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Preface

The theme of the 2020 Physics Education Research (PER) Conference was “Insights, Reflections, & Future Directions: Emergent Themes in the Evolving PER Community.” This theme suffused both the organization and the communication regarding the conference: in the run-up to the conference, the organizing committee prepared and produced a blog touching upon various topics of import to the community, and -- despite the tremendous challenges wrought by the events of the year 2020 -- the conference theme was also apparent in the sessions and plenary sections of the conference.

The plenary bridging session took the format of a panel discussion moderated by the organizing committee and featuring community members from a variety of areas of expertise: Geraldine Cochran, Joseph Krajcik, Sarah B. McKagan, Valerie K. Otero, and Robert H. Tai. The lively panel discussion centered around the conference theme and touched upon issues such as defining and disrupting the idea of expertise within a discipline, questions that move beyond practice and policy, and even what -- and who -- defines physics.

PERC 2020 saw a huge departure from traditional conference implementation, as several professional organizations, including the PER community and its leadership, struggled to adapt to the changing constraints of the COVID-19 pandemic. PERC 2020 was hosted in an online format, with all of the modifications that implies. Dine & Discuss dinner groups were modified to Snack & Chat teleconference hangouts; game night was remote; hotel lobby conversations were hosted in a virtual game-like space; and many others. The organizing committee worked extremely hard to successfully adapt the bridging plenary and closing sessions, as well as the rest of the conference, to the online format. The latter also included a memorial tribute to the late Lillian McDermott from PERLOC member Stamatis Vokos.

The PERC 2020 organizing committee included Alexis Knaub, Beth Cunningham, Lin Ding, and Steve Maier. The committee was supported in their efforts by leadership from both the American Association of Physics Teachers (AAPT) and the PER Leadership and Organization Council (PERLOC).

The PERC Proceedings online submission and review process was supported by Lyle Barbato and Bruce Mason, who work closely with the editors to ensure smooth functioning of the online system. New to the 2020 Proceedings cycle was the implementation of a double-confidential format of peer review. The shift to this new format required hundreds of person-hours of effort beyond normal work, and the editorial team could not have made this implementation without Lyle’s guidance and logistical support. The editors also thank AAPT for their ongoing Proceedings sponsorship, and for allowing it to be published open-access through the ComPADRE website.

As in every year, the editors wish to thank the referees for volunteering their time and expertise to give feedback to papers submitted to the Proceedings. This year 262 reviewers made recommendations on 141 submitted Peer-Review Section papers -- both authors and reviewers
adapting quickly to the new double-confidential format, with its earlier submission deadline and shorter review turnaround time. The PERC Proceedings is both an important archive of findings and also a place where many new members of the field publish their first physics education research, and we are deeply appreciative of the authors reviewers who make this year’s cycle possible. Future cycles will improve upon the implementation of the double-confidential review process, but for a first-time implementation, the editorial team could not be more appreciative of the community for their efforts.


Finally, the Editors wish to express our special thanks to the PERC Coordination Committee co-chaired by Adrienne Traxler and Bethany Wilcox, who facilitated communications and coordinated logistics among multiple parties to streamline the process for future years.

See you in Summer 2021 (COVID-willing) in Washington DC!

Steven Wolf
Editor-in-Chief
Those engaging in PER bring with them their histories, which in large part inform their research endeavors. Our relationships with others in and outside of PER extend our vision and practices, and in doing so, expand the scope of PER itself. It is this “PER itself” we hoped the community would explore during PERC 20/20. While self-reflection likely demonstrates in each of us our individual professional growth, we sought to turn a lens to the broader PER community and profession as an exercise investigating PER’s evolution with the prospect of glimpsing at its future, both what is likely with our given trajectory and what could be with different choices. We believe this call was answered in many ways during PERC 20/20 as evidenced by: influences and importances of discipline-based education research (DBER) in general were acknowledged; overt attention to research biases and personal stories entered the fold demonstrating subjectivity and vulnerability of the work we complete; and techniques both emergent and borrowed from other fields were shared as viable means to conduct PER.

While we had anticipated there would be yet unknown emergent themes and had strategies for weaving these into the conference, 2020 was a year that was wrought with significant challenges: the COVID-19 pandemic with its far-reaching disruptions and impacts ranging from individual hardships to national instabilities; the transition to a virtual conference and working in an entirely new infrastructure; and precipitous social injustice events of long existing racism, especially anti-Black racism. The PERC 20/20 organizers are sincerely grateful for each contributor, as well as those whose circumstances may have prevented them from participating this year. We understand personal and professional challenges were significant, complex, and likely are continuing.

Organizers: Alexis Knaub (American Association of Physics Teachers), Steve Maier (Northwestern Oklahoma State University), Lin Ding (The Ohio State University), Beth Cunningham (American Association of Physics Teachers)

The PERC 20/20 organizing committee extends a sincere thank-you to the following for their input, assistance, and contributions to this year’s conference. The Plenary Panelists (Geraldine L. Cochran, Joseph Krajcik, Sarah B. McKagan, Valerie K. Otero, Susan R. Singer, Robert H.
Tai); PERC/PERLOC liaison Bethany Wilcox; PERC/PERLOC liaison and accessibility committee, Erin Scanlon; PERLOC members; Lyle Barbato of comPADRE; Tiffany Hayes and Cerena Cantrell of AAPT; PERC Proceedings Editors Mike Bennett, Brian Frank, Stephen Wolf; Underline.io staff; for the end of PERC 20/20 reflective eulogy, Stamatis Vokos; and too many others to list here (please see the final page of the PERC 20/20 program). Without the dedication and involvement of these individuals, PERC 20/20 would not have been possible.

**PROGRAM**

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Students’ Understanding of Fluids: R. Lindell, D. Meredith, R. Rosenblatt  
Expanding your network: IPER Community buildathon: C. Fracchiolla, K. Hinko, B. Prefontaine  
Recent results on the classroom effectiveness of Virtual Reality and Augmented Reality technology: J. Canright, S. Greenwald, C. Orban, C. Porter, D. Rosengrant  
What was, is and will be Physics Education Research: R. Barthelemy, A. Knaub, V. Otero, B. Zamarripa, I. Rodriguez  
Establishing scientific norms in the lab: a spotlight on the instructor: D. Doucette, D. R. Dounas-Frazer, D. Langley, S. Levy, J. Rutberg, E. Yerushalmi |
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**Introduction**

The 2020 Physics Education Research Conference Proceedings papers consist of two different paper types: one peer-reviewed plenary paper and 99 peer-reviewed papers.

The peer-reviewed plenary paper was submitted by Dr. Geraldine L. Cochran and Dr. Mildred Boveda.

The peer-reviewed papers are written products of conference presentations including the juried talks, parallel sessions, and poster sessions. Each paper undergoes a rigorous peer review process in order to be published in the Proceedings. This year saw 141 submitted manuscripts, of which 100 (including the plenary paper) 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.