2008 PHYSICS EDUCATION RESEARCH CONFERENCE
Edmonton, Alberta, Canada 23 – 24 July 2008

EDITORS
Charles Henderson
Mel Sabella
Leon Hsu
2008
PHYSICS EDUCATION RESEARCH CONFERENCE
Proceedings in the Series of
Physics Education Research Conferences

<table>
<thead>
<tr>
<th>Year</th>
<th>Title</th>
<th>Publisher</th>
<th>ISBN</th>
</tr>
</thead>
</table>

To learn more about this title, or the AIP Conference Proceedings Series, please visit the webpage [http://proceedings.aip.org](http://proceedings.aip.org)
CONTENTS

Preface ..................................................................................... ix
Conference Program ................................................................ xi
Titles and Authors .................................................................. xv

INVITED PAPERS

Making Sense of Measurements, Making Sense of the Textbook ......................... 3
S. Allie, D. Demaree, J. Taylor, F. Lubben, and A. Buffler

Improving Learning for Underrepresented Groups in Physics and Engineering Majors ............... 7
S. White Brahmia

A Variety of Diversity: Facing Higher Education's Educational Challenges ......................... 11
E. L. Dey

Gender Differences in Both Force Concept Inventory and Introductory Physics Performance ........ 15
J. Docktor and K. Heller

Acting in Our Own Self-Interests: Blending University and Community in Informal Science Education .............................................................. 19
N. D. Finkelstein and L. Mayhew

What is “Nepantla” and How Can It Help Physics Education Researchers Conceptualize Knowledge for Teaching? .............................................. 23
R. Gutierrez

Similarities and Differences in Ideas Generated by Physics Learners: US College Students vs. Tibetan Buddhist Monks .............................................. 26
A. Johnson

Inequities in Physics Access and Enrollment in Urban High Schools ......................... 30
A. M. Kelly

Curriculum Design for the Algebra-Based Course: Just Change the ‘d’s to Deltas? ................. 34
M. E. Loverude, S. E. Kanim, and L. Gomez

An Idea for Generating Diversity Conversations: Physics Jeopardy and the Future Faces of Physics Kit .......................................................... 38
K. Rand and G. White

Using the Resources of the Student at the Urban, Comprehensive University to Develop an Effective Instructional Environment ........................................ 42
M. S. Sabella, K. Coble, and S. P. Bowen

Impact of Chemistry Teachers' Knowledge and Practices on Student Achievement .............. 46
K. Scantlebury

Fostering Science Learning in Diverse Urban Settings .................................................. 50
K. Tobin

Effects of Self Diagnosis on Subsequent Problem Solving Performance ......................... 53
E. Yerushalmi, A. Mason, E. Cohen, and C. Singh

PEER-REVIEWED PAPERS

What Levels of Guidance Promote Engaged Exploration with Interactive Simulations? .............. 59
W. Adams, A. Paulson, and C. E. Wieman

The Roles of Evidence in Scientific Argument .......................................................... 63
L. J. Atkins

Student Perspectives in Quantum Physics .............................................................. 67
C. Baily and N. D. Finkelstein

Using Warrants as a Window to Epistemic Framing ................................................ 71
T. J. Bing and E. F. Redish

Latent Response Times and Cognitive Processing on the FMCE ....................................... 75
S. Bonham

CLASS Shifts in Modeling Instruction .............................................................. 79
E. Brewe, L. Kramer, and G. O'Brien
The Specificity Effect: An Example from Refraction .............................................. 83
D. T. Brookes, B. H. Ross, and J. Mestre

Identifying Student Difficulty in Problem Solving Process via the Framework of the House
Model (HM) ........................................................................................................... 87
T. Byun, S. Ha, and G. Lee

Transforming Upper-Division Electricity and Magnetism ........................................ 91
S. V. Chasteen and S. J. Pollock

Understanding and Encouraging Effective Collaboration in Introductory Physics Courses ....................................................... 95
G. L. Cochran and M. S. Sabella

Identifying Differences in Diagnostic Skills between Physics Students: Students’ Self-Diagnostic Performance Given Alternative Scaffolding ........................................... 99
E. Cohen, A. Mason, C. Singh, and E. Yerushalmi

A Study of Peer Instruction Methods with High School Physics Students .................. 103
K. Cummings and S. G. Roberts

Quantitative and Qualitative Analysis of Student Textbook Summary Writing ............. 107
D. Demaree, S. Allie, M. Low, and J. Taylor

Probing Student Online Discussion Behavior with a Course Blog in Introductory Physics ...................................................... 111
G. Duda and K. Garrett

Resources Students Use to Understand Quantum Mechanical Operators ................ 115
E. Gire and C. Manogue

Indicators of Understanding: What TAs Listen for in Student Responses ................ 119
R. M. Goertzen, R. E. Scherr, and A. Elby

Analysis of Learning Assistants’ Views of Teaching and Learning .............................. 123
K. Gray and V. K. Otero

Students’ Understanding of Inclined Planes Using the CoMPASS Curriculum .......... 127
J. J. Haynicz, N. S. Rebello, and S. Puntambekar

Facilitating Change in Undergraduate STEM: Initial Results from an Interdisciplinary Literature Review ............................................................... 131
C. Henderson, A. Beach, N. D. Finkelstein, and R. S. Larson

Documenting the Conversion from Traditional to Studio Physics Formats at the Colorado School of Mines: Process and Early Results .................................................. 135
P. B. Kohl, H. V. Kuo, and T. G. Ruskell

The Persistence of the Gender Gap in Introductory Physics ..................................... 139
L. E. Kost, S. J. Pollock, and N. D. Finkelstein

The Effect of Initial Conditions and Discussion on Students’ Predictions for Interactive Lecture Demonstrations ................................................................. 143
J. Marx

Identifying Differences in Diagnostic Skills between Physics Students: Developing a Rubric ......................................................... 147
A. Mason, E. Cohen, E. Yerushalmi, and C. Singh

Use of Structure Maps to Facilitate Problem Solving in Algebra-Based Physics ........ 151
F. Mateyczik, D. H. Jonassen, and N. S. Rebello

New Media and Models for Engaging Under-Represented Students in Science ........ 155
L. M. Mayhew and N. D. Finkelstein

Examining Student Responses for Meaningful Understanding in the Context of Wavefront Aberrometry ................................................................. 159
D. L. McBride and D. A. Zollman

An Interdisciplinary Study of Student Ability to Connect Particulate and Macroscopic Representations of a Gas ................................................................. 163
K. Monteyne, B. L. Gonzalez, and M. E. Loverude

How Abstract is Abstract? Layering Meaning in Physics ........................................ 167
N. S. Podolefsky and N. D. Finkelstein

Comparing Student Learning with Multiple Research-Based Conceptual Surveys: CSEM and BEMA ................................................................. 171
S. J. Pollock

Archiving Student Solutions with Tablet PCs in a Discussion-Based Introductory Physics Class ................................................................. 175
E. Price and C. De Leone
<table>
<thead>
<tr>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determining the Various Perspectives and Consensus within a Classroom Using Q Methodology</td>
<td>179</td>
</tr>
<tr>
<td>S. E. Ramlo</td>
<td></td>
</tr>
<tr>
<td>Toward a Comprehensive Picture of Student Understanding of Force, Velocity, and Acceleration</td>
<td>183</td>
</tr>
<tr>
<td>R. Rosenblatt, E. C. Sayre, and A. F. Heckler</td>
<td></td>
</tr>
<tr>
<td>Preliminary Study of Impulse-Momentum Diagrams</td>
<td>187</td>
</tr>
<tr>
<td>D. Rosengrant and T. Mzoughi</td>
<td></td>
</tr>
<tr>
<td>Physics by Inquiry: Addressing Student Learning and Attitude</td>
<td>191</td>
</tr>
<tr>
<td>H. R. Sadaghiani</td>
<td></td>
</tr>
<tr>
<td>Evolution of Student Knowledge in a Traditional Introductory Classroom</td>
<td>195</td>
</tr>
<tr>
<td>E. C. Sayre and A. F. Heckler</td>
<td></td>
</tr>
<tr>
<td>Coupling Conceptual and Quantitative Problems to Develop Expertise in Introductory Physics Students</td>
<td>199</td>
</tr>
<tr>
<td>C. Singh</td>
<td></td>
</tr>
<tr>
<td>Enhancing Cognitive Development through Physics Problem Solving: A Taxonomy of Introductory Physics Problems</td>
<td>203</td>
</tr>
<tr>
<td>R. Teodorescu, C. Bennhold, and G. Feldman</td>
<td></td>
</tr>
<tr>
<td>Institutionalizing Reform in Introductory Physics</td>
<td>207</td>
</tr>
<tr>
<td>C. Turpen and N. D. Finkelstein</td>
<td></td>
</tr>
<tr>
<td>Reasoning Modes, Knowledge Elements and Their Interplay in Optics Problem-Solving</td>
<td>211</td>
</tr>
<tr>
<td>A. Undreiu, D. Schuster, and B. Adams</td>
<td></td>
</tr>
<tr>
<td>Interactive Problem Solving Tutorials through Visual Programming</td>
<td>215</td>
</tr>
<tr>
<td>L. Undreiu, D. Schuster, and A. Undreiu</td>
<td></td>
</tr>
<tr>
<td>Network Analysis of Social Interactions in Laboratories</td>
<td>219</td>
</tr>
<tr>
<td>A. R. Warren</td>
<td></td>
</tr>
<tr>
<td>Examining the Effectiveness of Clickers on Promoting Learning by Tracking the Evolution of Student Responses</td>
<td>223</td>
</tr>
<tr>
<td>E. P. Watkins and M. S. Sabella</td>
<td></td>
</tr>
<tr>
<td>Impact of the FIU PhysTEC Reform of Introductory Physics Labs</td>
<td>227</td>
</tr>
<tr>
<td>L. Wells, R. Valenzuela, E. Brewe, L. Kramer, G. O’Brien, and E. Zamalloa</td>
<td></td>
</tr>
<tr>
<td>Evaluation of Instruction Using the Conceptual Survey of Electricity and Magnetism in Mexico</td>
<td>231</td>
</tr>
<tr>
<td>G. Zavala and H. Alarcon</td>
<td></td>
</tr>
<tr>
<td>List of Participants</td>
<td>235</td>
</tr>
<tr>
<td>Author Index</td>
<td>237</td>
</tr>
</tbody>
</table>
PREFACE

The theme of the 2008 Physics Education Research Conference was Physics Education Research with Diverse Student Populations. As the number of students with different cultural and educational backgrounds taking physics grows, it is more important than ever for physics education researchers to broaden the scope of their investigations to include a wider range of student populations and contexts. The value of and necessity for studies of secondary implementations of research-based curricula also increases, as does the need for studies that identify similarities and differences that exist in the diverse populations we serve as instructors and researchers. The invited papers and a number of contributed papers in this volume address this developing need. The remainder of the papers represent the diversity of directions within physics education research and help this volume fulfill its purpose of providing an annual snapshot of the field. The Editors thank the organizers, Nicole Gillespie, Mel Sabella, and John Thompson, as well as the Physics Education Research Leadership and Organizing Council (PERLOC) for putting together a successful and well-run meeting.

One major change in the Proceedings this year was the creation of an online submission process for contributed papers and referee reports. For a first shot, the system worked remarkably well and the Editors hope that it will make the future production of the Proceedings more straightforward and efficient. Lyle Barbato, Matthew Riggsbee, and Bruce Mason of comPADRE.org deserve our thanks for developing the system.

Last but not least, this volume owes its existence to the referees, who volunteer their time and expertise to improve the quality not only of the papers published in the Proceedings, but also of the research in physics education. This year, the Editors thank Wendy Adams, Hugo Alarcon, Rhett Allain, Bradley Ambrose, Leslie Atkins, Charles Baily, Thomas Bing, Jennifer Blue, Scott Bonham, Eric Brewe, David Brookes, Brandon Bucy, Tae Jin Byun, Stephanie Chasteen, Yong Wook Cheong, Jacquelyn Chini (Haynicz), Warren Christensen, Alice Churukian, Geraldine Cochran, Karen Cummings, Melissa Dancy, Dedra Demaree, Lin Ding, Gintaras Duda, Eugenia Etkina, Cathy Ezrailson, Noah Finkelstein, Tom Foster, Elizabeth Gire, Renee Michelle Goertzen, Steve Goldhaber, Kara Gray, Ayush Gupta, Lee Gyoungho, Sang Woo Ha, Danielle Harlow, Kathleen Harper, Stan Jones, Kathy Koenig, Patrick Kohl, Lauren Kost, Laird Kramer, H. Vince Kuo, Julie Libarkin, Yuhfen Lin, Michael Loverude, Steve Maier, David Maloney, Jeffrey Marx, Fran Mateyck, Laurel Mayhew, Dyan McBride, Laura McCullough, Jose Mestre, Kereen Monteyne, Valerie Otero, Archie Paulson, Noah Podolefsky, Steven Pollock, Evan Pollock, Ed Price, Susan Ramlo, Sanjay Rebello, Evan Richards, Idaykis Rodriguez, Rebecca Rosenblatt, David Rosengrant, Maria Ruibal-Villasenor, Homeyra Sadaghiani, Jeff Saul, Vashti Sawtelle, Eleanor Sayre, Rachel Scherr, David Schuster, Kimberly Shaw, Chandralekha Singh, Paul Tarabek, Raluca Teodorescu, John Thompson, Chandra Turpen, Adriana Undreiu, Lucian Undreiu, Dave Van Domeelen, Laura Van Wormer, Aaron Warren, Jessica Watkins, Leanne Wells, Suzanne White Brahmia, Edit Yerushalmi, Genaro Zavala, and Dean Zollman.

See you next summer in Ann Arbor!

Leon Hsu
Outgoing Editor
**PROGRAM**

*Wednesday, July 23\textsuperscript{rd} (buses run from 6-6 PM and 8-10:30 PM)*

**Bridging Session | Presiding: Sabella**

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Location</th>
<th>Code</th>
</tr>
</thead>
</table>
| 3:30 PM | Inequities in Physics Access and Enrollment in Urban High Schools  
*Angela Kelly, Lehman College*                                                                                                                                                                           | JA.01             |      |
| 4:00 PM | A race-identity perspective on mathematics learning and participation  
*Danny Martin, University of Illinois - Chicago*                                                                                                                                                       | JA.02             |      |
| 4:30 PM | Impact of chemistry teachers’ knowledge and practices on student achievement  
*Kathryn Scantlebury, University of Delaware*                                                                                                                                                         | JA.03             |      |

*Contributed Posters can be set up between 5 PM and 8 PM in the TELUS Centre Atrium*

**Banquet and Poster Session | Presiding: Thompson**

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Location</th>
<th>Code</th>
</tr>
</thead>
</table>
| 6:00 PM | Dinner Banquet, Dinwoodie Lounge (Ticket Required)  
*Fostering science learning in diverse urban settings*  
*Kenneth Tobin, Graduate Ctr. of the City University of New York*                                                                                                                                 | Dinwoodie Lounge  | DT.01|
| 8:00 PM | Contributed Poster Session, Cash Bar  
*Posters will remain on display for the duration of the conference*                                                                                                                                 | TELUS Centre Atrium| CP.711 to CP.821 |
Thursday, July 24th  (buses run from 7-9 AM and 4-7 PM)

### Special Sessions 1

<table>
<thead>
<tr>
<th>Time</th>
<th>Location</th>
<th>Targeted Poster Sessions</th>
<th>Round-table Disc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30 AM – 10:00 AM</td>
<td>TELUS 217</td>
<td>TELUS 236</td>
<td>TELUS 145</td>
</tr>
<tr>
<td></td>
<td>TP-A</td>
<td>TP-B</td>
<td>RT-A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Implementing PER in Other Cultures (Dykstra)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Does PER-based instruction help underrepresented groups succeed, and how can it do so better? (Crouch)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Developing learning skills in the physics classroom to attend to diverse populations (Yerushalmi/Singh)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>It works there. Will it work here? (Cummings)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Analyzing PSET for Content, Confidence and Comfort ... So Why Don’t You Want to Teach Physical Science? (Van Wormer)</td>
<td></td>
</tr>
</tbody>
</table>

Discussant: Kenneth Tobin, Kathryn Scantlebury, Danny Martin, Eric Dey

<table>
<thead>
<tr>
<th>Time</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:00 AM</td>
<td>Break</td>
</tr>
</tbody>
</table>

**Invited Talks | Presiding: Singh**

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:30 AM</td>
<td>What is Nepantla and How Might it Help Educational Researchers Conceptualize Knowledge for Teaching?</td>
<td>IT.01</td>
</tr>
<tr>
<td></td>
<td>Rochelle Gutierrez, University of Illinois - Urbana-Champaign</td>
<td>TELUS 150</td>
</tr>
<tr>
<td>11:00 AM</td>
<td>A variety of diversity: Facing higher education’s educational challenges</td>
<td>IT.02</td>
</tr>
<tr>
<td></td>
<td>Eric Dey, University of Michigan</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>11:45 AM</td>
<td>Luncheon</td>
<td>Outside TELUS Centre</td>
</tr>
</tbody>
</table>
## Special Sessions 2

<table>
<thead>
<tr>
<th>Time</th>
<th>Targeted Poster Sessions</th>
<th>Round-table Disc.</th>
</tr>
</thead>
</table>
| 1:15 PM – 2:45 PM | TELUS 217 TP-A  
Implementing PER in Other Cultures (Dykstra) | TELUS 145 RT-B  
Learn "How to teach Physics" from The Feynman Lectures on Physics: An example on Gravitation (Lee) |
|               | TELUS 219 TP-B  
Does PER-based instruction help underrepresented groups succeed, and how can it do so better? (Crouch) | TELUS 236 TP-E  
Applications of PER in diverse settings: Perspectives on audience, method and implementation (Brewe) |
|               | TELUS 238 TP-F  
Showing Ourselves Friendly: Addressing Race in Physics Culture (Dancy) | TELUS Centre, Atrium       |
| Discussant:   | Kathryn Scantlebury  | Kenneth Tobin  | Angela Kelly  | Rochelle Gutierrez |

### Special Sessions 3

<table>
<thead>
<tr>
<th>Time</th>
<th>Targeted Poster Sessions</th>
</tr>
</thead>
</table>
| 3:00 PM – 4:30 PM | TELUS 217 TP-C  
Developing learning skills in the physics classroom to attend to diverse populations (Yerushalmi/Singh) |
|               | TELUS 219 TP-D  
It works there. Will it work here? (Cummings)  
Applications of PER in diverse settings: Perspectives on audience, method and implementation (Brewe) |
|               | TELUS 236 TP-E  
Showing Ourselves Friendly: Addressing Race in Physics Culture (Dancy) |
|               | TELUS 238 TP-F  |
| Discussant:   | Rochelle Gutierrez  | Angela Kelly  | Eric Dey  | Danny Martin |

---

*xiii*
<table>
<thead>
<tr>
<th>Panel Discussion</th>
<th>Presiding: Thompson, Sabella</th>
</tr>
</thead>
<tbody>
<tr>
<td>4:30 PM – 5:30 PM</td>
<td>Led by Dey, Gutierrez, Kelly, Martin, Scantlebury, Tobin</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PER Dating Service</th>
<th>Presiding: Thompson, Sabella</th>
</tr>
</thead>
<tbody>
<tr>
<td>5:30 PM</td>
<td>Interesting in replicating a study at another institution with a different population of students?</td>
</tr>
<tr>
<td></td>
<td>* if you did not submit a Dating Service abstract you can still participate and possibly find someone special.</td>
</tr>
</tbody>
</table>

xiv
Invited Talks

Wednesday, July 23rd

3:30 PM  Inequities in Physics Access and Enrollment in Urban High Schools
          Angela Kelly, Lehman College, ANGELA.KELLY@lehman.cuny.edu
          Despite reports to the contrary, the availability of physics as a course for secondary students is not equitably
distributed throughout the U.S. While some schools provide physics access for all, a more common scenario is
limited availability to select students. This is particularly true in urban districts, where this study examined access
to and availability of high school physics. New York City’s secondary schools were surveyed to determine where
physics was offered and how many students were enrolled. Statistics were performed to compare differences
between physics and non-physics schools. Additionally, organizational factors were examined that relate to
physics availability, such as the magnet school configuration, the AP Physics and conceptual physics options, and
science curricular sequence. Overall, it was determined that physics availability is limited in NYC schools, a serious
inequity that disproportionately affects students of color and poor children. Strategies for improving access and
enrollment will be discussed.

4:30 PM  Impact of Chemistry Teachers’ Knowledge and Practices on Student Achievement
          Kathryn Scantlebury, University of Delaware, kscantle@UDel.Edu
          Professional development programs promoting inquiry-based teaching are challenged with providing teachers
content knowledge and using pedagogical approaches that model standards based instruction. Inquiry practices
are also important for undergraduate students. This talk focuses on the evaluation of an extensive professional
development program for chemistry teachers that included chemistry content tests for students and the teachers
and the impact of undergraduate research experiences on college students’ attitudes towards chemistry. Baseline
results for the students showed that there were no gender differences on the achievement test but white
students scored significantly higher than non-white students. However, parent/adult involvement with chemistry
homework and projects, was a significant negative predictors of 11th grade students’ test chemistry achievement
score. This talk will focus on students’ achievement and attitude results for teachers who are mid-way through
the program provide evidence that on-going, sustained professional development in content and pedagogy is
critical for improving students’ science achievement.

7:00 PM  Fostering Science Learning in Diverse Urban Settings
          Kenneth Tobin, Graduate Center of the City University of New York, ktobin@gc.cuny.edu
          A common approach to the teaching of science is to create learning communities around sameness. In such
circumstances students who differ from the mainstream are disadvantaged and often are regarded as learning
disabled. This paper presents research on the uses of cogenerative dialogue to afford the creation of learning
communities in which difference is respected and regarded as a resource for advancing learning of the collective
as well as individuals within the collective. I describe what we learned from a five-year longitudinal authentic
ethnography in which cogenerative dialogues were used in high schools in the Bronx Borough of New York City to
create productive learning environments in which student achievement increased equitably for categories
defined by ethnicity, class and native language. The route toward higher achievement was paved by expanded
roles for science teachers and students. The ways in which these roles were enacted are described in the paper.
### Thursday, July 24th

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Speaker/Institution</th>
<th>Abstract</th>
</tr>
</thead>
</table>
| 10:30 AM | **What is Nepantla and How Might it Help Educational Researchers Conceptualize Knowledge for Teaching?**<br>
**Telus 150** | Rochelle Gutierrez, University of Illinois, Urbana-Champaign, rgutirrz@uiuc.edu | This presentation draws on Latina/Latino studies to offer education a potential framework for reconceptualizing "knowledge" and for engaging teacher candidates in a process that acknowledges the complex identities of students and the power relations they negotiate while in school. Specifically, I use Gloria Anzaldúa’s notion of Nepantla—a liminal space that facilitates transformation. In this presentation, I will describe aspects of a model of teacher education I have developed and offer examples of how teacher candidates move through states of what Anzaldúa would call ignorance/distancing versus knowledge/connection with others. Finally, I suggest that our work of preparing teachers must help them not only recognize a state of Nepantla (to see and participate in multiple realities) but also come to expect the uneasiness with being in that space, while celebrating its potential to birth new identities and create new (forbidden) knowledges. |
| 11:00 AM | **A Variety of Diversity: Facing Higher Education's Educational Challenges**<br>
**Telus 150** | Eric Dey, University of Michigan, dey@umich.edu | First among the many important challenges facing American higher education is the need to improve the effectiveness of our educational programs. Public concern has heightened the sense of urgency for colleges and universities to make progress on improving and measuring educational outcomes, which is made more challenging by the varieties of diversity facing us. Students are more diverse than ever, both in terms of their personal characteristics but also in terms of their abilities, preparation, and expectations. In order to make sense of the increasing varieties of diversity affecting our postsecondary educational efforts this session will draw upon research from a range of local and national efforts in these areas. One example is ongoing research at the University of Michigan that explores the educational implications of implementing a web-based lecture capture system in large lecture courses. Student use of and reactions to such systems is important, as is the potential to influence course performance for students in general, but also for underrepresented and at-risk student subpopulations. In addition to helping bring our current landscape into focus, the session will identify effective practices as well as continuing challenges to improving educational practice for undergraduate students. |
Invited: Targeted Poster Sessions

**Thursday, July 24th**

<table>
<thead>
<tr>
<th>Time</th>
<th>TP.A01: Implementing PER in Other Cultures</th>
<th>TP.A02: Similarities and Differences in Ideas Generated by Students of Physics: US College Students vs. Tibetan Buddhist Monks</th>
<th>TP.A03: Making Sense of Measurements, Making Sense of the Textbook</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30 AM</td>
<td>Organizers: Dewey Dykstra, Boise State University, <a href="mailto:ddykstra@boisestate.edu">ddykstra@boisestate.edu</a>&lt;br&gt;And Johnson, Black Hills State University, <a href="mailto:andyjohnson@bhsu.edu">andyjohnson@bhsu.edu</a></td>
<td>Andy Johnson, Black Hills State University&lt;br&gt;Dewey Dykstra, Boise State University&lt;br&gt;Hunter Close, Seattle Pacific University&lt;br&gt;Mel Sabella, Chicago State University</td>
<td>Saalih Allie, University of Cape Town, South Africa&lt;br&gt;Derch Demaree, Oregon State University&lt;br&gt;Julian Taylor, University of Cape Town, South Africa&lt;br&gt;Fred Lubben, University of York, UK&lt;br&gt;Andy Buffler, University of Cape Town, South Africa</td>
</tr>
<tr>
<td>1:15 PM</td>
<td>It is not obvious to what extent PER findings with English-speaking students apply to students from other cultures in other parts of the world and vice versa. Some PER community members have experience that shed light on this issue, which includes anticipations concerning initial conceptions, typical student responses to PER-based instructional strategies, preparation and understanding of teachers, and lack of resources available to teachers to a degree not generally seen in the US. Experiences, evidence, lessons learned and recommendations will be offered by the presenters in this targeted poster session.</td>
<td></td>
<td>Dewey Dykstra, Boise State University</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time</th>
<th>TP.A04: Experiences Sharing PER in Mexico</th>
<th>TP.A05: New Research from Cross Culture Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TP.A04: Experiences Sharing PER in Mexico</td>
<td>TP.A05: New Research from Cross Culture Studies</td>
</tr>
<tr>
<td>8:30 AM</td>
<td>Organizer: Catherine H. Crouch, Swarthmore College, <a href="mailto:ccrouch1@swarthmore.edu">ccrouch1@swarthmore.edu</a></td>
<td>Lei Bao, The Ohio State University&lt;br&gt;Tianfang Cai, Beijing Jiaotong University&lt;br&gt;Kathy Koenig, Wright State University</td>
</tr>
<tr>
<td></td>
<td>&amp; An issue of widespread concern among physicists is the low representation of women and certain ethnic minorities in physics. As PER seeks to improve physics learning for all, we must ask whether PER-based instructional methods can also help ameliorate (or at least not aggravate) the under-representation of these groups. This poster session will facilitate a forward-looking discussion of how PER-based instruction can best foster the success of these groups by bringing together insights from work in three areas: (1) evaluating the success of underrepresented students with PER-based methods, (2) identifying barriers to these students’ success in ordinary instructional environments, and (3) existing programs (not necessarily PER-based) aimed at improving the retention and learning of these underrepresented groups. After work in these three areas is presented and discussed, all attendees will participate in brainstorming future work that will identify strengths and weaknesses in the current PER-based methods, with the ultimate goal of developing improved instructional methods.</td>
<td></td>
</tr>
<tr>
<td>1:15 PM</td>
<td>Steven Pollock, University of Colorado at Boulder&lt;br&gt;Lauren Kost, University of Colorado at Boulder</td>
<td>Kenneth Heller, University of Minnesota&lt;br&gt;Jennifer Docktor, University of Minnesota</td>
</tr>
</tbody>
</table>

TP.B02: Gender Differences in Both Force Concept Inventory and Introductory Physics Performance
TP.B03: Gender and Student Achievement with Peer Instruction
Catherine Crouch, Swarthmore College
Mercedes Lorenzo, IES Universidad Laboral, Albacete, Spain
Jessica Watkins and Eric Mazur, Harvard University

TP.B04: Gender Differences in Student Responses to Peer Instruction
Jessica Watkins, Harvard University
Eric Mazur, Harvard University

TP.B05: Improving Learning for Underrepresented Groups in Introductory Physics for Engineering Majors
Suzanne White Brahmia, Rutgers University

TP.B06: Learning and Success in Introductory Physics for Black Science Students in the Post-Apartheid Era
Saalih Allie, University of Cape Town, Cape Town, South Africa

TP.B07: Enhancing the Number of African Americans in STEM PhD Programs: Meyerhoff Scholarship Program Outcomes, Processes, and Individual Predictors
Kenneth I. Maton, University of Maryland Baltimore County
Mariano R. Sto Domingo, University of Maryland Baltimore County
Kathleen E. Stolle-McAllister, University of Maryland Baltimore County
I. Lynn Zimmerman, University of Maryland Baltimore County
Freeman A. Hrabowski, III, University of Maryland Baltimore County

8:30 AM Telus 236
TP-C: Developing Learning Skills in the Physics Classroom to Attend to Diverse Populations
Organizers:
Edit Yerushalmi, Weizmann Institute of Science, yerushalmi@vms.huji.ac.il
Chandralekha Singh, University of Pittsburgh, cslsingh@pitt.edu

Physics Instructors believe many students enter their classes lacking the learning skills required to perform well in the introductory physics course. Yet traditional university teaching typically does not attempt to develop students’ learning skills required to benefit from the physics course.

An essential skill mentioned frequently is reflection in problem solving while carrying out a paper pencil task or while performing an experiment. Reflection upon the problem solving process in both types of tasks could include evaluating one’s own solution, self-diagnosing former steps while elaborating the understanding of the physics involved in the problem, as well as the perception that such behavior is constructive. How do students entering the introductory physics classroom differ in their reflection in problem solving? To what extent does this distribution of skill predict students’ ability to learn the material taught in the course? Does this skill improve as the students progress through traditional university courses which typically do not attempt to develop students’ learning skills? How can we modify instruction to help develop these learning skills in students who need it while also benefiting the students who already possess these learning skills?

The posters in the session will shed light on diverse aspects of the subject as follows: (1) the connection between learning skills and the achievements of the students in class, (2) instructors’ approaches regarding the development of these skills, (3) students’ epistemic stance regarding learning from problem solving both while performing paper pencil tasks and performing experiments, and (4) possible interventions aimed to help students reflect upon the problem solving process in different situations.

9:30 AM Telus 236
TP.C01: From Diagnostic Skills to Success in the Physics Classroom
Edit Yerushalmi, Weizmann Institute of Science
Eliseva Cohen, Weizmann Institute of Science
Andrew Mason, University of Pittsburgh
Chandralekha Singh, University of Pittsburgh

TP.C02: Strategy Writing and Conceptual Gains Among At-Risk Physics Students
Adam D. Smith, University of Illinois, Urbana Champaign
Gary Gladding, University of Illinois, Urbana Champaign
Jose Mestre, University of Illinois, Urbana Champaign
Robert Putman, University of Illinois, Urbana Champaign

TP.C03: Helping Students Develop Scientific Habits of Mind
E. Etkina, Rutgers University
A. Karelina, Rutgers University
M. Ruibal-Villaseno, Rutgers University

TP.C04: Reflective Problem Solving Skills are Essential for Learning, But it is Not My Job to Teach Them
Charles Henderson, Western Michigan University
Edit Yerushalmi, Weizmann Institute of Science
Eliseva Cohen, Weizmann Institute of Science
Vince Kuo, University of Minnesota
Ken Heller, University of Minnesota
Pat Heller, University of Minnesota
TP.C05: Collaborative Diagnosis of Scientific and Pedagogical Conceptions: A Strategy for Training Preservice Teachers

Osnat Eldar, Weizmann Institute of Science
Bat-Sheva Eylon, Weizmann Institute of Science
Miky Ronen, Weizmann Institute of Science

8:30 AM
TP.D: It Works There. Will it Work Here?
Telus 238

Organizers:
Karen Cummings, Southern Connecticut State University, cummingsk2@southernct.edu
&
This targeted poster session will focus on projects involving the use and/or adaptation of exemplary curricular materials at a wide variety of institutions. We will report on our successes, difficulties and insights gained in transplanting locally successful research-based materials and approaches.

3:00 PM
TP.D01: Lessons from the Adaptation and Implementation of a Non-Traditional Introductory Physics Course
Charles De Leone, California State University, San Marcos
Catherine Ishakawa, University of California, Davis
Edward Price, California State University, San Marcos

TP.D02: Curriculum Design for the Algebra-based Course: Just Change the d’s to Deltas?
Michael Loverude, California State University-Fullerton
Steve Kanim, New Mexico State University
Luanna Gomez, Buffalo State College

Karen Cummings, Southern Connecticut State University
Leon Hsu, University of Minnesota
Jack W. Taylor, Baltimore City Community College

TP.D04: Adaptations of the Physics By Inquiry Curriculum: Part II-Assessing Shifts in Student Attitudes
Leon Hsu, University of Minnesota, Twin Cities
Karen Cummings, Southern Connecticut State University
Jack W. Taylor, Baltimore City Community College

1:15 PM
TP.E: Applications of PER in Diverse Settings: Perspectives on Audience, Method and Implementation
Telus 236

Organizer:
Eric Brewe, Florida International University, eric.brewe@gmail.com
&

Physics education research has traditionally not addressed variation in student population. Are the tools, practices, and findings of PER relevant, applicable and valid across populations? This session includes four PER groups working with underrepresented student populations differing by audience, method and implementation. Brewe, Kramer and O’Brien at Florida International University, a Hispanic-Serving Institution, use reform to develop community; Sabella, Coble and Bowen of Chicago State University, a Black-Serving Institution, apply PER methods to identify underrepresented university students’ resources; Finkelstein and Mayhew of the University of Colorado investigate impacts and institutional implications of informal education programs; Steinberg of City College of New York implements PER-based approaches as a science teacher at a mixed public high school in Harlem. These researchers are united by the goal of identifying problems within the structures of physics/science education relevant to encouraging student successes. These posters identify a diversity of approaches to improving educational opportunities for underrepresented student groups and limitations, challenges and opportunities for broadening inclusion.

3:00 PM
TP.E01: Using Educational Reform as a Kernel for Growing Community at a Hispanic Serving Institution
Eric Brewe, Florida International University
Laird Kramer, Florida International University
George O’Brien, Florida International University

TP.E02: Utilizing the Individual and Collective Resources of Urban University Student to Develop an Effective Instructional Environment
Mel S. Sabella, Chicago State University
Kim Coble, Chicago State University
Samuel Bowen, Chicago State University
It is said that if you want to be a friend, you must show yourself friendly. This means that in order to forge a connection, we must deal with our own actions rather than the actions of those we want to befriend. This year’s PERC has been organized around issues of diversity, and this targeted poster session focuses specifically on issues of race. In order to show ourselves friendly in this context, we must examine our own behaviors and the effects they have on racial minorities. Each poster in this session offers us an opportunity to examine our own contributions to the racial aspects of physics culture. We hope that you will accept the invitation this opportunity extends, and share your ideas and experiences with us.

TP.F01: Understanding Privilege: An Interactive Poster
Melissa H. Dancy

TP.F02: An Idea for generating Diversity Conversations: Physics Jeopardy and the "Future Faces of Physics" Kit
Gary White, Society of Physics Students - American Inst. of Physics
Kendra Rand, Society of Physics Students - American Inst. of Physics

TP.F03: Inside the Golden Kingdom: Views of Physics from "Inside the Double Bind"
Apriel K. Hodari, National Society of Black Physicists
Maria (Mia) Ong, TERC

TP.F04: Proving Process: Minority High Achievers in the Classroom
Toyia K. Younger, University of Maryland at College Park
Sharon Fries-Britt, University of Maryland at College Park
Contributed: Roundtable Discussions & PER Dating Service

Thursday, July 24th

8:30 AM  TELUS 14S  RT-A: Analyzing PSET for Content, Confidence and Comfort...So Why Don’t You Want to Teach Physical Science?
Laura Van Wormer, Hiram College, vanwormerla@hiram.edu
Roxanne Sorrick, Hiram College

1:15 PM  TELUS 14S  RT-B: Learn "How to Teach Physics" from The Feynman Lectures on Physics: An Example from Gravitation
Gyoungho Lee, Seoul National University, ghlee@snu.ac.kr
Jiwon Kim, Seoul National University

5:30 PM  TELUS Atrium  DS.01: Evaluating How Students View Questioning in the Physics Class
Geraldine Cochran, Chicago State University, moniegeraldine@gmail.com
Mel S. Sabella, Chicago State University

5:30 PM  TELUS Atrium  DS.02: Evaluating Safe Science Teaching Practice in the U.S.
Cathy Mariotti Ezrailson, University of South Dakota, Cathy.Ezrailson@usd.edu
Contributed: Posters

Wednesday, July 23rd
8:00 PM – 10:00 PM
8:00 PM – 9:00 PM (even numbered posters present) and 9:00 PM – 10:00 PM (odd numbered posters present)
TELUS Atrium (posters may remain up until Thursday, 5:30 PM)

CP.711: Comparing Student Learning with Multiple Research-Based Conceptual Surveys: CSEM and BEMA
Steven Pollock, University of Colorado at Boulder, steven.pollock@colorado.edu

CP.712: Involving Undergraduate Researchers in PER
Mel S. Sabella, Chicago State University, msabella@csu.edu

CP.714: A Taxonomy of Introductory Physics Problems (TIPP)
Raluca E. Teodorescu, George Washington University, rteodore@gwu.edu
Cornelius Bennhold, George Washington University
Gerald Feldman, George Washington University

CP.715: The Persistence of the Gender Gap in Introductory Physics
Lauren Kost, University of Colorado at Boulder, Lauren.Kost@colorado.edu
Steven Pollock, University of Colorado at Boulder
Noah Finkelstein, University of Colorado at Boulder

CP.716: What Happens when Students Design Their Own Experiments: Frames, Goals and Strategies
Maria Ruibal-Villasenor, Rutgers University, mruibal@eden.rutgers.edu
Anna Karelina, Rutgers University
Eugenia Etkina, Rutgers University

CP.717: Analysis of Learning Assistants Views of Teaching and Learning
Kara E. Gray, University of Colorado Boulder, kara.gray@colorado.edu
Valerie K. Otero, University of Colorado Boulder

CP.718: Assessing Student Understanding in Upper-Division Undergraduate Electricity & Magnetism I
Stephanie V. Chasteen, University of Colorado at Boulder, stephanie.chasteen@yahoo.com
Steven J. Pollock, University of Colorado at Boulder

CP.719: Identification of Specific Cognitive Processes Used for In-Depth Problem Solving
Wendy Adams, University of Colorado at Boulder, wendy.adams@colorado.edu
Carl Wieman, University of British Columbia

CP.720: Student Understanding of Quantum Measurement and Uncertainty
Charles Baily, University of Colorado at Boulder, baily@colorado.edu
Noah Finkelstein, University of Colorado at Boulder

CP.721: Research on Student Use of Simulations
Archie Paulson, University of Colorado at Boulder, archie.paulson@colorado.edu
Kathrine Perkins, University of Colorado at Boulder
Wendy Adams, University of Colorado at Boulder

CP.722: Institutionalizing Change: Case Studies & Institutional Analysis of Pedagogical Reform in Intro Phys
Chandra Turpen, University of Colorado at Boulder, Chandra.Turpen@colorado.edu
Noah D. Finkelstein, University of Colorado at Boulder

CP.723: Coupling Conceptual and Quantitative Problems to Develop Student Expertise in Introductory Physics
Chandralekha Singh, University of Pittsburgh, chsingh@pitt.edu

CP.724: Identifying Differences in Diagnostic Skills between Physics Students: Developing a Rubric
Andrew Mason, University of Pittsburgh, ajm54+@pitt.edu
Elisheva Cohen, Weizmann Institute of Science, Israel
Edit Yerushalmi, Weizmann Institute of Science, Israel
Chandralekha Singh, University of Pittsburgh
CP.725: Identifying Differences in Self-Diagnosis with Alternative Scaffolding
Edit Yerushalmi, Weizmann Institute of Science, Israel, Edit.Yerushalmi@weizmann.ac.il
Eliseva Cohen, Weizmann Institute of Science, Israel; Andrew Mason, University of Pittsburgh
Chandralekha Singh, University of Pittsburgh

CP.726: What Levels of Guidance Elicit Engaged Exploration with Interactive Simulations?
Wendy Adams, University of Colorado at Boulder, wendy.adams@colorado.edu
Carl Wieman, University of British Columbia

CP.727: Developing a Framework for Analyzing Student Summaries of Textbooks
Dedra Demaree, Oregon State University, dedareed@science.oregonstate.edu
Michael Low, Oregon State University
Saalih Allie, University of Cape Town

CP.729: How TAs Infer Understanding from Student Responses
Renee Michelle Goertz, University of Maryland at College Park, goertzen@umd.edu
Rachel E. Sherr, University of Maryland at College Park
Andy Elby, University of Maryland at College Park

CP.730: Gender Differences in Student Responses to Peer Instruction
Jessica Watkins, Harvard University, watkinsj@seas.harvard.edu

CP.731: Student Perspectives on Learning Physics and Their Learning of Force and Motion Concepts
Susan Ramlo, The University of Akron, sramlo@uakron.edu

CP.732: Gender Differences in Conceptual Physics Lab Technology
Dave Van Domelen, Kansas State University, dvandom@phys.ksu.edu

CP.739: The Difficulties in Turning Students into Numbers
R. Padraic Springuel, University of Maine, R.Springuel@umit.maine.edu
John R. Thompson, University of Maine
Michael C. Wittmann, University of Maine

CP.743: Student Difficulty with Vector Field Notation in Upper Level E&M
Brant Hinrichs, Drury University, bhinrichs@drury.edu

CP.744: Examining the Effectiveness of Clickers on Student Learning by Tracking Student Responses
Erica P. Watkins, Chicago State University, ericapwatkins87@yahoo.com
Mel S. Sabella, Chicago State University

CP.745: Facilitating Change in Undergraduate STEM: Preliminary Results from an Interdisciplinary Literature
Charles Henderson, Western Michigan University, charles.henderson@wmich.edu
Andrea Beach, Western Michigan University
Noah Finkelstein, University of Colorado at Boulder
R. Sam Larson, Kaiser Permanente and Regis University

CP.746: Assessing Knowledge in a Graduate Course on PER
John R. Thompson, University of Maine, john.thompson@umit.maine.edu
Warren M. Christensen, University of Maine
Michael C. Wittmann, University of Maine

CP.747: Assessing the Concepts of Integration and Differentiation in Multivariable Calculus
Warren M. Christensen, University of Maine, warren.christensen@umit.maine.edu
John R. Thompson, University of Maine

CP.748: The Specificity Effect: Implications for Transfer in Physics Learning
David T. Brookes, University of Illinois at Urbana-Champaign, dbrookes@uiuc.edu
Brian H. Ross, University of Illinois at Urbana-Champaign
José Mestre, University of Illinois at Urbana-Champaign

CP.749: Targeting Student Success and Retention through Development of Scientific Reasoning Skills
Kathleen Koenig, Wright State University, kathy.koenig@wright.edu
Melissa Schen, Wright State University
Doug Bradley-Hutchison, Sinclair Community College
Michele Wheatly, Wright State University

CP.750: Network Analysis of Social Interactions in Laboratories
Aaron Warren, Purdue University North Central, awarren@pnc.edu

CP.751: Applying Successful Techniques to Transform Physics and Astronomy in Urban Classrooms
Sean Gallardo, Chicago State University, sean1g1@yahoo.com
Kim Coble, Chicago State University
Mel S. Sabella, Chicago State University
CP.752: Understanding and Encouraging Effective Collaboration in Introductory Physics Courses
Geraldine L. Cochran, Chicago State University, moniegeraldine@gmail.com
Virginia L. Hayes, Chicago State University
Mel S. Sabella, Chicago State University

CP.753: How Students Delineate "Force" from Other Terminology: Is There Change Following Instruction?
Steven J. Maier, Northwestern Oklahoma State University, sjmaier@nwosu.edu

CP.754: Using Warrants as a Window to Epistemic Framing
Thomas Bing, University of Maryland at College Park, tbing@physics.umd.edu
Edward F. Redish, University of Maryland at College Park

CP.756: The Role of Inference in the Problem Solving about Friction
Cheong Yong Wook, Seoul National University, zimusa@snu.ac.kr
Byun Tae Jin, Seoul National University
Ha Sangwoo, Seoul National University
Lee Gyoungho, Seoul National University

CP.757: Probing Student Online Discussion Behavior with a Course Blog in Introductory Physics
Gintaras K. Duda, Creighton University, gkduda@creighton.edu
Katherine Garrett, Creighton University

CP.758: How Abstract is Abstract? Signs, Salience, and Meaning in Physics
Noah S. Podolefsky, University of Colorado at Boulder, noah.podolefsky@colorado.edu
Noah D. Finkelstein, University of Colorado at Boulder

CP.759: Toward a Comprehensive Picture of Student Understanding of Force, Velocity, and Acceleration
Rebecca Rosenblatt, The Ohio State University, rosenblatt.rebecca@gmail.com
Eleanor C Sayre, The Ohio State University
Andrew F Heckler, The Ohio State University

CP.760: New Media and Models for Engaging Under-Represented Students in Science
Laurel M. Mayhew, University of Colorado at Boulder, laurel.mayhew@colorado.edu
Noah Finkelstein, University of Colorado at Boulder

CP.761: Mind the Gap Please
Vashti Sawtelle, Florida International University, davisisvas@gmail.com
Eric Brewe, Florida International University
Jeffery M. Saul, Florida International University

CP.762: Identifying Student Difficulty in Problem Solving Process via the Framework of the House Model(HM)
Taejin Byun, Seoul National University, vesaboy@dreamwiz.com
Yongwook Cheong, Seoul National University
Songwoo Ha, Seoul National University
Gyoungho Lee, Seoul National University

CP.763: Student Understanding of P-V Diagrams and Conceptions about Integration
Evan B. Pollock, University of Maine, evan.pollock@umit.maine.edu
Brandon R. Bucy, University of Maine
John R. Thompson, University of Maine
Donald B. Mountcastle, University of Maine

CP.764: Student Response to Instruction: When and How Much?
Eleanor C Sayre, The Ohio State University, le@zaposa.com
Andrew F Heckler, The Ohio State University

CP.765: Assessing Pre-Service Teachers Using an Interview Protocol Based on C-LASS
Idaykis Rodriguez, Florida International University, irod020@fiu.edu
Eric Brewe, Florida International University
Larid Kramer, Florida International University

CP.766: Disentangling the Force Concept Inventory Using Latent Class Analysis
Ivan Ivanov, Vanier College, ivanov@vaniercollege.qc.ca
Helena Dedic, Vanier College and CSLP Concordia University
Steve Rosenfield, Vanier College and CSLP Concordia University
Nathaniel Lasry, John Abbott College

CP.767: Assessing the Effect of Single-Concept Clicker Sequences on Students’ Learning
Lin Ding, Department of Physics, The Ohio State University, lding@mps.ohio-state.edu
Albert Lee, The Ohio State University
Neville W. Reay, The Ohio State University
Lei Bao, The Ohio State University
CP.768: Ontologies of Physics Concepts: A Toy Model
Ayush Gupta, University of Maryland at College Park, ayush@umd.edu
David Hammer, University of Maryland at College Park
E. F. Redish, University of Maryland at College Park

CP.769: Implementing Tutorials in a Statistical Physics Course
Hugo Alarcon, Tecnologico de Monterrey, halarcon@itesm.mx
Alejandro Mijangos, Tecnologico de Monterrey
Juan J. Velarde-Magaña, Tecnologico de Monterrey

CP.770: Interactive Problem Solving Tutorials through Visual Programming
Lucian Undreiu, UVA Wise, imu8y@uvawise.edu
David Schuster, Western Michigan University
Adriana Undreiu, Western Michigan University

CP.771: Examples of Student Geometric Reasoning in Upper-Division E&M Problems
Leonard Cerny, Oregon State University, cernyl@onid.orst.edu
Elizabeth Gire, Oregon State University
Corinne Manogue, Oregon State University

CP.772: Examining Student Responses for Meaningful Understanding in the Context of Wavefront Aberrometry
Dyan L. McBride, Kansas State University, dyamm@ksu.edu
Dean A. Zollman, Kansas State University

CP.773: Preliminary Study of Impulse-Momentum Diagrams
David Rosengrant, Kennesaw State University, drosengr@kennesaw.edu
Taha Mtoughi, Kennesaw State University

CP.775: Impact of the FIU PhysTEC Reform of Introductory Physics Labs
Leanne Wells, Florida International University, Leanne.Wells@fiu.edu
Ramona Valenzuela, Florida International University
Eric Brewe, Florida International University
Laird Kramer, Florida International University
George O’Brien, Florida International University

CP.777: The Roles of Evidence in Scientific Argument
Leslie Atkins, California State University - Chico, ljatkins@csuchico.edu

CP.779: How Differentials are Taught in Mathematics and Used in Physics
Ricardo Pulido, Tecnologico de Monterrey, Mexico

CP.780: Evaluation of Instruction Using the Conceptual Survey of Electricity and Magnetism in Mexico
Genaro Zavala, Tecnologico de Monterrey, Mexico, genaro.zavala@itesm.mx
Hugo Alarcon, Tecnologico de Monterrey, Mexico

CP.781: Implementing Tutorials in Introductory Physics in an International Context: The Effect of Language
Genaro Zavala, Tecnologico de Monterrey, Mexico, genaro.zavala@itesm.mx
Christian H. Kautz, Hamburg University of Technology

CP.782: Tutorials in Introductory Physics: A Mexican Experience
Genaro Zavala, Tecnologico de Monterrey, Mexico, genaro.zavala@itesm.mx
Carlos Hinojosa, Tecnologico de Monterrey, Mexico
Gustavo Quintanilla, Tecnologico de Monterrey, Mexico

CP.783: An Investigation of the Concept of Vectors with College Students in Mexico
Genaro Zavala, Tecnologico de Monterrey, Mexico, genaro.zavala@itesm.mx
Christian A. Moran, Tecnologico de Monterrey, Mexico

CP.785: The Dynamics of Small Group Verbal Interaction: A Case Study in Mechanics Problem Solving
Songwoo Ha, Seoul National University, hswgcb3@snu.ac.kr
Yong Wook Cheong, Seoul National University
Taijin Byun, Seoul National University
Gyoungho Lee, Seoul National University

CP.787: Identifying and Addressing Partial Differentiation Difficulties in Calculus and Thermodynamics
Brandon R. Bucy, University of Maine, brandon.bucy@umit.maine.edu
John R. Thompson, University of Maine
Donald B. Mountcastle, University of Maine

CP.788: All Roads Lead to Palinscar and Brown
Evan Richards, North Carolina State University, etrichard@ncsu.edu
Ruth Chabay, North Carolina State University
CP.789: Which One is Right? How Students Choose between Problem Solutions
Evan Richards, North Carolina State University, etrichar@ncsu.edu
Jon D. H. Gaffney, North Carolina State University
Ruth Chabay, North Carolina State University

CP.790: Southwest Ohio Science Institutes: A Partnership Model for Professional Development
Jennifer Blue, Miami University, bluejm@muohio.edu

CP.791: From Physics Major to Physics Teacher and From Elementary Teacher to Elementary Physics Teacher
Valerie Otero, University of Colorado at Boulder, valerie.oter@colorado.edu

CP.792: Reasoning Modes, Knowledge Elements, and Their Interplay in Optics Problem-Solving
Adriana Undreiu, Western Michigan University, adriana.undreiu@wmich.edu
David Schuster, Western Michigan University
Betty Adams, Western Michigan University

CP.793: Curricular Process and Communicative Conception in Physics Education
Pavol Tarabek, Educational Publisher Didaktis (European Educational Publishers Group), didaktis@t-zones.sk

CP.794: Triangular Model of Concept Structure
Pavol Tarabek, Educational Publisher Didaktis - member of EEPG (European Educational Publishers Group), didaktis@t-zones.sk

CP.795: Resources Students Use to Understand Quantum Mechanical Operators
Elizabeth Gire, Oregon State University, giree@physics.oregonstate.edu
Leonard Cerny, Oregon State University
Corinne Manogue, Oregon State University

CP.796: Physics Education Research with Diverse Student Populations
Homeyra Sadaghi, Cal Poly Pomona, hrsadaghian@csupomona.edu

CP.798: Pre-Service Teachers’ Conceptual Understanding of and Attitudes toward Physics
Stan Jones, The University of Alabama, stjones@bama.ua.edu
Charlotte E. Horton, The University of Alabama

CP.799: A Design and Evaluation Study for Teaching Science Safely in South Dakota
Cathy Mariotti Ezrailson, University of South Dakota, Cathy.Ezrailson@usd.edu
Rachel Kluft, University of South Dakota
Phillip Millard, University of South Dakota

CP.802: The Gender Gap on the FCI - Question by Question
Richard D. Dietz, University of Northern Colorado, rdietz@unco.edu
Matthew Semak, University of Northern Colorado
Courtney W. Willis, University of Northern Colorado

CP.803: Archiving Student Solutions with Tablet PCs in a Discussion-Based Introductory Physics Class
Edward Price, California State University - San Marcos, eprice@csusm.edu
Charles De Leone, California State University - San Marcos
Robin Marion, California State University - San Marcos
John Saunders, California State University - San Marcos

CP.804: Latent Response Times and Cognitive Processing on the FMCE
Scott Bonham, Western Kentucky University, scott.bonham@wk.edu

CP.805: An Investigation of Student Ability to Connect Particulate and Macroscopic Representations of a Gas
Keree Monteyne, California State University - Fullerton, kmonteyne@fullerton.edu
Barbara L. Gonzalez, California State University - Fullerton
Michael E. Loverude, California State University - Fullerton

CP.806: College Students’ Lunar Phases Concept Domain
Rebecca S. Lindell, Southern Illinois University Edwardsville, rlindel@siue.edu

CP.808: Studio Physics at the Colorado School of Mines: Studying the Implementation
Patrick B. Kohl, Colorado School of Mines, patkohl@wsmd.com
H. Vincent Kuo, Colorado School of Mines
Todd G. Rusell, Colorado School of Mines

CP.811: Students’ Use of Structure Maps to Facilitate Problem Solving in Algebra-Based Physics
Fran Mateyck, Kansas State University, mateyf@ksu.edu
David H. Jonassen, University of Missouri
N. Sanjay Rebello, Kansas State University
CP.812: Students’ Understanding of Inclined Planes Using the CoMPASS Curriculum
Jacquelyn J. Haynicz, Kansas State University, haynicz@phys.ksu.edu
N. Sanjay Rebello, Kansas State University
Sadhana Puntambekar, University of Wisconsin-Madison

CP.813: A Study of Peer Instruction Methods with High School Physics Students
Karen Cummings, Southern Connecticut State University, cummingsk2@southerncst.edu
Stephen G. Robert, Staples High School

CP.820: Effect of Initial Conditions and Discussion on Predictions for Interactive Lecture Demonstrations
Jeffrey Marx, McDaniel College, jmarx@mcdaniel.edu

CP.821: Learning Problem-Solving Using Formative Assessment Rubrics
Sahana Murthy, Massachusetts Institute of Technology, sahana@mit.edu