

# 2016 PHYSICS EDUCATION RESEARCH CONFERENCE

Sacramento, CA, USA July 20 – 21, 2016

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## PREFACE

Research frameworks were the focus of the 2016 Physics Education Research Conference, under the theme “A Methodological Approach to PER.” The more than 300 conference attendees were encouraged to join in a lively discussion about methodologies and their role and importance for strengthening research.

The AAPT/PERC Bridging Session highlighted work by Kerrie Douglas on “Appropriate Use of Assessments through Applications of Validity Theoretical Framework” and Jesper Bruun on “Network Analysis as a Research Methodology in PER.” Douglas challenged attendees to consider whether assessment instruments are appropriate for certain uses and provided a practical framework for that determination. Bruun presented a network analysis approach that provides insightful maps of learning in a rich methodological framework.

In a change of format from previous years, the banquet was replaced with time for participants to have dinner on their own and then return for a plenary and “first-timers” poster session. Saalih Allie presented the first plenary on “Methodology and Theorizing in PER: The Role of Humble Theories,” where he presented an approachable category of theorizing that could be applicable to specific content and contexts of PER research.

Along with 185 contributed posters over four sessions, 13 parallel sessions with 38 talks and 16 poster presentations, and two workshops, two additional Plenary sessions were held on the second day of the conference. Peter Hewson encouraged disciplinary connections as he spoke “On the Interaction of Physics with Physics Education Research.” George Bodner’s talk, “Theoretical Frameworks for Qualitative Research from Chemical Education Research,” shared lessons from the integration of qualitative research into CER. A Speaker Panel Summary served to reflect back on the methodology theme and wrap up the event.

The Editors thank this year’s conference organizers Paul Irving, Rebecca Lindell, and Cedric Linder, and the Physics Education Research Leadership and Organizing Council (PERLOC). As always, the dedication of all involved in the planning and implementation of the PERC was evident as another successful and engaging conference is in the books.

The Proceedings’ online submission process for contributed papers and referee reports are supported each year by Lyle Barbato and Bruce Mason who work closely with the PERC Proceedings Editors to make improvements to the system and ensure that everything runs smoothly. Lyle and Bruce are owed a great many thanks for their ongoing commitment and tireless work for the whole community and on behalf of the PERC Proceedings in particular.

We also acknowledge and thank the American Association of Physics Teachers for their sponsorship of the The Proceedings as it is published on-line through comPADRE and for their support throughout the process.

Last but not least, this volume owes its existence to the referees, who volunteer their time and expertise to help improve the quality of the papers published in the Proceedings. This year we

had 197 reviewers who reviewed the 128 papers submitted to the Peer Reviewed Section, including some who were willing to step in and review with extremely short notice.

The Editors thank: Elise Agra, John Aiken, Carolina Alvarado, Katherine Ansell, Gordon Aubrecht, Ryan Badeau, Charles Baily, Pablo Barniol, Alexander P. Becker, Abigail Bogdan, Andrew Boudreaux, Danielle Bugge, John B. Buncher, Adam Burgasser, Esmeralda Campos, Stacey L. Carpenter, Eduardo Castro, Stephanie Chasteen, Zhongzhou Chen, Jacquelyn Chini, Warren Christensen, Alice D. Churukian, Eleanor W. Close, Geraldine Cochran, Vincent P. Coletta, Jessica Conn, Monica K. Cook, Joel C. Corbo, Jessica Creamer, Abigail R. Daane, Melissa Dancy, Debbie DeRoma, Seth Devore, Angeles Dominguez, Leanne Doughty, Dimitri R. Dounas-Frazer, Benjamin W. Dreyfus, Gintaras Duda, Ben Van Dusen, Andrea Van Duzor, Melissa Eblen-Zayas, Melissa Eblen-Zayas, Mark Eichenlaub, Andrew Elby, Leslie Atkins Elliott, Paul Emigh, Jennifer Esswein, Eugenia Etkina, Brian Farlow, William N. Ferm Jr., Noah Finkelstein, Claudia Fracchiolla, Andrew Gavrin, Elizabeth Gire, Lisa M. Goodhew, Kara Gray, Mark D. Greenman, Bor Gregorcic, Ian T. Griffin, Nathaniel Grosz, Jenaro Guisasola, Ayush Gupta, David Hammer, Alexandria K. Hansen, Danielle B. Harlow, Zahra Hazari, Ryan L. C. Hazelton, Andrew F. Heckler, Deborah Hemingway, Charles Henderson, Rachel Henderson, Ilkka Hendolin, Paula R. L. Heron, Sarah T Hierath, Kathleen Hinko, Andrew S. Hirsch, N.G. Holmes, Jessica Hoy, Zdeslav Hrepic, Simone Hyater-Adams, Bashirah Ibrahim, Joss Ives, Manher Jariwala, Anders Johansson, Joseph Johnson, Christof Keebaugh, Patrick Kelley, Alexis V. Knaub, Joshua Von Korff, Hagit Kornreich-Leshem, Laird Kramer, Mila Kryjevskaja, Thanh K. Le, Anne Leak, Sunbok Lee, MacKenzie Lenz, Charles De Leone, H. Lewandowski, Shih-Yin Lin, Rebecca Lindell, Beth Lindsey, Angela Little, Michael E. Loverude, Brandon Lunk, Alexandru Maries, James Marshall, Emily Marshman, Kelly Martin-Gaffney, KK Mashood, Andrew Mason, Michele Frances Mateycik, McColgan, Alistair McInerny, Daryl McPadden, Laura Millay, Bahar Modir, Camila Monsalve, Emily B. Moore, Elise C. Morgan, Gary A. Morris, Alice Olmstead, Gina Passante, Andrew Pawl, James Perrone, Jeffrey A. Phillips, Steven J. Pollock, C. D. Porter, Edward Price, Gina M. Quan, Monica Quezada-Espinoza, Jennifer Radoff, Katherine Rainey, Ajith Rajapaksha, Carina M. Rebello, N. Sanjay Rebello, Daniel Reinholz, AJ Richards, Amy Robertson, Rebecca Rosenblatt, Edward A. Roualdes, Gabriel Rowe, Andy Rundquist, Qing X. Ryan, Mel Sabella, Homeyra Sadaghiani, Oscar Sanchez-Mata, Emily Sandt, Brianna Santangelo, Vashti Sawtelle, Ryan Sayer, Eleanor Sayre, Erin Scanlon, Benjamin P. Schermerhorn, Rachel E. Scherr, Bill Schmitt, Emily Scott, Ozden Sengul, Peter S. Shaffer, Chandralekha Singh, Trevor Smith, Erin Ronayne Sohr, Patricia Soto, J. Caleb Speirs, Jared B. Stang, Jacob T. Stanley, MacKenzie Stetzer, Linda E. Strubbe, Nutifafa Kwaku Sumah, R. Talbot, John Thompson, Eugene Torigoe, Adrienne Traxler, Chandra Turpen, Marlene Vega, Michael Vignal, Stamatis Vokos, Jarrett Vosburg, Paul J. Walter, Tong Wan, Jue Wang, Daniel R. White, Jada-Simone S. White, Bethany R. Wilcox, Matthew Wilcox, Michael Wittmann, Steven F. Wolf, Bert C. Xue, Edit Yerushalmi, Tugba Yuksel, Genaro Zavala, Liang Zeng, Jing Zhang, Guangtian Zhu, Dean Zollman, Tianlong Zu, Kristina Zuza, and Benjamin Zwickl

Last, though certainly not least, the Editors wish to thank the Community at large for their innovation, dedication to the field, and support for all things PER.

Dyan L. Jones  
Editor-in-Chief

## Conference Overview

### 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 was an invitation for the PER community to engage in debate and discussion about research methodology and its role in how we will 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 were both internal and external to the PER community were 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 was 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*

The organizing committee of the PERC 2016 would like to express gratitude to the following individuals for their invaluable assistance in creating this conference:

The plenary speakers: Saalih Allie, Peter Hewson, and George Bodner; Lyle Barbato and Bruce Mason with ComPADRE; Tiffany Hayes, Cerena Cantrell, Janet Lane, and Pearl Watson from AAPT; and the PERC Proceedings Editors: Dyan Jones, Lin Ding, and Adrienne Traxler.

## PROGRAM

Wednesday, July 20, 2016

- 2:00pm **Bridging Session**  
Kerrie A. Douglas  
Appropriate Use of Assessments through Applications of Validity  
Theoretical Framework
- Jesper Bruun  
Network Analysis as a Research Methodology in PER
- 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 – Magnolia / Camellia Ballroom**  
Saalih Allie  
Methodology and Theorizing in PER: The Role of Humble Theories
- 5:30pm **Dinner on own**
- 7:30pm **Poster session I – Gardenia / Grand Ballroom Foyer**
- 8:15pm **Poster session II – Gardenia / Grand Ballroom Foyer**

Thursday, July 21, 2016

- 8:30am **Plenary # 2 – Magnolia / Camellia Ballroom**  
Peter Hewson  
On the Interaction of Physics with Physics Education Research
- 9:15am **Coffee – Grand Nave Ballroom Foyer**
- 9:45am **Poster session III – Gardenia / Grand Ballroom Foyer**
- 10:30am **Parallel Session I**  
**Talk Symposium – Bondi**  
Conceptual Blending as a Theoretical Framework in PER  
Discussant: Jesper Haglund  
Moderator: Bor Gregorcic  
Presenters: B. Dreyfus, N. Finkelstein, B. Gregorcic, A. Gupta, J. Haglund, J. Hoy, Z. Hrepic, N. S. Rebello, E. Ronayne Sohr, M. Wittmann, D. Zollman
- Talk Symposium – Compagno**  
Investigating the Impact of Learning Assistant Model Adoption on Students and Learning Assistants  
Discussant & Moderator: Valarie Otero  
Presenters: R. Benabentos, J. Boyer, E. Close, H. Close, J. Conn, L. Doughty, L. Hartley, Z. Hazari, H. Kornreich-Leshem, L. Kramer, P. Le,

A. Nasim, G. Potvin, I. Rodriguez, R. Talbot, B. Van Dusen, J. White

**Talk Symposium – Falor**

Methodologies for Video-Based Research in PER

Discussant: Rahcel Scherr

Moderators: Benedikt Harrer and Luke Conlin

Presenters: L. Conlin, V. Flood, A. Gupta, B. Harrer, E. Kuo

**Poster Symposium – Bataglieri**

Expanding Research Questions by Expanding Quantitative Methodologies

Moderator: J. Chini

Presenters: E. Brewé, J. Bruun, J. Chini, J. Cribbs, I. Griffin, Z. Hazari, R. Lock, D. McPadden, J. Pond, G. Potvin, T. Smith, N. Wright

**Talk Symposium – Kamilos**

Building Research Questions from Observational Data

Moderator: E. Sayre

Presenters: D. Chari, A. Chase, A. Hansen, D. Harlow, K. Hinko, H. Nguyen, J. Zwolak

**Discussion Symposium – Beavis**

Physics Teaching for Social Justice

Facilitators: A. Daane, M. Rifkin, A. Robertson

**Workshop – Baker**

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

Presenters: A. Churukian, L. Ding, D. Jones, A. Traxler

12:00pm

**Lunch – Magnolia / Camellia Ballroom**

12:30pm

**Plenary # 3 – Magnolia / Camellia Ballroom**

George Bodner

Theoretical Frameworks for Qualitative Research, a Story from Chemical Education Research

1:15pm

**Parallel Session II**

**Poster Symposium – Bataglieri**

Methodologies Using Identity Frameworks

Discussant: Idaykis Rodriguez

Presenters: E. Close, H. Close, J. Conn, J. Doyles, S. McKagan, G. Potvin, A. Robertson, K. Rosa, R. Scherr

**Talk Symposium – Bondi**

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

Discussant & Moderator: R. Russ

Presenters: L. Elliott, D. Hammer, L. Jaber, A. Leak, A. Little, A.

Phillips, J. Radoff, J. Watkins, B. Zwickl

**Talk Symposium – Compagno**

Educating Pre-service Physics Teachers

Moderator: Eugenia Etkina

Presenters: E. Etkina, B. Gregorcic, S. Kapon, A. Merzel, G. Planinsic, G. Stewart, J. Stewart, S. Vokos

**Talk Symposium – Falor**

Conceptual Issues and Content Revisions in the Introductory Physics Course for Life Science Students

Moderator: Nancy Beverly

Presenters: C. Anderson, W. Christensen, A. Churukian, C. Crouch, D. Deardorff, B. Geller, D. Hemingway, K. Mashood, R. Matz, L. McNeil, K. Moore, E. Mylott, V. Sawtelle, E. Scott, D. Smith, C. Turpen, S. Underwood, C. Wallace, R. Widenhorn

**Workshop – Beavis**

NSF Education Programs for Physics & Astronomy

Organizer: Kevin Lee

**Poster Symposium – Tofanelli**

Network Analysis in PER

Moderator: Adrienne Traxler

Presenters: M. Bodin, E. Brewe, J. Bruun, R. Dou, A. Gavrinn, M. Lindahl, R. Lindell, C. Linder, A. Traxler, E. Williams, J. Zwolak

2:45pm

**Coffee**

3:15pm

**Speaker Panel Summary Discussion – Magnolia / Camellia Ballroom**

4:00pm

**End of PERC**

## **Introduction**

Papers published in the *2016 Physics Education Research Conference Proceedings* consist of two categories, plenary papers and peer-reviewed papers.

Plenary papers are authored by the conference plenary speakers. Although copy-edited by the Proceedings' editors, plenary papers do not undergo a peer-review process.

Peer-reviewed papers are written products of any presentation other than the plenary talks. Each paper in this category must undergo a rigorous peer-review process in order to be published in the Proceedings. This year has seen 128 submitted manuscripts, among which 98 are accepted for final publication.

The readership of the *2016 Physics Education Research Conference Proceedings* includes faculty, post-doctoral associates, and graduate and undergraduate students in physics education; scholars in other discipline-based science education or closely related fields, such as cognitive science; practitioners in physics or other sciences, such as teaching faculty at undergraduate and graduate levels, and high school physics teachers.