# Table of Contents

**Preface: 2012 Physics Education Research Conference**  
N. Sanjay Rebello  
1

**Conference Overview**  
3

## INVITED PAPERS (NOT PEER REVIEWED)

**Building classroom and organizational structure around positive cultural values**  
Badr F. Albanna, Joel C. Corbo, Dimitri R. Dounas-Frazer, Angela Little, and Anna M. Zaniewski  
7

**Critical classroom structures for empowering students to participate in science discourse**  
Shelly N. Belleau and Valerie K. Otero  
11

**A framework for assessing learning assistants’ reflective writing assignments**  
Geraldine L. Cochran, David T. Brookes, and Laird H. Kramer  
15

**Supporting and sustaining the holistic development of students into practicing physicists**  
Elizabeth Gire, Mary Bridget Kustusch, and Corinne Manogue  
19

**Design guidelines for adapting scientific research articles: An example from an introductory level, interdisciplinary program on soft matter**  
Elon Langbeheim, Samuel A. Safran, and Edit Yerushalmi  
23

**Establishing reliability and validity: An ongoing process**  
Rebecca Lindell and Lin Ding  
27

**Initial replication results of learning assistants in university physics**  
Paul M. Miller, Jeffrey S. Carver, Aniketa Shinde, Betsy Ratcliff, and Ashley N. Murphy  
30

**Cultural toolkits in the urban physics learning community**  
Mel S. Sabella and Andrea Gay Van Duzor  
34

**Instructional changes based on cogenerative physics reform**  
Natan Samuels, Eric Brewe, and Laird Kramer  
38

**Student predictions of functional but incomplete example programs in introductory calculus-based physics**  
Shawn Weatherford and Ruth Chabay  
42
<table>
<thead>
<tr>
<th>Title</th>
<th>Authors</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understanding student computational thinking with computational modeling</td>
<td>John M. Aiken, Marcos D. Caballero, Scott S. Douglas, John B. Burk, Erin M. Scanlon, Brian D. Thoms, and Michael F. Schatz</td>
<td>46</td>
</tr>
<tr>
<td>Using scientists' notebooks to foster authentic scientific practices</td>
<td>Leslie J. Atkins and Irene Y. Salter</td>
<td>50</td>
</tr>
<tr>
<td>Research-based course materials and assessments for upper-division electrodynamics (E&amp;M II)</td>
<td>Charles Baily, Michael Dubson, and Steven J. Pollock</td>
<td>54</td>
</tr>
<tr>
<td>Students' difficulties in interpreting the torque vector in a physical situation</td>
<td>Pablo Barniol, Genaro Zavala, and Carlos Hinojosa</td>
<td>58</td>
</tr>
<tr>
<td>Introduction of studio physics teaching in Panama</td>
<td>Azael Barrera-Garrido</td>
<td>62</td>
</tr>
<tr>
<td>The graduate research field choice of women in academic physics and astronomy: A pilot study</td>
<td>Ramón S. Barthelemy, Megan L. Grunert, and Charles R. Henderson</td>
<td>66</td>
</tr>
<tr>
<td>Improving physics instruction by analyzing video games</td>
<td>Ian D. Beatty</td>
<td>70</td>
</tr>
<tr>
<td>Multidimensional student skills with collaborative filtering</td>
<td>Yoav Bergner, Saif Rayyan, Daniel Seaton, and David E. Pritchard</td>
<td>74</td>
</tr>
<tr>
<td>Self-efficacy in introductory physics in students at single-sex and coeducational colleges</td>
<td>Jennifer Blue, Mary Elizabeth Mills, and Ellen Yezierski</td>
<td>78</td>
</tr>
<tr>
<td>Evaluation of a multiple goal revision of a physics laboratory</td>
<td>Scott W. Bonham, Doug L. Harper, and Lance Pauley</td>
<td>82</td>
</tr>
<tr>
<td>Student interactions leading to learning and transfer: A participationist perspective</td>
<td>David T. Brookes, Alexander Moncion, and Yuhfén Lin</td>
<td>86</td>
</tr>
<tr>
<td>ACER: A framework on the use of mathematics in upper-division physics</td>
<td>Marcos D. Caballero, Bethany R. Wilcox, Rachel E. Pepper, and Steven J. Pollock</td>
<td>90</td>
</tr>
<tr>
<td>Evidence of embodied cognition via speech and gesture complementarity</td>
<td>Evan A. Chase and Michael C. Wittmann</td>
<td>94</td>
</tr>
<tr>
<td>Alignment of TAs' beliefs with practice and student perception</td>
<td>Jacquelyn J. Chini and Ahlam Al-Rawi</td>
<td>98</td>
</tr>
<tr>
<td>Comparing student conceptual understanding of thermodynamics in physics and engineering</td>
<td>Jessica W. Clark, John R. Thompson, and Donald B. Mountcastle</td>
<td>102</td>
</tr>
</tbody>
</table>
Understanding the learning assistant experience with physics identity
Eleanor W. Close, Hunter G. Close, and David Donnelly

Nesting in graphical representations in physics
Hunter G. Close, Eleanor W. Close, and David Donnelly

Conserving energy in physics and society: Creating an integrated model of energy and the second law of thermodynamics
Abigail R. Daane, Stamatis Vokos, and Rachel E. Scherr

A comparative study of middle school and high school students’ views about physics and learning physics
Lin Ding

Students' interdisciplinary reasoning about “high-energy bonds” and ATP
Benjamin W. Dreyfus, Benjamin D. Geller, Vashti Sawtelle, Julia Svoboda, Chandra Turpen, and Edward F. Redish

Building knowledge for teaching: Three cases of physics graduate students
Brian W. Frank and Natasha Speer

Diversity of faculty practice in workshop classrooms
Scott V. Franklin and Tricia Chapman

How an active-learning class influences physics self-efficacy in pre-service teachers
Jon D. H. Gaffney, Amy L. Housley Gaffney, Ellen L. Usher, and Natasha A. Mamaril

The effect of research-based instruction in introductory physics on a common cognitive bias
Ross K. Galloway, Simon P. Bates, Jonathan Parker, and Evguenia Usoskina

Contrasting students’ understanding of electric field and electric force
Alejandro Garza and Genaro Zavala

Students' reasoning about interdisciplinarity
Benjamin D. Geller, Benjamin W. Dreyfus, Vashti Sawtelle, Julia Svoboda, Chandra Turpen, and Edward F. Redish

Arrows as anchors: Conceptual blending and student use of electric field vector arrows
Elizabeth Gire and Edward Price

Exploring student difficulties with pressure in a fluid
Matthew Goszewski, Adam Moyer, Zachary Bazan, and D. J. Wagner

Applying cognitive developmental psychology to middle school physics learning: The rule assessment method
Nicole R. Hallinen, Min Chi, Doris B. Chin, Joe Prempeh, Kristen P. Blair, and Daniel L. Schwartz

Students talk about energy in project-based inquiry science
Benedikt W. Harrer, Virginia J. Flood, and Michael C. Wittmann
<table>
<thead>
<tr>
<th>Title</th>
<th>Authors</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investigating student ability to apply basic electrostatics concepts to conductors</td>
<td>Ryan L. C. Hazelton, MacKenzie R. Stetzer, Paula R. L. Heron, and Peter S. Shaffer</td>
<td>166</td>
</tr>
<tr>
<td>Department-level change: Using social network analysis to map the hidden structure of academic departments</td>
<td>Charles Henderson and Kathleen Quardokus</td>
<td>170</td>
</tr>
<tr>
<td>Student performance on conceptual questions: Does instruction matter?</td>
<td>Paula R. L. Heron</td>
<td>174</td>
</tr>
<tr>
<td>Impacting university physics students through participation in informal science</td>
<td>Kathleen Hinko and Noah D. Finkelstein</td>
<td>178</td>
</tr>
<tr>
<td>Pedagogy and/or technology: Making difference in improving students’ problem solving skills</td>
<td>Zdeslav Hrepic, Katherine Lodder, and Kimberly A. Shaw</td>
<td>182</td>
</tr>
<tr>
<td>Characterizing student use of differential resources in physics integration problems</td>
<td>Dehui Hu and N. Sanjay Rebello</td>
<td>186</td>
</tr>
<tr>
<td>A conceptual physics class where students found meaning in calculations</td>
<td>Michael M. Hull and Andrew Elby</td>
<td>190</td>
</tr>
<tr>
<td>Evidence of epistemological framing in survey question misinterpretation</td>
<td>Paul Hutchison and Andrew Elby</td>
<td>194</td>
</tr>
<tr>
<td>Upper-level physics students’ conceptions of understanding</td>
<td>Paul W. Irving and Eleanor C. Sayre</td>
<td>198</td>
</tr>
<tr>
<td>DC circuits: Context dependence of student responses</td>
<td>Ignatius John and Saalih Allie</td>
<td>202</td>
</tr>
<tr>
<td>Comparing physics and math problems</td>
<td>Dyan L. Jones and Reni B. Roseman</td>
<td>206</td>
</tr>
<tr>
<td>Student expectations in a group learning activity on harmonic motion</td>
<td>Adam Kaczynski and Michael C. Wittmann</td>
<td>210</td>
</tr>
<tr>
<td>Comparing the use of multimedia animations and written solutions in facilitating problem solving</td>
<td>Neelam Khan, Dong-Hai Nguyen, Zhongzhou Chen, and N. Sanjay Rebello</td>
<td>214</td>
</tr>
<tr>
<td>Successful propagation of educational innovations: Viewpoints from principal investigators and program</td>
<td>Raina Khatri, Charles Henderson, Renee Cole, and Jeff Froyd</td>
<td>218</td>
</tr>
<tr>
<td>Narratives of the double bind: Intersectionality in life stories of women of color in physics, astrophysics and astronomy</td>
<td>Lily T. Ko, Rachel R. Kachchaf, Maria Ong, and Apriel K. Hodari</td>
<td>222</td>
</tr>
<tr>
<td>Examining inconsistencies in student reasoning approaches</td>
<td>Mila Kryjevskaia and MacKenzie R. Stetzer</td>
<td>226</td>
</tr>
</tbody>
</table>
Considering factors beyond transfer of conceptual knowledge
   Eric Kuo, Danielle Champney, and Angela Little 230

An expert path through a thermo maze
   Mary Bridget Kustusch, David Roundy, Tevian Dray, and Corinne Manogue 234

Changing classroom designs: Easy; Changing instructors’ pedagogies: Not so easy...
   Nathaniel Lasry, Elizabeth Charles, Chris Whittaker, Helena Dedic, and Steven Rosenfield 238

Physics learning identity of a successful student: A plot twist
   Sissi L. Li and Dedra Demaree 242

Identity and belonging: Are you a physicist (chemist)?
   Sissi L. Li and Michael E. Loverude 246

Student difficulties in translating between mathematical and graphical representations in introductory physics
   Shih-Yin Lin, Alexandru Maries, and Chandralekha Singh 250

Using collaborative group exams to investigate students’ ability to learn
   Yuhfen Lin and David T. Brookes 254

Assessing students’ metacognitive calibration with knowledge surveys
   Beth A. Lindsey and Megan Nagel 258

Physics career intentions: The effect of physics identity, math identity, and gender
   Robynne M. Lock, Zahra Hazari, and Geoff Potvin 262

They still remember what I never taught them: Student understanding of entropy
   Michael E. Loverude 266

Welcome to America, welcome to college: Comparing the effects of immigrant generation and college generation on physical science and engineering career
   Florin Lung, Geoff Potvin, Gerhard Sonnert, and Philip M. Sadler 270

Do perceptually salient elements in physics problems influence students’ eye movements and answer choices?
   Adrian Madsen, Amy Rouinfar, Adam Larson, Lester Loschky, and N. Sanjay Rebello 274

Regression analysis exploring teacher impact on student FCI post scores
   Jonathan V. Mahadeo, Seth R. Manthey, and Eric Brewe 278

To use or not to use diagrams: The effect of drawing a diagram in solving introductory physics problems
   Alexandru Maries and Chandralekha Singh 282

Assessing students’ epistemic logic using clause topics during problem comparison
   Fran Mateycik and Kendra Sheaffer 286
Using student notecards as an epistemological lens
    Timothy L. McCaskey 290

The experience sampling method: Investigating students' affective experience
    Jayson M. Nissen, MacKenzie R. Stetzer, and Jonathan T. Shemwell 294

A study of graduate students in an astrophysics bridging year: Identifying contradictions in a complex system
    Victoria Nwosu, Saalih Allie, Dedra Demaree, and Andrew Deacon 298

Guiding without feeling guided: Implicit scaffolding through interactive simulation design
    Ariel Paul, Noah Podolefsky, and Katherine Perkins 302

Affordances of play for student agency and student-centered pedagogy
    Noah S. Podolefsky, Danny Rehn, and Katherine K. Perkins 306

Impacts of curricular change: Implications from 8 years of data in introductory physics
    Steven J. Pollock and Noah Finkelstein 310

Additional evidence of far transfer of scientific reasoning skills acquired in a CLASP reformed physics course
    Wendell H. Potter and Robert B. Lynch 314

Supporting scientific writing and evaluation in a conceptual physics course with calibrated peer review
    Edward Price, Fred Goldberg, Scott Patterson, and Paul Heft 318

Transfer of argumentation skills in conceptual physics problem solving
    Carina M. Rebello and N. Sanjay Rebello 322

Students’ conceptions about rolling in multiple contexts
    N. Sanjay Rebello and Carina M. Rebello 326

Students’ use of resources in understanding solar cells
    A. J. Richards and Eugenia Etkina 330

Coupling epistemology and identity in explaining student interest in science
    Jennifer Richards, Luke Conlin, Ayush Gupta, and Andrew Elby 334

Is conceptual understanding compromised by a problem-solving emphasis in an introductory physics course?
    J. Ridenour, G. Feldman, R. Teodorescu, L. Medsker, and N. Benmouna 338

Cookies as agents for community membership
    Idaykis Rodriguez, Renee Michelle Goertzen, Eric Brewe, and Laird Kramer 342

Utilization of hands-on and simulation activities for teaching middle school lunar concepts
    Reni B. Roseman and Dyan L. Jones 346
<table>
<thead>
<tr>
<th>Title</th>
<th>Authors</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Challenging traditional assumptions of secondary science through the PET curriculum</td>
<td>Mike Ross and Valerie Otero</td>
<td>350</td>
</tr>
<tr>
<td>Scaffolding students’ understanding of force in pulley systems</td>
<td>Amy Rouinfar, Adrian M. Madsen, Tram Do Ngoc Hoang, Sadhana Puntambekar, and N. Sanjay Rebello</td>
<td>354</td>
</tr>
<tr>
<td>Mathematical vs. conceptual understanding: Where do we draw the line?</td>
<td>Homeyra Sadaghiani and Nicholas Aguilera</td>
<td>358</td>
</tr>
<tr>
<td>Surveys fail to measure grasp of scientific practice</td>
<td>Irene Y. Salter and Leslie J. Atkins</td>
<td>362</td>
</tr>
<tr>
<td>Examining the positioning of ideas in the disciplines</td>
<td>Vashti Sawtelle, Tiffany-Rose Sikorski, Chandra Turpen, and E. F. Redish</td>
<td>366</td>
</tr>
<tr>
<td>The dependence of instructional outcomes on individual differences: An example from DC circuits</td>
<td>Thomas M. Scaife and Andrew F. Heckler</td>
<td>370</td>
</tr>
<tr>
<td>Effect of paper color on students’ physics exam performances</td>
<td>David R. Schmidt, Todd G. Ruskell, and Patrick B. Kohl</td>
<td>374</td>
</tr>
<tr>
<td>Predicting FCI gain with a nonverbal intelligence test</td>
<td>M. R. Semak, R. D. Dietz, R. H. Pearson, and C. W. Willis</td>
<td>378</td>
</tr>
<tr>
<td>Core graduate courses: A missed learning opportunity?</td>
<td>Chandralekha Singh and Alexandru Maries</td>
<td>382</td>
</tr>
<tr>
<td>Identifying student difficulties with conflicting ideas in statistical mechanics</td>
<td>Trevor I. Smith, Donald B. Mountcastle, and John R. Thompson</td>
<td>386</td>
</tr>
<tr>
<td>Students’ understanding of density: A cognitive linguistics perspective</td>
<td>Philip Southey, Saalih Allie, and Dedra Demaree</td>
<td>390</td>
</tr>
<tr>
<td>Applying a framework for characterizing physics teaching assistants’ beliefs and practices</td>
<td>Benjamin T. Spike and Noah D. Finkelstein</td>
<td>394</td>
</tr>
<tr>
<td>&quot;Learning Arc&quot;: The process of resolving concerns through student-student discourse</td>
<td>Sean Stewart, Maria Paula Angarita, Jared Durden, and Vashti Sawtelle</td>
<td>398</td>
</tr>
<tr>
<td>How a gender gap in belonging contributes to the gender gap in physics participation</td>
<td>Jane G. Stout, Tiffany A. Ito, Noah D. Finkelstein, and Steven J. Pollock</td>
<td>402</td>
</tr>
<tr>
<td>3rd grade English language learners making sense of sound</td>
<td>Enrique Suarez and Valerie Otero</td>
<td>406</td>
</tr>
<tr>
<td>Influencing students’ relationships with physics through culturally relevant tools</td>
<td>Ben Van Dusen and Valerie Otero</td>
<td>410</td>
</tr>
</tbody>
</table>
Reflective discourse techniques: From in-class discussions to out-of-classroom problem solving  
Wendi Wampler, Dedra Demaree, and Dennis Gilbert  414

Upper-division student understanding of Coulomb’s law: Difficulties with continuous charge distributions  
Bethany R. Wilcox, Marcos D. Caballero, Rachel E. Pepper, and Steven J. Pollock  418

New ways of investigating the canonical coin toss acceleration problem  
Michael C. Wittmann and Jeffrey M. Hawkins  422

Differentiating expert and novice cognitive structures  
Steven F. Wolf, Daniel P. Dougherty, and Gerd Kortemeyer  426

Promoting children’s agency and communication skills in an informal science program  
Rosemary Wulf, Kathleen Hinko, and Noah Finkelstein  430

Authentic assessment of students’ problem solving  
Qing Xu, Kenneth Heller, Leonardo Hsu, and Bijaya Aryal  434

Students’ understanding of dot product as a projection in no-context, work and electric flux problems  
Genaro Zavala and Pablo Barniol  438

Development and validation of the Colorado learning attitudes about science survey for experimental physics  
Benjamin M. Zwickl, Noah Finkelstein, and H. J. Lewandowski  442

List of Participants and E-mail Addresses  446

Author Index  449