

2021 PHYSICS EDUCATION RESEARCH CONFERENCE

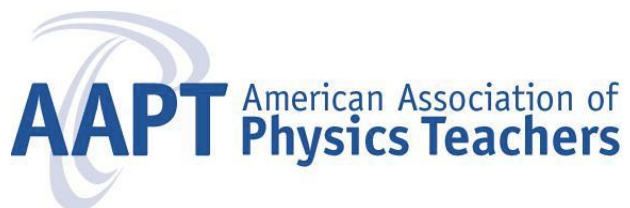
Virtual August 4-5, 2021

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ISSN (Print): 1539-9028
ISSN (Online): 2377-2379
ISBN: 978-0-917853-48-7

2021 Physics Education Research Conference

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Preface

The theme of the 2021 Physics Education Research (PER) Conference was “*Making Physics More Inclusive and Eliminating Exclusionary Practices in Physics.*” Despite the tremendous strain on both the community and the organization team caused by planning a conference from start to finish during a global pandemic, the conference theme was highlighted in a number of ways, from pre-conference communication to the plenary talks. Karsonya “Kay” Wise Whitehead and Robert T. Teranishi gave talks during the Wednesday bridging session, and Joshua C. Collins gave the Thursday afternoon plenary.

As with PERC 2020, PERC 2021 was hosted in an online format, involving both a generalized online platform through Underline and format-specific platforms, such as Zoom for discussions and Gather for poster sessions. Snack & Chat teleconferences made their return as well. The PERC 2021 organizing committee, which included Geraldine L. Cochran, Suzanne White Brahmia, Eric Brewster, Debbie Andres, Gina Passante, and Trevor I. Smith, worked tirelessly throughout the year to ensure a successful and meaningful conference despite the constraints and hurdles caused by COVID. 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. The 2021 Proceedings continued and improved upon the double-confidential review process first implemented in 2020. The PERC Editors also began the process of working with PERLOC to transition the Proceedings review system to a dedicated platform in order to cut down the amount of work undertaken by the editorial team each year. The editors also welcomed a new administrative assistant to help with non-editorial tasks. As always, the editorial team could not have successfully published the Proceedings this year without sponsorship from AAPT as well as support for open-access publishing through ComPADRE.

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 204 reviewers made recommendations on 114 submitted Peer-Review Section papers -- again the editors want to thank authors and referees alike for adapting to the 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 and reviewers who make this year’s cycle possible.

The editors wish to thank Abdurrahman, F., Abraham, Y., Adams, A., Adams, W., Allen, E., Allen, S., Alsultan, J., Crimmins, K., Anthony, A., Barniol, P., Barth-Cohen, L., Barthelemy, R., Basara, R., Bauman, L., Becker, S., Bergeron, P., Bologna, V., Bonham, S., Bottomley, E., Braden, S., Bralin, A., Breakall, J., Brewster, E., Bridges, B., Brundage, M., Bumbacher, E., Buncher, J., Caballero, D., Callan, K., Campos, E., Canright, J., Cao, Y., Cardona, P., Cervantes, B., Chen, Y., Chen, Z., Chini, J., Coffie, C., Cook, K., Corbo, J., Crawford-Goss, I., Crossette, N., Cwik, S., Daane, A., Degtiareva, V., Delgado, J., DiCaro, J., Dickey, B., Ding, L., Donaldson, J., Doucette, D., Doughty, L., Dounas-Frazer, D., Ehrlich, G., El-Adawy, S., Elhady,

Y., Erukhimova, T., Falconer, K., Feldman, A., Fiedler, B., Finkelstein, N., Fischer, C., Fracchiolla, C., Franklin, M., Gambrell, J., Garcia, T., Gavrin, A., Genz, F., Gifford, K., Goertzen, R.M., Good, M., Goodhew, L., Green, C., Griston, M., Hansen, B., Hass, C., Henderson, R., Herington, J., Hernandez, E., Hernandez, J., Heron, P., Hinrichs, B., Hu, P., Hull, M., Huynh, T., Ibrahim, B., Irving, P., Izadi, D., Jambuge, A.P., Jaramillo, S., Jariwala, M., Justice, P., Kazmi, M., Keebaugh, C., Khong, H., Kinnischtzke, M., Knippertz, L., Kohnle, A., Kryjevskaiia, M., Kuhn, J., Kumar, S., Kuo, E., Lane, B.W., Lassen, I.C., Lavery, J., LeGresley, S., Leontyev, A., Li, Y., Lindsey, B., Liu, D., Lock, R., Logan, S., Longo, F., Lopez, G., Mackessy, G., Madsen, A., Malespina, A., Maries, A., Marshman, E., Mathis, C., Mavor, K., May, J., Mays, M., McInerny, A., McKagan, S., McPadden, D., Meehan, M., Meyer, J., Mickelsen, J., Miles, P., Miller, C., Modir, B., Moore, E., Morphew, J., Mukhametov, S., Muller, A., Munsell, J., Murray, J., Newton, W., Ngai, C., Nissen, J., Nokes-Malach, T., O'Donnell, C., Oleynik, D., Oliver, K., Olmstead, A., Perry, J., Phillips, A., Pollock, S., Porter, C., Poteet, W., Potvin, G., Prefontaine, B., Quan, G., Rainey, K., Randall, A., Rebello, C., Rebello, N.S., Rios, L., Robertson, A., Rodriguez, M., Romick, C., Rosenblatt, R., Ruzika, S., Sarles, R., Sawtelle, V., Sayre, E., Sbrana, J., Scanlon, E., Scherr, R.E., Schmoll, S., Sikorski, T., Singh, C., Sirnoorkar, A., Smith, E., Smith, T., Soper, C., Stetzer, M., Talbot, R., Tanona, S., Traxler, A., Trucks, J., Van Dusen, B., Vemuri, G., Vignal, M., Walter, P., Wan, T., Weliweriya Liyanage, N., Wilcox, B., Wild, V., Yasuda, J., Young, T., Zavala, G., Zhang, M., Zich, R., Zimmerman, C., Zipperer, E., Zohrabi Alae, D. and Zwickl, B.

Michael Bennett
Editor-in-Chief

PERC 2021

Making Physics More Inclusive and Eliminating Exclusionary Practices in Physics Conference Overview

As a gateway discipline to STEM majors and careers, physics plays a central role in deciding who does, and who doesn't, get to discover and pursue scientific careers. Technical and scientific professionals are rewarded with economic privilege and status which affords them both social and cultural power. Therefore, social justice will be realized only when the opportunity, and the choice, to excel in physics is open to all students. The culture and practices of the physics classroom reflect the culture of physics at large, which raises the question of how our professional physics communities can embrace, rather than inadvertently repel, a diverse group of academics that can help improve physics culture.

To this end, the 2021 Physics Education Research Conference focused on defining inclusive spaces and practices. Additionally, explored strategies for eliminating exclusionary practices in our classrooms, research spaces, and professional organizations. We called on the community to organize sessions that drive conversations related to these initiatives throughout PERC 2021.

- What would it mean for physics and physics education research to be inclusive fields?
- How might faculty hiring and promotion practices be restructured to establish and support work in social justice as an important departmental value?
- What implicit expectations and practices in our courses result in students from majority groups and more privileged backgrounds having increased opportunities for success at the expense of marginalized populations?
- How could success in physics be redefined as an inclusive practice?

We approached this conference with the knowledge that historical inequities in K-20 education exist and are exacerbated by current practices, which have become even more evident in light of the current economic crisis, global pandemic, and civil unrest due to racialized violence. We share the world view that it is incumbent on us as researchers and academics to understand the landscape of those inequities in our field. We also frame this work as hopeful and optimistic, that within our communities we have the intellectual power, deep commitment and strong intention to help create a better tomorrow.

Organizers:

Geraldine L. Cochran, *Rutgers University*

Suzanne White Brahmia, *University of Washington*

Eric Brewe, *Drexel University*

Debbie Andres, *Paramus High School*

Gina Passante, *California State University, Fullerton*

Trevor I. Smith, *Rowan University*

The PERC 2021 organizers are deeply appreciate of everyone who worked to make this conference successful, including:

- Plenary Speakers: Karsonya "Kaye" Wise Whitehead, Robert T. Teranishi, and Joshua C. Collins
- Session Organizers: Jacquelyn Chini, Geraldine Cochran, Dimitri R. Dounas-Frazer, Claudia Elena Fracchiolla, Rachel Henderson, Dena Izadi, Angela M. Kelly, Jianlan Wang, Charlotte Zimmerman
- Discussants: Carolina Alvarado, Zahra Hazari, and Xandria Quichocho
- AAPT staff: Lyle Barbato, Cerena Cantrell, and Tiffany Hayes
- PERLOC Liaisons Bethany Wilcox and Rebecca Rosenblatt
- PERC Proceedings Editors and Staff: Michael Bennett, Brian Frank, Rebecca Vieyra, and Francette Fey
- Financial support from PERLOC and AAPT

AT-A-GLANCE SCHEDULE

Wednesday, Aug 4, 2021		Page
3:00 pm EDT (12:00 pm PDT)	Bridging Session	6
	<ul style="list-style-type: none"> • Why is Every Conversation a Conversation About Race? <i>Speaker: Karsonya “Kaye” Wise Whitehead</i> • Anti-Asian Racism: Implications for Research in Education <i>Speaker: Robert T. Teranishi</i> 	8
4:30 pm EDT (1:30 pm PDT)	Poster Session 1 The poster session will be split into 4 rooms: A, B, C, and D. Presenters with odd-numbered posters will present during the first 20 minutes. Following a 5-minute transition period, presenters with even-numbered posters will present during the last 20 minutes.	9
5:15 pm EDT (2:15 pm PDT)	Break (30 minutes)	
5:45 pm EDT (2:45 pm PDT)	Snack & Chat Informal conversations hosted by volunteer participants.	14
6:45 pm EDT (3:45 pm PDT)	End of PERC Day 1	

Thursday, Aug 5, 2021		Page
11:00 am EDT (8:00 am PDT)	Parallel Sessions Cluster 1	15
	<ul style="list-style-type: none"> • Talk Symposium (prerecorded; live Q&A) Reimagining physics curricula <i>Moderators: D. R. Dounas-Frazer, A. V. Knaub</i> <i>Presenters: C. Alvarado, D. Marasco, C. Mathis,</i> • Talk symposium (prerecorded; live Q&A) Considering covariational reasoning in math and physics <i>Moderators: C. Zimmerman</i> <i>Presenters: C. Byerley, J. Canright, P. J. Emigh, I. W. Founds, D. A. González, M. Loverude, C. A. Manogue, H. Taylor, S. White Brahmia, C. Zimmerman</i> • Roundtable Discussion (live) Building a network for Informal Physics Educators and Researchers <i>Facilitators: C. E. Fracchiolla, M. Bennett, K. Hinko, R. Villatoro</i> 	
12:00 pm EDT (9:00 am PDT)	Poster Session 2 The poster session will be split into 4 rooms: A, B, C, and D. Presenters with odd-numbered posters will present during the first 20 minutes. Following a 5-minute transition period, presenters with even-numbered posters will present during the last 20 minutes.	22
12:45 pm EDT (9:45 am PDT)	Break (15 minutes)	

1:00 pm EDT (10:00 am PDT)	Plenary <ul style="list-style-type: none"> • Frameworks to enhance inclusion in physics education: Everyone must participate <i>Speaker: Joshua C. Collins</i> 	26
1:45 pm EDT (10:45 am PDT)	Break (15 minutes)	
2:00 pm EDT (11:00 am PDT)	Parallel Session Cluster 2 <ul style="list-style-type: none"> • Talk symposium (live): Equity in Pre college Physics Access, Teaching, and Learning <i>Moderator: D. Rosen</i> <i>Presenters: A. M. Kelly, R. Krakehl, M. Palermo, D. M. Robbins, K. Sheppard</i> • Roundtable Discussion (live): How can early-career members of our community shape inclusivity discourse and practice within physics? <i>Facilitators: R. Henderson, W. B. Lane, T. Finzell</i> • Workshop (live): Doing Physics Education Research Inclusively: Designing for Variation in Participants' Needs, Abilities, and Interests <i>Facilitators: J. Chini, D. Oleynik, E. Scanlon</i> 	28
3:00 pm EDT (12:00 pm PDT)	Break (30 minutes)	
3:30 pm EDT (12:30 pm PDT)	Parallel Session Cluster 3 <ul style="list-style-type: none"> • Talk symposium (live): Physics Public Engagement in the COVID Era: Lessons Learned and Moving Forward <i>Facilitators: D. Izadi, M. Bennett, C. Fracchiolla</i> <i>Presenters: B. Stanley, J. Key, S. Schmoll, Z. Constan</i> • Talk Symposium (live): Identifying the Resources that Support the Success of African Americans in STEM <i>Moderator: G. L. Cochran</i> <i>Presenters: S. Gross, N. Howard</i> • Workshop (live): Measuring learning assistants' Pedagogical Content Knowledge for Questioning with a written instrument <i>Facilitators: J. Wang, B. Thacker, S. Hart, K. Wipfli</i> 	33
4:30 pm EDT (1:30 pm PDT)	Closing Session: Panel Discussion	38
5:15 pm EDT (2:15 pm PDT)	End of PERC	

Introduction

The 2021 Physics Education Research Conference Proceedings papers consist of two different paper types: one plenary paper and 77 peer-reviewed papers.

The plenary paper was submitted by Dr. Joshua C. Collins.

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 114 submitted manuscripts, of which 78 (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.