Astronomy Education	A21
Eriksson, Moa	Towards understanding learning challenges involving sign conventions in introductory level kinematics	A22
Etson, Candice M.	Transition Analysis: A new method for tracking changes in student understanding using concept inventories	A23
Faries, Whitney	Student Attitudes in Introductory Physics: How Students Experience	A24

Poster Session II — Grand South

Wednesday, Aug. 1, 8:00pm [Odd 8:00-8:45, Even 8:45-9:30]

Agra, Elise	An alternate method to examine CLASS data	B1
Aiken, John M.	Towards a model of students pathways in STEM	B2
Atkins Elliott, Leslie	The EDISIn Project: Engineering Design in Scientific Inquiry	B3
Bennett, Michael B.	How Does Program Design Promote or Constrain Pedagogical Approaches?	B4
Beverly, Nancy	Assessing competence in authentic modeling by life science students in the introductory course	B5
Bogdan, Abigail M.	Comparing Student Understanding of Units and Dimensional Analysis Between Universities	B6
Bugge, Danielle	How'd you do that? Student reflections in physics labs	B7
Cai, Bei	Using reflections to explore student learning during the project component of an advanced laboratory course	B8
Chastain, Raymond	Using a Student-Authored Problem Assignment as a Bridge from Instruction to Practice	B9
Chasteen, Stephanie Viola	What do thriving physics teacher education programs do? The Physics Teacher Education Program Analysis (PTEPA) Rubric	B10
Chen, Zhongzhou	Measuring the effectiveness of online problem-solving tutorials by multi-level knowledge transfer	B11
Christensen, Warren	Development of a Rubric for Improved Understanding of IPLS Curricula	B12
Coble, Kimberly	Evaluation of an Interactive Undergraduate Cosmology Curriculum	B13
Coble, Kimberly	Impacts of a Course-based Undergraduate Research Experience in Introductory Astronomy Using Robotic Telescopes	B14
Conn, Jessica	"What is the task?: LA Prep as locus of identity reconciliation?"	B15
Daane, Abigail R.	Let's talk about equity: Two-year college students' and physics culture	B16
De Leone, Charles J.	Long-Term Fidelity in a Research-Based Introductory Physics Curriculum*	B17
Delgado, Jennifer	Logic and Quantitative Reasoning in an Introductory Astronomy Class	B18
Doucette, Danny	What's happening in traditional and inquiry-based introductory labs? An integrative analysis at a large research university	B19
Doughty, Leanne	Investigating the Relationship between Active Learning Task Characteristics and Student Success	B20
Dounas-Frazer, Dimitri R.	Student ownership of laboratory projects and attitudes about experimental physics	B21
	This space left intentionally blank	B22
Duffy, Andrew G.	Project Accelerate: Closing the Access Gap for STEM Careers and Academic Programs	B23
Durden, Jared	Do I Belong Here?:Understanding Participation and non-Participation in a Contentious "Board" Meeting	B24
Edri, Haim	Students Perceptions of Simplification- From Fine-Grained to Coarse- Grained Modeling	B25
Engelhardt, Paula V.	Developing a student outcomes assessment for Next Gen PET	B27
Evans, William R.	Results from Piloting a Design-style Lab in Introductory Algebra-	B28

Sadaghiani, Homeyra	Student sense-making and interpretation of quantum mechanical expectation values	B77
Scanlon, Erin	Ability Profiles: A Framework for Conceptualizing Dimensions of Ability	B78
Sealfon, Carolyn D.	Classifying Students' Free Responses in Large Classes	B79
Simmons, Amber	Assessing instructors with student grades: introductory physics	B80
Singh, Chandralekha	Improving student understanding of the many-particle Hamiltonian and stationary state wavefunction for non-interacting identical particles	B81
Smith, Trevor I.	PIQL: Measuring Physics Quantitative Literacy using Multiple-Choice/Multiple-Response Questions	B82
Strzys, Martin P.	Smartglasses in STEM laboratory courses – the augmented thermal flux experiment	B83
Thees, Michael	Smartglasses as assistive tools for STEM laboratory courses – Theoretical Foundations	B85
Topdemir, Zeynep	The Factors That Affect Students' Persistence in the Undergraduate Physics Program	B86
Traxler, Adrienne	Visual representations of classroom activity: What captures the essence?	B87
Turpen, Chandra	Maintaining the agency of educators in collaborative problem-solving about teaching	B105
Walter, Paul J.	A metric for measuring the constancy of item response curves	B90
Watson, Kevin	How Students' Understanding of Normalization Changes After Taking Quantum Mechanics	B91
Wilcox, Matthew	Selling the Studio Style to Students: a Qualitative Study	B92
Willoughby, Shannon D.	Space Sciences as a Context for College Physics	B93
Wittmann, Michael C.	Biology teachers' engagement with a physics model of energy flow	B94
Wolf, Steven F.	Collaboration structure and student group exam performance	B95
Wolf, Steven F.	Learning Assistants' changing perception of teaching	B96
Wolf, Steven F.	Student Attitudes on Group Exams in STEM Courses	B97
Wolf, Steven F.	Surviving STEM: Pathways to getting a STEM degree	B98
Young, Nicholas	Using Machine Learning to Predict Integrating Computation into Physics Courses	B99
Zamarripa Roman, Brian	Success is a puzzle: sorting out the pieces with metaphor analysis	B73
Zeng, Liang	Know-Why in Using Right-Hand Rules to Determine Directions in Electromagnetism in College Physics	B100
Zich, Raymond	Using eye tracking to identify instructive features of diagrams	B101
Zohrabi Alaee, Dina	Comparison between equal signs in students' homework and solution manuals	B26
Zu, Tianlong	Effects of Peer-Interaction on Conceptual Test Performance and Cognitive Load	B102

*PERLOC will host an interactive poster during this session to solicit ideas for PERC 2020 and make the PERC application/organization process more transparent – stop by!

People of Color Discussion and Writing Space

Alexis V. Knaub, Michigan State
Geraldine Cochran, Rutgers University

Building off of last year's People of Color (POC) Discussion Space during PERC 2017, we plan on using this parallel session in two ways. One is to continue to form community among POC. Safe spaces are important because they often provide an opportunity for individuals in the group to vocalize shared experiences and utilize their agency to act and speak on their own behalf. They also aid in creating solidarity among the group. Thus, this intimate session is intended for individuals who identify as a Person of Color. NOTE: People of Color is a term with many different interpretations. We do not want to impose our own ideas of race on individuals' identity. Because we also cover agreed upon rules of engagement for this session, we ask that participants make every effort to arrive within 10 minutes of the session start time. The second goal of this session is to take the discussion further by collaboratively summarizing the discussion from last summer and articulating action items for the broader PER community to consider.

The New Advanced Placement Physics Exams: PER-Based National Assessment

S. Kanim, New Mexico State University
Co-Presenters: S. Brahmia, A. Elby, M. Sckalor, S. Willoughby

In fall 2014, the algebra-based AP Physics 1 and AP Physics 2 replaced the AP Physics B curriculum, with the first exams in the new courses administered in May 2015. Many hundreds of person-hours by teams of experts drawn from physics education research, state-level curriculum planners, college faculty, and high school faculty have gone into developing learning objectives, a curriculum framework and crafting exams and their grading rubrics.

The influence that PER-inspired questions on high-stakes assessments are having on high school AP physics learning is promising. Teachers and students are developing students' wonderful ideas in ways that had not been previously possible in the AP Physics B course.

This session will bring together a veteran AP teacher and exam developer, along with Physics Education Researchers who are AP exam question and test developers and the Chief Reader - who is in charge of coordinating the scoring of over half a million open-ended questions for the AP 1 and 2 exams each year.

We will discuss changes in emphasis inspired by PER. We will give examples of the difference in the style of the questions found on the new AP exams, and early results of student performance on some of the novel free response questions (laboratory design, qualitative/quantitative transfer and paragraph length response). We will discuss the constraints and affordances of designing tests that are administered on a national scale, and that are hand scored by professional teachers. We will close with a discussion of the role that the PER community can have in enriching instructional practices at the high school level through engagement with the AP community.

Wonderful Ideas Bookclub

L. Atkins Elliott, Boise State University
R. Russ, University of Wisconsin – Madison

The theme of this conference is drawn from Eleanor Duckworth's book, *The Having of Wonderful Ideas and Other Essays*. In this session, we will organize a discussion of the book, focusing on the title essay, and its implications for physics education. Participants are invited to read the book and **submit discussion questions in advance here**. Organizers will facilitate a discussion based on the submissions.

An Introduction to Data Science for Emerging Quantitative Researchers with R-Studio

John Buncher, North Dakota State University
Co-facilitators: D. McPadden, J. M. Nissen, G. Potvin, R. Talbot

This workshop provides an introduction to several statistical tests for comparing two groups by applying these methods to common tasks in physics education research. The workshop will emphasize the application, interpretation, and limitations of p-values and effect sizes. Participants will develop a conceptual understanding of variance in data, create visualizations that incorporate variance, and explore the relationships between variance, effect sizes, and p-values. Participants will work in small groups with facilitators and participate in larger group discussions. They will use parametric tests (for interval and ratio scale data) and nonparametric tests (for ordinal and nominal data) to compare students' scores on concept inventories and students' responses to a multiple-choice question. For each comparison, participants will learn how to select the correct statistical test to use, how to test the assumptions for that statistical test, how to interpret and report the results from Rstudio, and alternative tests to use. By focusing on the process for learning new statistical methods, we hope that participants will leave with the skills and resources to conduct, evaluate, and report their own analysis. We will provide a working file for RStudio to facilitate these conversations. However, participants need no prior experience with statistics or with Rstudio, though we invite more advanced Rstudio users and quantitative researchers to participate and to support the other participants. To make the most of the in-person workshop time, we ask that participants come with a laptop loaded with the latest versions of R and Rstudio. Instructions for downloading and installing R and Rstudio and supporting materials for the workshop are available at https://tinyurl.com/statworkshopresources.

Encouraging Students to Have Wonderful Ideas About Functions of Several Variables in Multiple Physics Contexts

Corinne Manogue, Oregon State University
Presenters: T. Dray, P. Emigh, E. Gire, M. B. Kustusch, M. Vignal, Aaron Wangberg

Functions of several variables occur everywhere in physics, from E&M through thermodynamics. These applications require students to have rich concept images of such functions which go well beyond what is typically taught in a multivariable calculus course, particularly concepts which deal with data and experimental representations.

You are invited to a modified poster symposium/workshop where you will have the opportunity to explore research projects that use a mixture of approaches and theoretical perspectives and also several classroom activities that use innovative hands-on tools. Finally you can investigate a learning progression that we are developing to help faculty make decisions about which activities might be useful in their courses, and when. We hope that you will be inspired to have wonderful ideas about how to introduce functions of several variables to your students and wonderful ideas about how to study students' evolving understanding of functions of several variables, so they can have wonderful ideas, in turn.

Juried Talks I

Organizing Committee, PERC

Moderator: B. Zwickl

This session consists of four juried talks.

Juried Talk 1

Transformative Experience in a Physics Course Designed to Facilitate Connections to Biology

Primary Contact: Benjamin Geller, Swarthmore College

We examine the trajectory of a biology student ("Bryn") who entered an Introductory Physics for Life Science (IPLS) course with a negative view about the relevance of physics to her primary interests, and with a strong disciplinary identity as a biologist. After the IPLS course, Bryn's perspective on physics had evolved in profound ways. We leverage the idea of "transformative experience" (Pugh, 2010) to understand Bryn's evolution, and suggest how one might expand Pugh's definition to account for the experiences of students as they move between disciplinary classrooms. We argue that transformation is not just about seeing physics in the everyday world, but about seeing physics in other disciplines. By the end of the IPLS semester, Bryn has a set of "wonderful ideas" not only about physics, but about the relationship of physics to her primary biological interests.

Juried Talk 2

Intersectional physics identity framework

Primary Contact: Angela Johnson, St. Mary's College of Maryland

For the past several years, I have been studying a physics department where women of color feel successful and like they belong. In this presentation, I will present the physics identity which is available in this setting, and how that identity is accessible to women of color. I will also describe the framework I used to derive this identity, a framework that would be useful to other scholars interested in either physics identity or issues of diversity in physics.

Juried Talk 3

Misaligned Visions for Improving Graduate Diversity: Student Characteristics vs. Systemic/Cultural Factors?

Primary Contact: Lindsay Owens, Rochester Institute of Technology
Co-authors: Benjamin M. Zwickl, Scott V. Franklin, and Casey W. Miller

There has been a positive movement for physics departments to increase diversity of graduate programs by using more holistic strategies in their admission and retention practices. In this multiple case study of three graduate programs, faculty and graduate students were interviewed on the topics of admission and retention. While the goal of improving retention is shared between faculty and graduate students, their visions for how retention could be improved are not aligned. For two of the participating programs, faculty believe that retention could be improved by reforming admissions practices to select for students with attributes critical for success in graduate school, such as self-motivation. In contrast, the graduate student note more systemic or socio-cultural factors as impacting retention. It will be difficult to move onto next steps in the change process if there is divergence on the problem needing to be solved.

Juried Talk 4

Studying Community Development: A Network Analytical Approach

Primary Contact: Christopher A. Hass, TBA
Co-authors: P. A. Ouimet, F. Genz, M.B. Kustusch, K. Pomian, E.C. Sayre, and J.P. Zwolak

Research shows that community plays a central role in learning, and strong community support helps to engage students and aid in student persistence. Thus, understanding the function and structure of communities in learning environments is essential to education. We use social network analysis to explore the community dynamics of STEM students in a pre-matriculation, two-week summer program. Unlike previous network analysis studies in PER, we build our networks from classroom video that has been coded for student interactions using labeled, directed ties. We define 3 types of interaction: task oriented interactions (regarding the assigned task), topical interactions (having to do with STEM), and off topic interactions (unrelated to the assignment or STEM). To understand the development of community in this program, we analyze the evolution of the network during an activity, as well as over the course of the program by comparing the network from two different days.

Poster Session III — Grand South
Thursday, August 2, 9:45 AM

Thursday, August 2, 9:45 AM **Lafayette**

PERLOC Office Hours

During Poster Session III, PERLOC members will hold drop-in office hours to answer questions like the following (and any others that you may have):

What is PERLOC? What does PERLOC do? How can PERLOC help me? Can I become part of PERLOC? How much money does PERLOC have, and can I have some of it? Can PERLOC fix a problem that I noticed? Is PERLOC good at asking questions about itself?

In all seriousness, drop by and chat with PERLOC members. We'd love to hear from you!

Prosperity, Family and Identity: Learning From What Helps Women of Color Thrive

Apriel K. Hodari, Council for Opportunity in Education
Co-authors: Angela C. Johnson, Elizabeth Mulvey, Vanessa Webb, Rose Young

Centering marginalized voices has long been a tool for critiquing mainstream institutions and individual practices by feminist theorists and critical race scholars. In this paper session, we present four papers that center women of color in order to study predominantly white physics departments in which they thrive. The ultimate goal of this work is to provide insights into how physics spaces that were not created for women of color can become more welcoming of them, and thereby increase their own thriving. Elizabeth Mulvey will present results of quantitative analyses of postsecondary institutional data pointing to schools in which women of color are succeeding beyond the national norm. Angela Johnson will describe qualitative evidence of what such institutions do facilitate extraordinary success for women of color. Rose Young will report on her interviews with undergraduate STEM students who parent. Vanessa Webb will focus on STEM undergraduates of trans experience, and present her findings on whether/how environments that are inclusive for women of color are inclusive for trans students as well. Apriel Hodari will provide a framework for these papers, and co-facilitate a conversation between the audience and speakers, along with a thoughtful discussant. The overarching goal of this session is to consider broader notions of race and gender intersectionality via explicit engagement with ideas of family and identity beyond those traditionally considered. We invite a participant audience to join with us to wrestle with the lived realities of the collective voices our data represents. We request participants consider how they can contribute to increased inclusion in their home institutions based on what they learn in this session.

Abstracts for individual talks in this session:
https://www.compadre.org/per/perc/2018/Detail.cfm?ID=7422

Researching Graduate Education in Physics: From Aspiration to Dissertation

Sara Mueller, The Ohio State University
Co-Presenters: D. Chari, A. Heckler, A. Koenka, A. Maries, E. Marshman, C. Porter, G. Potvin, A. B. Simmons, C. Singh

Challenges related to diversification, representation, and retention of students persist in graduate-level physics education, as in other levels of physics education. Increased attention has been given to a narrow window of graduate physics education, particularly to admission criteria and bridging underrepresented students from bachelor's to PhD. Since these efforts focus on the application process and on successful applicants, there remain questions about why students choose to apply to graduate school and what current graduate students experience during their studies. Therefore, it is important to understand the decision-making of all undergraduate students regarding graduate physics education to identify the motivations/barriers of graduate education. Additionally, there exist a number of distinct issues that affect nearly all graduate students which are largely unstudied, including the role of core course instruction and physics core understanding, logistical pathways through physics programs, and motivational factors that impact students' continuance in graduate school. To understand the complicated trajectory of a graduate student, we must examine the individual experiences of graduate students and their mentors (from the decision to apply for graduate school to defending their dissertation), but also contextualize their experiences with an understanding of the institutional structures that have shaped the traditional training of graduate students.

This mixed-mode talk/panel session will include speakers whose research programs have begun to address these topics, and a panel of speakers and graduate students who will discuss under-studied issues that they are facing in physics.

Abstracts for individual talks in this session:
https://www.compadre.org/per/perc/2018/Detail.cfm?ID=7423

Aspiring to Lead: Opportunities for Research on Physics Teacher Leadership in K-12 Education

Rebecca E. Vieyra, AAPT
Colleen Megowan Romanowicz, AMTA

In the gap that often exists between K-12 education policy and K-12 science education research, the teacher voice is frequently missing. In May 2017, the AAPT released a report, Aspiring to Lead, co-authored by 18 teachers with contributions from a total of 43 members of the K-12 physics teaching and teacher preparation community (https://www.aapt.org/K12/upload/PMTL-Report-2017__aapt_fina.pdf). This report laid out a vision for the role of AAPT in engaging physics teachers as agents of national change -- from policy to practice -- through a coherent series of programs meant to grow teacher leadership. Undergirding the Aspiring to Lead report and its programs is detailed ethnographic research that looks at personas, self-efficacy, skill growth, and engagement of teacher leaders in the physics community, as well as the social habitus, social capital, and distributed cognition of teacher leaders within networks.

This discussion will allow for members of the PER community to gather to share interests and work related to teacher leadership, including K-12 physics induction and mentoring, continuing growth through teacher-led professional networks, and policies affecting K-12 teaching. Expected products from this discussion will include a list of potential research questions or themes for physics education research, opportunities for collaboration, and a simple annotated literature review. Participants are encouraged to read the Executive Summary of the report on pages 5-9 in advance of the discussion.

Making Sense of Physics Sensemaking

R. Russ, University of Wisconsin, Madison
Co-authors: A. Elby, P. Emigh, E. Gire, A. Gupta, K. Hahn, M. M. Hull, S. Kapon, E. Kuo, M. Lenz, T. Odden, R. Russ, M. Schvartzer

The scientific endeavor is fundamentally about making sense of the universe. Sensemaking should therefore be supported explicitly by physics instruction. However, recognizing sensemaking often relies on expert intuition rather than clear definitions. This session aims to add sharpness and coherence to this often fuzzy or fragmented theoretical construct. In our talks, we will characterize physics sensemaking in a variety of educational contexts (secondary school, undergraduate courses, and clinical interviews). We aim to spark a discussion of sensemaking in physics as a theoretical construct, clarify its meaning, and suggest approaches for cultivating it in physics instruction.

Abstracts for individual talks in this session:
https://www.compadre.org/per/perc/2018/Detail.cfm?ID=7433

Community Resources for Research and Collaboration

A. Madsen, American Association of Physics Teachers
Co-authors: M. Bolan, S. Chasteen, S. Franklin, E. Sayre

We recognize that our community has diverse skills and tools, and that when these are brought together, they can enable wonderful research. Come to this session to learn about several resources that can support you in your research and participate in a discussion with the leaders of these resources about other kinds of support you need as a researcher. We will highlight four resources including the PER Consultants' Directory, the PhysPort Data Explorer, the PEER Program and NSF funding. The PER Consultants Directory is a community-supported list of PERers who will assist diverse projects with program evaluation, data collection, reduction, and analysis; and focused research tasks. The Directory allows you to search for an evaluator or researcher by interests, seniority, or project scope; you can also list yourself to find new collaborations and contract work. The PhysPort Data Explorer pairs basic data analysis and intuitive visualizations for researchers developing or using concept inventories in their research. The Data Explorer also makes large anonymized datasets available to quantitative researchers trying novel methods or tests on existing instruments. The PEER program conducts field schools for emerging or isolated researchers who want to increase their research, paper-writing, and mentoring skills. As much of the research in our community is supported by the NSF, this session will also include a presentation by an NSF program officer on ideas for building collaboration and research programs supported by NSF funding.

Identifying Conceptual Resources for Understanding Physics

B. Frank, Middle Tennessee State University
Co- Moderators: B. Frank and L. Goodhew
Presenters: C. Alvarado, B. Brizuela, Y. Cao, A. Daane, B. Geller, L. Goodhew, D. Meredith, A. D. Robertson, H. Sabo, M. C. Wittmann, D. Young

Historically, research identifying student ideas in physics has focused on student misunderstandings, misconceptions, or difficulties. This work has supported the development of curriculum that elicits and addresses these misunderstandings and has informed instructors' knowledge of student ideas. More recently, research has begun to systematically identify student conceptual resources for understanding physics -- that is, the productive "beginnings" of physics that students bring to bear as they learn. This session showcases some of this research, highlighting a range of samples (K-12 students, university students, and teacher-learners) and physics topics (thermal physics, energy, electricity and magnetism, and pressure).

Abstracts for individual posters in this session:
https://www.compadre.org/per/perc/2018/Detail.cfm?ID=7435

Supporting Student Leadership and Ownership in Equity Work: Insights From The Access Network

B. Gutmann, University of Illinois - Urbana Champaign
Moderator/Discussant: B. Gutmann
Presenters: D. Dounas-Frazer, B. Gutmann, S. Hyater-Adams, G. Lee, M. Lopez, M. Marshall, G. Quan, K. Rainey, C. Turpen, C. Woodrum

The Access Network is a coalition of nine university-based organizations that advance equity and inclusion in physics and other physical sciences. While they differ in their implementations, these organizations share a set of five core goals that together embody the network's values: 1) fostering supportive learning communities, 2) engaging students in authentic science, 3) developing students' professional skills, 4) empowering students to take ownership of their education, and 5) increasing diversity and equity in the physical sciences. The Access Network enhances the efforts of individual organizations by cultivating intersite communication, especially facilitating the documenting and sharing of ideas across sites through a variety of network-level activities.

Many Access members are conducting foundational research on student participation within the programs, including their senses of community and feelings of ownership over their learning. Within this session, we showcase the brilliant ideas that student leaders have implemented in their local sites and discuss how the network has supported those efforts.

Abstracts for individual posters in this session:
https://www.compadre.org/per/perc/2018/Detail.cfm?ID=7436

Déana Scipio, IslandWood

Inclusive and transformative epistemic agency: Broadening participation by valuing "wonderful ideas"

Whose ideas are seen as "wonderful ideas" in science research and learning environments? Broadening participation scholarship on the experiences of participants from non-dominant communities has focused on success, persistence, and resilience and has created opportunities for designers of learning environments to consider new pathways to participation in STEM fields. This work has pushed designers, educators, and policy makers to support the participation and persistence of individuals from non-dominant communities and the institutions that serve them. Critical STEM education scholars have built upon and questioned assimilative narratives of disciplinary participation and questioned the burden that narratives of participation based in resilience place upon students from non-dominant communities (McGee & Bentley, 2017).

Within this context, a focus on science teaching and learning that engages *inclusive* and *transformative* epistemic agency has the power to expand the ways we think about broadening participation. *Inclusive* epistemic agency relates to the ways that youth from non-dominant communities were positioned to contribute to the ongoing knowledge making practices of a chemical oceanography laboratory. *Transformative* epistemic agency refers to the ways youths' actions and interests shifted the ongoing practices of the laboratory. I argue that broadening participation in STEM needs to include both increasing non-dominant community participation in existing STEM paradigms i.e. inclusive epistemic agency but also *transformative* epistemic agency that pushes for changing definitions of STEM participation which include other ways of knowing and doing.

About Déana

Dr. Déana Scipio is the Director of the Graduate Program in Education for Environment and Community at IslandWood, and has focused much of her career on broadening participation for learners from non-dominant communities in Science, Technology, Engineering, and Math (STEM). She has designed and studied learning environments within formal and informal contexts and focuses on equitable design, creating spaces for learners from non-dominant groups to demonstrate and create disciplinary expertise, architecting community-university partnerships to facilitate multidirectional learning, and helping experts and mentors build pedagogical capacity. Déana was a graduate researcher at the Institute for Science and Math Education and the LIFE Center; an ERC Postdoctoral fellow at the Chèche Konnen Center at TERC in Cambridge Massachusetts; and most recently, a postdoctoral scholar and researcher in the School of Education at the University of California, Davis where she conducted

research to understand how youth develop environmental science agency through their participation in citizen science projects. She is an alumna of IslandWood's Graduate Program in Education for Environment and Community (2008) and earned her Master of Education in Curriculum and Instruction (2009) and her Ph.D. in Learning Sciences and Human Development (2015) from the University of Washington's College of Education.

What is the Goal of Introducing Computation Into High School Physics and Physical Science?

Rebecca Vieyra, American Association of Physics Teachers
Discussant: D. Weintrop
Presenters: C. Megowan-Romanowicz, C. Orban, R. Teeling-Smith, S. Temple, R. Vieyra

There is a growing interest in incorporating programming into high school physics and physical science classes. As more projects are developed to meet this need, an important question is, "What are the goals of integrating programming at this level?" Is it sufficient to introduce coding just to raise student familiarity with computer science? Is the goal to make physics instruction more effective through coding? Or is the main goal to emphasize computational thinking as a kind of new learning objective, where programming is simply a means to that end? What are the opportunities for improving upon the current state of physics instruction? Answers to these questions can help to frame physics education research on student experiences with coding at this level, which is a research area that is still in its infancy.

This session will highlight a few different groups working to integrate coding at this level: (1) a STEM+C funded partnership between AAPT, AMTA, and Bootstrap, (2) the STEMcoding project (go.osu.edu/STEMtube) which is led by Prof. Chris Orban (Ohio State U) and Prof. Richelle Teeling-Smith (Univ. of Mt. Union), (3) Tychos.org which is led by Bay-area physics teacher Steve Temple, and (4) a popular code, vpython, which some teachers have customized for high school level purposes. Each of these groups will give a brief presentation and talk about their goals and motivation and how their work conforms to those goals.

Following this, participants will discuss at round tables: (1) Which of the various goals and motivations discussed in the presentations connects most closely to your opinion of where courses at this level need to improve? and (2) What questions should education researchers focus on as they conduct studies on coding in high school physics and physical science? Finally, each table will summarize their discussions to the wider group.

What Can Be Achieved By Building On Wonderful Ideas

Eric Kuo, University of Pittsburgh
Co-authors: B. Frank, A. Leak, E. Manz, A. Phillips, J. Watkins

While Eleanor Duckworth makes an intuitively compelling argument for supporting students' novel, wonderful ideas in classrooms, the practical question for PER is how this educational philosophy is and can be aligned with the instructional goals in teaching physics. Critically, the answer depends not only on the intrinsic value of Duckworth's proposal, but also on how we imagine and define these instructional goals. This session will explore both (i) the novel (and familiar) learning goals that can be achieved by recognizing, valuing, and building on students' own ideas in physics and (ii) the pedagogical approaches for doing so. Four presentations will provide research-based and instructional perspectives on these issues, and an extended panel discussion will invite attendees to contribute their questions and thoughts around "wonderful" learning outcomes and their implications for teaching and research.

Anna Phillips will present on a physics course focused on developing students own ideas and arguments. In this course, students came to value their own ideas more over the course of the semester.

Jessica Watkins and Eve Manz will examine an introductory physics episode to analyze how a teacher responds to a student's "wonderful" uncertainty to engage a class in collective sense-making while making progress toward canonical ideas.

Brian Frank will ask, "Is there room for wonderful student ideas within the canon of introductory physics?" He will present case studies of students having wonderful ideas in introductory physics and discuss how such moments benefit from careful instructional planning and curriculum design.

Anne Leak will present two studies on bringing wonderful ideas into the classroom and the novel approaches that students develop for solving problems outside of the classroom. She will discuss how integrating students' wonderful ideas into physics courses can motivate and prepare students for solving complex problems.

Abstracts for individual talks in this session:
https://www.compadre.org/per/perc/2018/Detail.cfm?ID=7438

Wonderful Ideas Deserve Wonderful Research: Techniques for Studying Informal Physics Programs

Kathleen Hinko, Michigan State University
Moderator/Discussant: K. Hinko, C. Fracchiolla
Presenters: M.B. Bennett, B. Fiedler, S. Hyater-Adams, T. Williams, E. Price, M. McColgan, B. Jones, C. Alvarado

Informal physics spaces, with their focus on building student agency, creativity, and identity, are "wonderful" environments for both teaching and learning. Such spaces provide a unique opportunity for foundational research on physics education, since they are free of the constraints of most classroom settings: grades, compulsory attendance, predetermined curricula, etc. However, this freedom means that implementation of informal programs can vary greatly, thus creating novel challenges to evaluation and research as well. There is therefore a real need for critical discussion of the different approaches to and methods of studying the diverse participants who engage in these environments.

This dynamic and interactive poster session will provide an opportunity for interested community members to engage with a number of topics important to informal physics education. Presenters will be assembled from diverse perspectives and locales to share their experiences and insight on topics such as data collection, diversity of participants and pedagogies, evaluation and research, differences from formal education, etc. For the first half of the session, presenters will give ~8-minute presentations to session participants in a rotating symposium format, focusing on the research and implementation of their specific programs. The second half of the session will take the form of a panel discussion, moderated by one of the session organizers, and featuring the presenters. Participants will be able to direct the conversation, allowing them to dig deeper into presenters' research and experience while also touching upon broader topics such as challenges inherent to the field of informal physics itself. To facilitate continued conversation and support for participants, the discussion will be documented, curated, and distributed following the session. This session will thus be able to serve as a critical catalyst for the formation of this emerging informal physics community.

Beyond the IRB: Examining the Relationship Between the Researcher and the Researched

Brian Zamarripa Roman, University of Central Florida
Discussants: Brian Zamarripa Roman (University of Central Florida), Jacquelyn J. Chini (University of Central Florida)
Facilitators: Ayush Gupta (University of Maryland), Eleanor C. Sayre (Kansas State University), Katemari Rosa (Universidade Federal da Bahia), Adrienne Traxler (Wright State University), Déana Scipio (UC Davis)

Professor of indigenous education Linda Tuhiwai Smith states, "'research' is probably one of the dirtiest words in the indigenous world's vocabulary." Research, as a method of generating knowledge, has a history of colonialist practices. The trajectories of methodologies now employed in education research also pass through colonized landscapes, retaining problematic but taken-for-granted routines and ways of thinking that structure power and positionalities of the researcher and researched via metaphors of saving, helping, separation of purposes, etc. The tools of thought and action provided in IRB stipulations and trainings can often reify rather than challenge these routines. The epistemic and structural/institutional power dynamic between the researcher and researched is complicated by other dimensions of power, especially when the researched are from traditionally disempowered groups. In this session, we want the physics education community members to grapple with these ideas, becoming more aware of our own standing as a participant in our own research enterprise through a lens of power and an anti-colonial orientation, and explore ways in which we can build capacity for praxis (reflection and action) towards resisting colonialist routines and the possibility of mutual liberation within a knowledge-generating enterprise.

In the session, we will start with an orienting talk, followed by moderated small-group discussions exploring abovementioned themes, first organized around qualitative and quantitative methodologies and then seeking to articulate personally and communally meaningful short and long term possibilities for action. As session moderators, we will aim to create a space where community members with differing histories of exposure to these ideas can participate legitimately, valuing knowledge from lived experiences as well as formal learning experiences.

Probing understanding of the sophisticated use of "simple" mathematics in physics

Peter S. Shaffer, University of Washington
Presenters: S. Brahmia, A. Elby, A. Gupta, M. M. Hull, E. Kuo, T. Sikorski, E. Torigoe, J. Von Korff, G. White

Introductory physics starts with mathematics that is familiar to most students yet is used in novel and sophisticated ways. University students taking introductory physics often succeed in executing mathematical procedures in context, but struggle with using mathematical concepts for sense making. Even students in calculus-based courses have difficulty with the basic algebraic reasoning that is a foundation for more advanced mathematical thinking.

An important component of physics is quantitative modeling, which requires conceptual understanding of not only the underlying physical phenomenon, but also of the mathematics used to describe it. The blend of physical, arithmetic, and algebraic reasoning is more challenging for students than many instructors realize. For example, the interdependence of physical quantities is at the heart of symbolic models in physics, yet many students have difficulties with co-variational reasoning even in the context of pure numbers in mathematics. The use of variables (instead of numbers) to represent quantities, which is also known to make reasoning more difficult in mathematics, can pose additional barriers to reasoning about physics concepts and relationships. Flexibility with the varied uses of negative quantities can be an indicator of mastery in algebra; however, in physics, negative quantities have additional nuances that are not always apparent to students. Similarly, differentials, which pose a significant challenge for learners of calculus, can present additional difficulties in physics as their application can differ depending on context.

This session targets student understanding of the application of mathematics concepts in physics contexts that may be regarded by experts as "just" basic math. It brings together researchers who have asked questions related to expert-like thinking and student understanding of conceptual quantitative ideas as well as exploring the space between already-learned mathematics and physics.

Abstracts for individual posters in this session:
https://www.compadre.org/per/perc/2018/Detail.cfm?ID=7445

Juried Talks II

Organizing Committee, PERC

Moderator: L. Ding

This session consists of four juried talks.

Juried Talk 1

Comparing Methods for Addressing Missing Data for Concept Inventories

Primary Contact: J. Nissen, University of Maine
Co-authors: R. Donatello, and B. Van Dusen

The most common method for addressing missing data in the PER literature is complete case analysis, where researchers only analyze matched samples. However, many statisticians recommend researchers use multiple-imputation (MI) to address missing data. We used simulated datasets to compare estimates of student learning using complete case analysis and MI. We based the simulated datasets on grades and concept inventories from 1,310 students in 3 physics courses and grade distributions from 192 STEM courses. We created missing data in the simulated datasets based on participation models from Jariwala et al. (PERC, 2017). Results showed that complete-case analysis tended to overestimate scores with a larger effect on the posttest but that MI only slightly overestimated scores. To improve the accuracy, precision, and utility of pre/post CI measurements, we recommend that researchers use MI and that researchers report descriptive statistics for both the participants and non-participants in their studies.

Juried Talk 2

When students are in an indeterminate state: Valuing the messiness of students' ontological reasoning in quantum mechanics

Primary Contact: J.R. Hoehn, University of Colorado, Boulder
Co-authors: N.D. Finkelstein

Student reasoning in physics can be messy, and this messiness ought be valued because, in part, it can lead to students having wonderful ideas. Messiness of student reasoning takes many forms; here we consider the messiness of ontological structures (categorical organization of entities, such as "photon" or "electron"). We present a framework to describe the dynamics of ontologies. In a

Modern Physics course environment, we demonstrate students' flexible use of ontologies in multiple contexts and show how the messiness of reasoning structures can be valuable for student learning. Finally, we identify pedagogical and curricular cues that may or may not invoke certain patterns of use of ontological structures. In so doing, we seek to move beyond the "get it or don't get it" view of student learning and focus instead on valuing and supporting the messiness and tentative nature of students' reasoning, or the having of wonderful ideas.

Juried Talk 3

Student Outcomes Across Collaborative-Learning Environments

Primary Contact: X. Herrera, California State University Chico
Co-authors: J. Nissen and B. Van Dusen

The Learning Assistant (LA) model supports instructors in implementing research-based teaching practices in their own courses. In the LA model undergraduate students are hired to help facilitate research-based collaborative-learning activities. Using the Learning About STEM Student Outcomes (LASSO) database, we examined student learning from 112 first-semester physics courses that used either lecture-based instruction, collaborative instruction without LAs, or LA supported instruction. We measured student learning using 5959 students' responses on the Force and Motion Conceptual Evaluation (FMCE) or Force Concept Inventory (FCI). Results from Hierarchical Linear Models (HLM) indicated that LA supported courses had higher posttest scores than collaborative courses without LAs and that LA supported courses that used LAs in laboratory and recitation had higher posttest scores than those that used LAs in lecture.

Juried Talk 4

How Freshmen Generate Evidence for Reasoning in Physics and Non-physics Tasks

Primary Contact: B. Ibrahim, The Ohio State University, School of Teaching and Learning
Co-authors: L. Ding

We explore undergraduate students' sources of self-generated evidence and their meta-cognition when they solve physics and non-physics questions. Our sample comprises 50 freshmen taking or having taken introductory physics. Each student participated in a one-hour interview to complete five open-ended reasoning questions taken from published instruments. Two questions are non-physics that deal with correlation of variables. The three physics questions pertain to the topic of energy. Results indicate that for the non-physics questions, the students

predominantly used given information in the task as source of evidence. They realised that everyday experiences or assumptions are informal ideas and hence assigned them a less weight. For the physics questions, the students did not realise that they used informal ideas. They packaged informal knowledge in the form of formal physics knowledge. These differences may be explained by the students' ease to deal with the context of the questions and cognitive load.

Thursday, August 2, 3:15 PM
Closing Activities

We are providing four distinct ways to close out your conference experience!

Plenary Panel **Renaissance Ballroom**

Moderator: L. Atkins Elliott
Join the three plenary speakers as they discuss themes that cut across their talks with time for more Q&A.

Discussions: Emergent Questions **Meeting Room 2**

Moderator: J. Richards
In true wonderful ideas fashion, we'll organize small group conversations around your emergent questions that came up during the conference. Feel free to join any group you wish and pitch new questions as well!

Discussion: Implications for Teaching **Meeting Room 3**

Moderator: A. Elby
In this informal discussion, we'll consider how the ideas introduced in the plenary talks (and other sessions) could inform how we teach our physics courses.

Art/Music Room **Meeting Room 4**

Moderator: A. Robertson
Want some space to unwind and/or process your experience at the conference by making art or music? Join us in the art/music room! (And bring an instrument if you wish!)

Renaissance Hotel Maps