2017 PHYSICS EDUCATION RESEARCH CONFERENCE

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EDITORS

Lin Ding
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# 2017 Physics Education Research Conference

## Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preface</td>
<td>ix</td>
</tr>
<tr>
<td>Conference Overview</td>
<td>xii</td>
</tr>
<tr>
<td>Conference Program</td>
<td>xiii</td>
</tr>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
</tbody>
</table>

### JURIED PAPERS

- **The use of epistemic distancing to create a safe space to sensemake in introductory physics tutorials**  
  Luke D. Conlin  
  Pages: 3

- **Investigating and promoting epistemological sophistication in quantum physics**  
  Jessica R. Hoehn and Noah D. Finkelstein  
  Pages: 7

- **Examining students’ personal epistemology: the role of physics experiments and relation with theory**  
  Dehui Hu and Benjamin M. Zwickl  
  Pages: 11

- **Mathematization and the ‘Boas course’**  
  Michael E. Loverude  
  Pages: 15

- **Impact of perceived grading practices on students’ beliefs about experimental physics**  
  Bethany R. Wilcox and H.J. Lewandowski  
  Pages: 19

### PEER REVIEWED PAPERS

- **The Role of Students’ Gender and Anxiety in Physics Performance**  
  Elise Agra, Susan M. Fischer, and Sian L. Beilock  
  Pages: 24

- **The effects of a redesign on students’ attitudes and evaluations for an introductory calculus-based physics lab**  
  Saif M. Ali and Brian D. Thoms  
  Pages: 28

- **Assessing a GTA professional development program**  
  Emily Alicea-Munoz, Joan Espar Masip, Carol Subiño Sullivan, and Michael F. Schatz  
  Pages: 32

- **The Learning Assistant model and DFW rates in introductory physics courses**  
  Jessica L. Alzen, Laurie Langdon, and Valerie Otero  
  Pages: 36

- **Using lesson design to change student approaches to dorm-room design prelabs**  
  Katherine Ansell and Mats Selen  
  Pages: 40

- **Quantitative Measures of Equity in Small Groups**  
  Ben Archibeque, Florian Genz, Maxwell Franklin, Scott Franklin, and Eleanor Sayre  
  Pages: 44

- **Modifying the Thermodynamic Concept Survey: Preliminary results**  
  Pablo Barniol and Genaro Zavala  
  Pages: 48
The effect of explicit preparation in pedagogical modes on informal physics educators
Michael B. Bennett, Kathleen A. Hinko, Brett Fiedler, and Noah D. Finkelstein

The Effect of Students’ Learning Orientations on Performance in Problem Solving Pedagogical Implementations
Charles Bertram and Andrew Mason

What is the role of motivation in procedural and conceptual physics learning? An examination of self-efficacy and achievement goals
Kelly Boden, Eric Kuo, Timothy J. Nokes-Malach, Tanner LeBaron Wallace, and Muhsin Menekse

Negative quantities in mechanics: a fine-grained math and physics conceptual blend?
Suzanne White Brahmia

Concept and empirical evaluation of a new curriculum to teach electricity with a focus on voltage
Jan-Philipp Burde and Thomas Wilhelm

Testing group composition within the studio learning environment
Kristine E. Callan, Bethany R. Wilcox, and Wendy K. Adams

Exploring instructors’ interpretation of electric field lines
Esmeralda Campos and Genaro Zavala

Longitudinal associations between learning assistants and instructor effectiveness
Daniel Caravez, Angelica De La Torre, Jayson Nissen, and Ben Van Dusen

Designing online learning modules to conduct pre- and post-testing at high frequency
Zhongzhou Chen, Geoffrey Garrido, Zachary Berry, Ian Turgeon, and Francisca Yonekura

Characterization of time scale for detecting impacts of reforms in an undergraduate physics program
Eleanor W. Close, Jean-Michel Mailloux-Huberdeau, Hunter G. Close, and David Donnelly

Identifying barriers to ethnic/racial minority students’ participation in graduate physics
Geraldine L. Cochran, Theodore Hodapp, and Erika E. Alexander Brown

Inquiry-based activities and their effects on students’ ability to explain related problem scenarios
Edgar de Guzman Corpuz, Ma. Aileen Corpuz, and Brenda Ramirez

Participants’ perceptions of the Faculty Online Learning Community (FOLC) experience
Melissa H. Dancy, Alexandra Lau, Joel C. Corbo, Charles Henderson, and Andy Rundquist

Exploring the Underlying Factors in Learning Assistant - Faculty Partnerships
Felicia Davenport, Fidel Amezcua, Mel S. Sabella, and Andrea G. Van Duzor

Teaching about Inequity: Shifts in Student Views about Diversity in Physics
Sierra Decker and Abigail R. Daane

Comparison of normalized gain and Cohen’s d for Force Concept Inventory results in an introductory mechanics course
David Donnelly, Jean-Michel Mailloux-Huberdeau, Jayson M. Nissen, and Eleanor W. Close

Instructor perspectives on iteration during upper-division optics lab activities
Dimitri R. Donas-Frazer, Jacob T. Stanley, and H. J. Lewandowski
Student Interpretations of Partial Derivatives
Paul J. Emigh and Corinne A. Manogue

Changing Student Conceptions of Newton’s Laws Using Interactive Video Vignettes
Jonathan Engelman and Kathy Koenig

Exploring how students use sandbox software to move between the physical and the formal
Elias Euler and Bor Gregorcic

A comparison of the impact of 3 forms of “hands-on” activities for learners with different scientific reasoning abilities
Susan M. Fischer, Elise Agra, and Sian L. Beilock

Student responses to chain rule problems in thermodynamics
Ian W. Founds, Paul J. Emigh, and Corinne A. Manogue

Multiple tools for visualizing equipotential surfaces: Optimizing for instructional goals
Elizabeth Gire, Aaron Wangberg, and Robyn Wangberg

Graduate teaching assistants’ perceptions of a context-rich introductory physics problem
Melanie Good, Emily Marshman, Edit Yerushalmi, and Chandralekha Singh

Student conceptual resources for understanding mechanical wave propagation
Lisa M. Goodhew, Amy D. Robertson, Paula R.L. Heron, and Rachel E. Scherr

The use of ACER to develop and analyze student responses to expectation value problems
Chrystyn Green and Gina Passante

Mastery learning in the zone of proximal development
Brianne Gutmann, Gary Gladding, Morten Lundsgaard, and Timothy Stelzer

Student sense-making on homework in a sophomore mechanics course
Kelby T. Hahn, Paul J. Emigh, MacKenzie Lenz, and Elizabeth Gire

Representational Use on a Lab Question by Modeling Workshop Participants
Kathleen A. Harper, Ted M. Clark, Lin Ding, and Matthew A. Kennedy

Examining Thematic Variation in a Phenomenographical Study on Computational Physics
Nathaniel T. Hawkins, Paul W. Irving, Marcos D. Caballero, and Michael J. Obsniuk

Racial and ethnic bias in the Force Concept Inventory
Rachel Henderson and John Stewart

Student Objections to and Understanding of Non-Cartesian Unit Vector Notation in Upper-Level E&M
Brant Hinrichs

Towards quantification of the FCI’s validity: the effect of false positives
Michael M. Hull, Jun-ichiro Yasuda, Masa-aki Taniguchi, and Naohiro Mae

Intersectionality and Physics Identity: A Case Study of Black Women From Different Nationalities
Simone Hyater-Adams, Tamia Williams, Claudia Fracchiolla, Noah Finkelstein, and Kathleen Hinko
<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understanding the PICUP community of practice</td>
<td>188</td>
</tr>
<tr>
<td>Paul Irving and Marcos D. Caballero</td>
<td></td>
</tr>
<tr>
<td>Exploring learner variability: experiences of students with cognitive disabilities in post-secondary STEM</td>
<td>192</td>
</tr>
<tr>
<td>Westley James, Kamryn Lamons, Jillian Schreffler, Eleazar Vasquez III, and Jacquelyn J. Chini</td>
<td></td>
</tr>
<tr>
<td>Participation rates of in-class vs. online administration of low-stakes research-based assessments</td>
<td>196</td>
</tr>
<tr>
<td>Manher Jariwala, Jayson Nissen, Xochith Herrera, Eleanor W. Close, and Ben Van Dusen</td>
<td></td>
</tr>
<tr>
<td>Students’ understanding of continuous charge distributions</td>
<td>200</td>
</tr>
<tr>
<td>Tharindu Jayasinghe and Homeyra Sadaghiani</td>
<td></td>
</tr>
<tr>
<td>Motivational characteristics of underrepresented ethnic and racial minority students in introductory physics courses</td>
<td>204</td>
</tr>
<tr>
<td>Z. Yasemin Kalender, Emily Marshman, Tim Nokes-Malach, Christian Schunn, and Chandralekha Singh</td>
<td></td>
</tr>
<tr>
<td>Teaching assistants' performance at identifying common introductory student difficulties revealed by the conceptual survey of electricity and magnetism</td>
<td>208</td>
</tr>
<tr>
<td>Nafis I. Karim, Alexandru Maries, and Chandralekha Singh</td>
<td></td>
</tr>
<tr>
<td>Physics Instruction That Facilitates Learning Among Underrepresented Groups</td>
<td>212</td>
</tr>
<tr>
<td>Jennifer Keil, Nicole Schrode, and Rebecca Stober</td>
<td></td>
</tr>
<tr>
<td>Text Mining Online Discussions in an Introductory Physics Course</td>
<td>216</td>
</tr>
<tr>
<td>Patrick Kelley, Andrew Gavrin, and Rebecca Lindell</td>
<td></td>
</tr>
<tr>
<td>Analyzing student understanding of vector field plots with respect to divergence</td>
<td>220</td>
</tr>
<tr>
<td>Pascal Klein and Jochen Kuhn</td>
<td></td>
</tr>
<tr>
<td>Do learning communities encourage potential STEM majors?</td>
<td>224</td>
</tr>
<tr>
<td>Alexis V. Knaub, Jenifer N. Saldanha, Clark R. Coffman, and Charles Henderson</td>
<td></td>
</tr>
<tr>
<td>The Invention Coach: A computer-based environment that supports the transfer of STEM concepts</td>
<td>228</td>
</tr>
<tr>
<td>Marianna Lamnina, Helena Connolly, Vincent Alevin, and Catherine C. Chase</td>
<td></td>
</tr>
<tr>
<td>An analysis of community formation in faculty online learning communities</td>
<td>232</td>
</tr>
<tr>
<td>Alexandra Lau, Melissa H. Dancy, Joel C. Corbo, Charles Henderson, and Andy Rundquist</td>
<td></td>
</tr>
<tr>
<td>Examining students’ perceptions of innovation and entrepreneurship in physics</td>
<td>236</td>
</tr>
<tr>
<td>Anne E. Leak, Christian Cammarota, Nathan Cawley, and Benjamin Zwickl</td>
<td></td>
</tr>
<tr>
<td>Student perspectives of and experience with sense-making: a case study</td>
<td>240</td>
</tr>
<tr>
<td>MacKenzie Lenz, Kelby T. Hahn, Paul J. Emigh, and Elizabeth Gire</td>
<td></td>
</tr>
<tr>
<td>Student reasoning about measurement uncertainty in an introductory lab course</td>
<td>244</td>
</tr>
<tr>
<td>H. J. Lewandowski, Robert Hobbs, Jacob T. Stanley, Dimitri R. Dounas-Frazer, and Benjamin Pollard</td>
<td></td>
</tr>
<tr>
<td>Pre-service teachers' experience with Khan Academy in introductory physics</td>
<td>248</td>
</tr>
<tr>
<td>Christine Lindstrøm and James Gray</td>
<td></td>
</tr>
<tr>
<td>Examining the factors that impact group work effectiveness in studio physics</td>
<td>252</td>
</tr>
<tr>
<td>Robynne M. Lock, Melanie Schroers, and William G. Newton</td>
<td></td>
</tr>
</tbody>
</table>
The impact of stereotype threat on gender gap in introductory physics
Alexandru Maries, Nafis I. Karim, and Chandralekha Singh

Student difficulties with finding the corrections to the energy spectrum of the hydrogen atom for the strong and weak field Zeeman effects using degenerate perturbation theory
Emily Marshman, Christof Keebaugh, and Chandralekha Singh

Guided and Unguided Student Reflections
Amanda Matheson, Laura Wood, Elizabeth Hane, and Scott Franklin

Using disciplinary perspectives to refine conceptions of the “real world”
Abhilash Nair, Paul Irving, and Vashti Sawtelle

Performance differences for in-class and online administration of low-stakes research-based assessments
Jayson Nissen, Manher Jariwala, Xochith Herrera, Eleanor W. Close, and Ben Van Dusen

Investigation of male and female students’ motivational characteristics throughout an introductory physics course sequence

“Charges are everywhere”: A case of student sensemaking about electric current
Tor Ole B. Odden and Rosemary Russ

Managing teams for instructional change: Understanding three types of diversity
Alice Olmstead, Charles Henderson, and Andrea Beach

A novel approach for using programming exercises in electromagnetism coursework

Equity of success in CLASP courses at UC Davis
Cassandra Paul, David Webb, Mary Chessey, and Wendell Potter

Increasing the accessibility of PhET Simulations for students with disabilities: Progress, challenges, and potential
Katherine Perkins and Emily Moore

Students’ epistemological beliefs from two studies of calculus and physics
Anna McLean Phillips and Caroline J. Merighi

Impact of Argumentation Scaffolds in Contrasting Designs Tasks on Elementary Pre-Service Teachers’ Use of Science Ideas in Engineering Design
Yuri B. Piedrahita Urueña, Carina M. Rebello, Chandan Dasgupta, Alejandra J. Magana, and N. Sanjay Rebello

Evaluation of Cambodian high school students’ comprehension of the projectile trajectory using the model analysis technique
So Piten and Suttida Rakkapao

Impact of an introductory lab on students’ understanding of measurement uncertainty
Benjamin Pollard, Robert Hobbs, Jacob T. Stanley, Dimitri R. Dounas-Frazer, and H. J. Lewandowski
Using Social Network Analysis on classroom video data
Katarzyna E. Pomian, Justyna P. Zwolak, Eleanor C. Sayre, Scott V. Franklin, and Mary Bridget Kustusch

Prelecture Questions and Conceptual Testing in Undergraduate Condensed Matter Courses
C. D. Porter, A. Bogdan, and A. F. Heckler

Interview Validation of the Physics Lab Inventory of Critical thinking (PLIC)
Katherine N. Quinn, Carl Wieman, and N.G. Holmes

STEM Majors’ Perceptions of Racism and Sexism in STEM
Katherine Rainey, Melissa H. Dancy, Roslyn Mickelson, Elizabeth Stearns, and Stephanie Moller

University Student Conceptual Resources for Understanding Forces
Amy D. Robertson, Lisa M. Goodhew, Rachel E. Scherr, and Paula R. L. Heron

A study on the beliefs about the role of physics and physicists amongst introductory students
Miguel Rodriguez and Geoff Potvin

Investigating peer and teaching assistant interactions of physics students working on computational coding
Zack Rowatt, Rebecca Rosenblatt, and Raymond Zich

Students’ use of symbolic forms when constructing Boundary conditions
Qing X. Ryan, Thu Chau, Homeyra Sadaghiani, and Gina Passante

Effect of supplementary videos on scientific reasoning in a general physics course
Amber Sammons, Jessica Tolmie, Rebecca Rosenblatt, and Raymond Zich

Integration of mathematics and communication in physics-intensive workplaces
Brianna Santangelo, Nicholas Young, Anne Leak, Kelly Martin, and Benjamin Zwickl

Students’ determination of differential area elements in upper-division physics
Benjamin P. Schermerhorn and John R. Thompson

Using observations of Universal Design for Learning to enhance post-secondary STEM teaching practices
Jillian Schreffler, Eleazar Vasquez III, Westley James, and Jacquelyn Chini

Exploring All I See: Interdisciplinary Affinity and Goal Orientations of Physics and Engineering Majors
Tyler D. Scott and Riley Harder

Uptake of solution checks by undergraduate physics students
Tiffany-Rose Sikorski, Gary D. White, and Justin Landay

Student difficulties with finding the fine structure corrections to the energy spectrum of the hydrogen atom using degenerate perturbation theory
Chandralekha Singh, Emily Marshman, and Christof Keebaugh

A controlled study of stereoscopic virtual reality in freshman electrostatics
J. R. Smith, A. Byrum, T. M. McCormick, N. Young, C. Orban, and C. D. Porter

Showing the dynamics of student thinking as measured by the FMCE
Trevor I. Smith, Kerry A. Gray, Kyle J. Louis, Bartholomew J. Ricci, and Nicholas J. Wright
<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle School Physics Teachers’ Content Knowledge of Acceleration</td>
<td>384</td>
</tr>
<tr>
<td>Elijah Tabachnick, Peter Colesworthy, and Michael C. Wittmann</td>
<td></td>
</tr>
<tr>
<td>Introductory physics students’ retention of conceptual understanding</td>
<td>388</td>
</tr>
<tr>
<td>of forces</td>
<td></td>
</tr>
<tr>
<td>Brian D. Thoms and Paul W. Beaty</td>
<td></td>
</tr>
<tr>
<td>Understanding life science majors’ ideas about diffusion</td>
<td>392</td>
</tr>
<tr>
<td>Samuel Luke Tunstall, Abhilash Nair, Kathleen Hinko, Paul Irving,</td>
<td></td>
</tr>
<tr>
<td>and Vashti Sawtelle</td>
<td></td>
</tr>
<tr>
<td>Investigating physics faculty’s reasoning about inequities in</td>
<td>396</td>
</tr>
<tr>
<td>undergraduate physics education</td>
<td></td>
</tr>
<tr>
<td>Chandra Turpen, Angela Little, and Vashti Sawtelle</td>
<td></td>
</tr>
<tr>
<td>Systemic inequities in introductory physics courses: the impacts of</td>
<td>400</td>
</tr>
<tr>
<td>learning assistants</td>
<td></td>
</tr>
<tr>
<td>Ben Van Dusen and Jayson M. Nissen</td>
<td></td>
</tr>
<tr>
<td>Analogues in thermodynamics: the Partial Derivative Machine and</td>
<td>404</td>
</tr>
<tr>
<td>Legendre transformations</td>
<td></td>
</tr>
<tr>
<td>Michael Vignal, Corinne A. Manogue, David Roundy, and Elizabeth Gire</td>
<td></td>
</tr>
<tr>
<td>Physics students learning about abstract mathematical tools when</td>
<td>408</td>
</tr>
<tr>
<td>engaging with “invisible” phenomena</td>
<td></td>
</tr>
<tr>
<td>Trevor S. Volkwyn, John Airey, Bor Gregorcic, Filip Heijkensköld,</td>
<td></td>
</tr>
<tr>
<td>and Cedric Linder</td>
<td></td>
</tr>
<tr>
<td>Design strategies for research-based physics activities</td>
<td>412</td>
</tr>
<tr>
<td>Joshua Von Korff, Amin Bayat Barooni, Monica Cook, Brian Ferguson,</td>
<td></td>
</tr>
<tr>
<td>and Kyle Simmons</td>
<td></td>
</tr>
<tr>
<td>The prevalence of selected buoyancy alternate conceptions at two</td>
<td>416</td>
</tr>
<tr>
<td>colleges</td>
<td></td>
</tr>
<tr>
<td>DJ Wagner and Peter S. Shaffer</td>
<td></td>
</tr>
<tr>
<td>Student understanding of the measurable effects of relative phases</td>
<td>420</td>
</tr>
<tr>
<td>in superposition states</td>
<td></td>
</tr>
<tr>
<td>Tong Wan, Paul J. Emigh, and Peter S. Shaffer</td>
<td></td>
</tr>
<tr>
<td>Comparing Chinese and American students’ performance in quantum</td>
<td>424</td>
</tr>
<tr>
<td>mechanics</td>
<td></td>
</tr>
<tr>
<td>Jue Wang and Guangtian Zhu</td>
<td></td>
</tr>
<tr>
<td>Quantum mechanics students’ understanding of normalization</td>
<td>428</td>
</tr>
<tr>
<td>Kevin Lee Watson</td>
<td></td>
</tr>
<tr>
<td>Standing fast: Translation among durable representations using</td>
<td>432</td>
</tr>
<tr>
<td>evanescent representations in upper-division problem solving</td>
<td></td>
</tr>
<tr>
<td>Nandana Weliweriya, Tra Huynh, and Eleanor Sayre</td>
<td></td>
</tr>
<tr>
<td>Physics major engagement and persistence: a phenomenography interview</td>
<td>436</td>
</tr>
<tr>
<td>study</td>
<td></td>
</tr>
<tr>
<td>Eric A. Williams, Justyna P. Zwolak, and Eric Brewe</td>
<td></td>
</tr>
<tr>
<td>Using multiple survey questions about energy to uncover elements of</td>
<td>440</td>
</tr>
<tr>
<td>middle school student reasoning</td>
<td></td>
</tr>
<tr>
<td>Michael C. Wittmann, Adam Z. Rogers, Carolina Alvarado, Joshua</td>
<td></td>
</tr>
<tr>
<td>Medina, and Laura Millay</td>
<td></td>
</tr>
<tr>
<td>Information flow in group exams</td>
<td>444</td>
</tr>
<tr>
<td>Steven F. Wolf, Timothy M. Sault, and Hunter G. Close</td>
<td></td>
</tr>
<tr>
<td>Characterizing practices and resources for inclusive physics</td>
<td>448</td>
</tr>
<tr>
<td>learning</td>
<td></td>
</tr>
<tr>
<td>Laura A. Wood and Amy D. Robertson</td>
<td></td>
</tr>
<tr>
<td>Models of Math Use in Non-academic Workplace Settings</td>
<td>452</td>
</tr>
<tr>
<td>Nicholas T. Young, Brianna Santangelo, Kelly Norris Martin, Anne</td>
<td></td>
</tr>
<tr>
<td>Leak, and Benjamin Zwickl</td>
<td></td>
</tr>
<tr>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Model-based inquiry vs. Traditional computer simulation-based instruction: Which can better help students construct the quantum-mechanical model of an atom?</td>
<td>456</td>
</tr>
<tr>
<td>Tugba Yuksel, N. Sanjay Rebello, and Lynn A. Bryan</td>
<td></td>
</tr>
<tr>
<td>Differences between the SCALE-UP model and instructors' perceptions of implementation</td>
<td>460</td>
</tr>
<tr>
<td>Brian Zamarripa Roman, Constance M. Doty, Matthew Wilcox, Noel Klinger, Jarrad W. T. Pond, Joshua S. Von Korff, and Jacquelyn J. Chini</td>
<td></td>
</tr>
<tr>
<td>Student mental models about conductors and dielectrics</td>
<td>464</td>
</tr>
<tr>
<td>Jing Zhang and Lin Ding</td>
<td></td>
</tr>
<tr>
<td>Using eye tracking to differentiate student difficulties reasoning with data</td>
<td>468</td>
</tr>
<tr>
<td>Raymond Zich and Rebecca Rosenblatt</td>
<td></td>
</tr>
<tr>
<td>Use of Eye-Tracking Technology to Investigate Cognitive Load Theory</td>
<td>472</td>
</tr>
<tr>
<td>Tianlong Zu, John Hutson, Lester C. Loschky, and N. Sanjay Rebello</td>
<td></td>
</tr>
<tr>
<td>Characterizing analytical and computational mathematics use during PhD research</td>
<td>476</td>
</tr>
<tr>
<td>Benjamin Zwickl, Kingston Chen, Joshua Deslongchamps, Anne Leak, and Kelly Martin</td>
<td></td>
</tr>
<tr>
<td>Student perceptions of the value of out-of-class interactions: Attitudes vs. Practice</td>
<td>480</td>
</tr>
<tr>
<td>Justyna P. Zwolak, Remy Dou, and Eric Brewe</td>
<td></td>
</tr>
<tr>
<td>List of Participants and E-mail Addresses</td>
<td>484</td>
</tr>
<tr>
<td>Index</td>
<td>488</td>
</tr>
</tbody>
</table>
PREFACE

The theme of the 2017 Physics Education Research (PER) Conference was Mathematization and Physics Education Research. This theme was selected because of the increasing number of recent publications on mathematics in physics and also because of the growing connections between the PER community and the Research in Undergraduate Mathematics Education (RUME) community. Events and activities of this year’s PER Conference revolved around discussions of how students conceptualize and proceduralize mathematical operations in the context of physics problem solving. This conference attracted nearly 400 participants and inspired them to engage in deep reflection of the current status of learners’ approaches to mathematization as well as effective ways to improve their conceptual framing of mathematical procedures in physics problem solving. The participants also discussed a variety of other topics related to teaching and learning of physics.

The first Plenary Session, also serving as the AAPT-PERC bridging session, shone a spotlight on two invited speakers Michael Oehrtmann and Megan Wawro, who brought the audience from the physics kingdom into the mathematics arena. Michael Oehrtmann presented a talk titled “Quantitative reasoning and mathematical modeling in an introductory calculus sequence,” in which he reported multiple studies of student development of mathematical expressions and equations. Megan Wawro presented a talk titled “Student understanding and symbolization of eigen-theory.” In this talk she provided a unique lens on how students in quantum physics courses reason about and symbolize eigenvectors and eigenvalues for a 2x2 matrix.

Another highlight of the conference is the lunch program on the second day, in which three researchers—Andrew Boudreaux, Ayush Gupta, and David Meltzer shared their journeys of studying and improving student mathematical skills in physics classes.

This year’s conference boasted a large number of presentations, including one (1) first-timer and undergraduate poster session, two (2) contributed poster sessions, and three (3) parallel clusters. One unique feature of this year’s conference was that a new presentation format, namely juried talks, was introduced into the parallel clusters. Prior to the conference, authors of the juried talks submitted their proposals to the conference organizers for review. Accepted proposals then were developed into talks for presentation at the conference. Along with symposiums and invited presentations, juried talks allowed the authors to present their emerging findings from more mature research and to receive feedback for their future improvement. As a result of this new presentation format, this year’s PERC Proceedings now includes a separate section for the five juried talks presented at the conference.

It is important to recognize and thank the conference organizers who sacrificed hours of after-work time to make the 2017 PERC successful. These individuals are: Steve Kanim, Suzanne White Brahmia, Michael Loverude, and John Thompson. Also playing crucial roles behind the scene to make the conference possible are the American Association of Physics Teachers (AAPT), and the Physics Education Research Leadership and Organizing Council (PERLOC).

As with the previous years, the 2017 PERC Proceedings online submission and review process was supported by Lyle Barbato and Bruce Mason who work closely with the PERC Proceedings
Editors to ensure smooth functioning of the online system. We owe Lyle and Bruce a great deal of thanks. The Editors also thank the AAPT for their sponsorship of the Proceeding as it is published on-line through comPADRE.

Last but not least, the Editors wish to thank the referees for volunteering their time and expertise to help maintain the quality of the papers published in the Proceedings. This year we had 222 reviewers who reviewed the 155 papers submitted to the Peer Reviewed Section.


Finally, the Editors wish to express our special thanks to the PERC Coordination Committee chaired by Joel Corbo, who facilitated communications and coordinated logistics among multiple parties to make this year’s PERC Proceedings a great success.

See you next summer in Washington, DC!

Lin Ding
Editor-in-Chief
Conference Overview: Mathematization and Physics Education Research

The number of publications that are focusing on mathematics in physics is increasing, and there are increasing connections between PER and the Research in Undergraduate Mathematics Education (RUME) community. As a result, we have chosen to highlight mathematization research at the 2017 PERC in Cincinnati. By mathematization, we refer to the spontaneous tendency to use mathematical concepts to quantify and make sense of the physical world. It is not about how well people can perform the procedures of mathematics. Rather, mathematization describes how people conceptualize the meaning of mathematics in the context of physics.

Expert-like mathematization in physics involves both a procedural and conceptual mastery of the prerequisite mathematics involved (Redish and Kuo, 2015; Thompson, 2011). Gray and Tall (1994) highlight this distinction, and refer to the target learning goal as proceptual understanding, in which procedural mastery and conceptual understanding coexist. When reasoning mathematically with physics quantities, many students become entrenched in a procedural approach. Some students reach a high level of procedural efficiency without much conceptual mathematical understanding, while other students develop greater mathematical flexibility. An achievement gap emerges between those who perform procedurally and those who develop greater flexibility. Gray and Tall refer to this gap in early math learning as the proceptual divide.

The proceptual divide is evident in physics courses, where success depends on having a proceptual understanding of both the prerequisite math and the learned physics. For example, Brahmia, Boudreaux, and Kanim (under review) report on obstacles that many calculus level students encounter using basic proportional reasoning when it involves physics quantities and real numbers, rather than everyday quantities and whole numbers. Rebello et al. (2007) observed that most introductory physics students approach symbol-rich physics problems that involve calculus or trigonometry as a procedure, framing their task as one of answermaking instead of sensemaking.

Organizers:
Steve Kanim, New Mexico State University
Suzanne White Brahmia, University of Washington
Michael Loverude, California State University Fullerton
John Thompson, University of Maine

The organizing committee of the PERC 2017 would like to express gratitude to the following individuals for their invaluable assistance in creating this conference:

The plenary speakers, Michael Oehrtmann and Megan Wawro; Lillian McDermott and Joe Redish; lunch speakers for Lillian and Joe, David Meltzer, Andrew Boudreaux, Ayush Gupta; Tim Fukawa-Connelly; Lyle Barbato and Bruce Mason with ComPADRE; Tiffany Hayes, Cerena Cantrell, Janet Lane, and Pearl Watson from AAPT; PERLOC for supporting award plaques; reviewers of juried talk proposals; and the PERC Proceedings Editors: Lin Ding, Adrienne Traxler, and Ying Cao.
PROGRAM

Wednesday, July 26, 2017

2:00pm  Bridging Plenary Talks – Event Center II
        Michael Oehrtmann
        Quantitative reasoning and mathematical modeling in an introductory
        calculus sequence

        Megan Wawro
        Student Understanding and Symbolization of Eigentheory

3:30pm  Break, Poster Setup – 1st Floor Lobby

4:00pm  First Timer / Undergraduate Poster Session – Event Center I

5:00pm  Dinner (on your own) / Poster set up

8:00pm  Contributed poster session (dessert, 2 groups, 45 min per group) –
        Event Center I

Thursday, July 27, 2017

8:00am  Contributed poster session 2 (coffee) – Event Center I

9:00am  Parallel Sessions Cluster I
        Juried Talks + Posters – IA – Meeting Room 6
        Experimental Labs
        Presenters: D. Andres, K. Ansell, L. Bao, M. D. Caballero, E. Etkina, K.
        Funkhouser, N. Holmes, D. Hu, K. Koenig, H. Lewandowski, L. Owens,
        K. Quinn, R. Rosenblatt, C. Ruggieri, V. Sawtelle, M. Selen, M. R.
        Stetzer, K. L Van De Bogart, S. White Brahmia, C. Wieman, B. Wilcox,
        K. E. Wood, R. Zich, B. Zwickl

        Talk Symposium – IB – Meeting Room 1
        Contrasting Cases and Invention Activities in PER: Grounding students'
        understanding of conceptual and mathematical relations in physical
        contexts
        Presenters: V. Aleven, D. M. Beardmore, A. Boudreaux, C. C. Chase, H.
        Connolly, N. R. Hallinen, S. E. Kanim, M. F. Keil, E. Kuo, T. K. Lê, M.
        Stetzer, B. A. Towle, S. White Brahmia, C. Wieman

        Custom Format – IC – Meeting Room 2
        Funny Physics: The Roles of Humor in Learning and Teaching Physics
        Discussant: Rachel Scherr
        Moderator: Luke Conlin
        Presenters: L. Conlin, C. Gillespie Nyeggen, S. L. Li, E. Ronayne Sohr

        Poster Symposium – ID – Meeting Room 3
        Bridging Research and Practice in the Access Network
Talk Symposium – IE – Meeting Room 4
Mathematical representations in quantum mechanics instruction
Moderator: John Thompson

10:45am
Parallel Sessions Cluster II
Juried Talks – IIA – Meeting Room 6
Juried Talks II
Presenters: L. Conlin, N. Finkelstein, J. Hoehn, M. Loverude

Talk Symposium – IIB – Meeting Room 5
Math for making sense or math for making answers?
Moderator: Natasha Holmes
Presenters: N. Hallinen, N. Holmes, E. Kuo, D. McPadden

Talk Symposium – IIC – Meeting Room 2
Mathematization in university level undergraduate physics courses
Moderator: Eleanor Sayre
Presenters: V. Dini, S. Franklin, B. Modir, N. Weliweriya, S. White Brahmia, B. Wilcox, D. Zohrabi Alaee

Talk Symposium – IID – Meeting Room 4
Multiple perspectives on graduate admissions and diversity in physics
Moderator: Deepa Chari

Workshop – IIE – Meeting Room 3
"What Are You?" – Considerations and Best Practices in Operationalizing Identity through Demographic Variables
Presenters: J. J. Chini, J. Doyle, A. Little, B. Z. Roman, A. Traxler, C. Turpen

12:15pm
Lunch: Recognizing Pioneers of Mathematization in Physics Education: Honoring Joe Redish and Lillian McDermott – Event Center II

1:30pm
Parallel Sessions Cluster III
Poster Symposium – IIIA – Meeting Room 3
Emerging Scholarship
<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>3:15pm</td>
<td>Closing and summary, including invited speaker panel – Event Center II</td>
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<tr>
<td>4:00pm</td>
<td>End of PERC</td>
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Introduction

Papers published in the 2017 Physics Education Research Conference Proceedings consist of two categories, juried papers and peer-reviewed papers.

Juried papers represent the juried talks that were new in the 2017 PERC Proceedings format. These papers describe mature research projects and undergo double-blind peer review. Twenty-four juried talk proposals were submitted, of which five were accepted.

Peer reviewed papers are written products of any presentation other than the plenary or juried talks. Each paper in this category undergoes a rigorous peer review process in order to be published in the Proceedings. This year saw 156 submitted manuscripts, of which 115 were accepted for final publication.

The readership of the 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.