Editorial: Focused Collection: Gender in Physics

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I. INTRODUCTION

We are pleased to present the Focused Collection on Gender in Physics. For several decades statistics have demonstrated a lack of women participating in the field of physics, with the percentage of women receiving bachelor's degrees in physics in the United States holding constant at 21% for the past several years [1]. This disparity has opened the door to researchers interested in studying the differences among women and men in the field, as well as exploring gender research in science education more broadly. The goals for this collection included the following: extending gender research in physics beyond documenting performance gaps between female and male students, examining assumptions regarding the study of gender in the context of physics, and pulling researchers on gender from the broader science education community into physics education research. The articles contained in this collection reflect these goals.

The call for papers for the collection was published in March 2014 [2]. We were particularly outward in soliciting proposals for this focused collection. Internationally, the issues surrounding women in physics are different than in the United States (e.g., in 2010 female participation in physics in Turkey rose to 53% at the university level), thus we reached out to various professional societies in the U.S. as well as internationally. In addition, we identified specific research groups and individuals who focus on gender and encouraged submissions and sharing of the call for proposals. In total, we received 42 proposals including 21 from outside of the United States. Based on these proposals, 33 authors were invited to submit full manuscripts. Twenty-one full manuscripts were submitted. Each manuscript was reviewed by at least two reviewers through the standard PR-PER peer-review process. Ultimately, the focused collection includes 17 articles, including six from authors from outside of the United States.

Papers in this focused collection fall into four primary categories: review papers describing how the literature has examined gender in a variety of arenas; evidence-based papers that use tools from outside traditional gender work in physics; research that looks at gender gaps in outcomes and works to understand why those gendered outcomes exist; and work that situates studying gender in physics in a broader context of STEM

education. In what follows, we give a brief overview of the collection and describe how the various research threads fit together.

II. LITERATURE REVIEWS

The number of literature reviews we received was a surprising result of the proposal submission process. On reflection, because gender research has an extensive history outside of physics it is reasonable to consider the multiple, complementary perspectives on gender. Three separate groups submitted literature reviews. During the proposal review process we coordinated among groups to ensure that the domain of each review was complimentary and not overlapping. These three papers serve as a strong primer on the current state of research on gender in physics and how the broader literature can be applied to physics. Further, these three represent the complex ways in which gender impacts and influences people engaged in physics. Traxler *et al.* [3] provide a guide to conducting research on gender in physics and a synthesis of the history of physics education research in this area. In particular, this manuscript pushes for researchers in the PER community to use alternative lenses when studying gender. Two additional reviews, Kelly [4] and Lewis *et al.* [5] deal with complimentary, social aspects of gender in physics. Kelly focuses her review on the sociocognitive elements of gender among undergraduates. Lewis *et al.* address sociopsychological aspects of the choices and challenges women face in becoming part of a community of physics.

III. EMPIRICAL PAPERS USING NEW WAYS OF THINKING

The next set of papers, in many ways, answers the call from Traxler *et al.* [3], using a variety of modern tools to study gender in the context of physics. These papers are excellent examples of how to conduct empirical work on gender that moves beyond dichotomizing gender as “male” and “female.” From a theoretical perspective Gonsalves *et al.* [6] and Rosa and Mensah [7] provide a series of case studies that broaden gender beyond these typical dualistic perspectives. Research from Gonsalves *et al.* examines gender in physics through a collection of masculinity case studies. Rosa and Mensah use critical race theory to examine the intersection of race and gender for case studies of successful black women physicists. Also in this thread of moving beyond

dichotomizing gender, Koul *et al.* [8] do not simply ask students to identify as female or male, instead they investigated the correlations between students' gender identity, endorsement of gender stereotypes, and identification with the domains of math and physics. Work from Barthelemy *et al.* [9] continues this thread by using a Feminist Standpoint Theory lens and a focus on microaggressions to understand how sexism for female graduate students in physics is often subtle, but still impactful.

Two other papers in this category use methodological tools new to PER for investigating gender in physics. The research from Rodriguez *et al.* [10] introduces survival analysis as a tool for examining the differential impact of reformed introductory experiences on female and male students' survival through upper division courses and the physics major. Nissen and Shemwell [11] use an in-the-moment technique to examine university students' self-efficacy. Through this Experience Sampling Method, the authors illuminate a trend where physics instruction is detrimentally impacting women's self-efficacy in physics.

An additional two manuscripts in this thread treat gender as a binary category, but focus on the effect of gender outside of traditional performance measures. Ivie *et al.* [12] examine the gender gap in attrition of students out of astronomy. Using statistical modeling tools they find that a respondent's reported gender had an indirect effect on attrition by impacting other variables such as imposter syndrome. Potvin *et al.* [13] study the gender bias in student evaluations of physics teachers. Beyond documenting the bias, the researchers unpack how a student's physics identity score predicts the gender bias in favor of male physics teachers.

IV. DOCUMENTING GAPS BETWEEN FEMALE AND MALE STUDENTS

The collection includes some manuscripts that examine gender through a more traditional lens of documenting differences between female and male students. These manuscripts extend this work beyond simply identifying and reporting gaps. First, all of these papers were intentional about studying gender, rather than making gender an added-on analysis to another research question. Further, these papers investigate the intricacies of how gendered differential outcomes arise and how these outcomes might be mitigated.

Three papers in the collection connect to more traditional gender in PER work through their focus on documenting gender differences on conceptual surveys and course outcomes. Each of these manuscripts adds a deeper layer of data analysis to understand *why* the outcomes on these measures are different for women and men. Wilson *et al.* [14] examined the gender gap on the Australian Science Olympiad Exam. However, they went beyond documenting this gap by examining how the differential performance could be explained by examining the ways the questions were asked. Andersson *et al.* [15] examined the gender gap on course grades in an electromagnetism course. In this

work the authors found that the gender gap in course grades was largely accounted for by the differences in student perceptions of practice as connected to their larger program of study. Day *et al.* [16] documented a gender gap on the Concise Data Processing Assessment, as well as documenting differences in laboratory practices for male and female students. This study suggests that the documented gender gap is not strongly connected to the differential participation of female and male students in the laboratory.

V. GENDER IN PHYSICS AS PART OF A LARGER STEM ISSUE

In the last thread of this collection are papers that situate physics as part of a larger issue in Science, Technology, Engineering, and Mathematics. These articles started from the assertion that there are things to learn from examining the connection between physics and other STEM disciplines. These three articles took a broader view of gender in physics and situated the discussion in the larger STEM body of literature. Eddy and Brownell [17] asked this question directly, looking to understand what is it that physics can learn from other disciplines about gender. This paper examined how participation of women in STEM can be understood through examining underlying mechanisms such as engagement, self-efficacy, identity, and sense of belonging. Sax *et al.* [18] built on this theme by examining how women's interest and intention to major in physics has changed over time. They situated this work by comparing it to interest and intention to major in other STEM disciplines. Finally, Dare and Roehrig [19] turned to the early stages of students building interest in physics careers. This paper considered the early roots of how gendered perceptions of physics influence middle school students' interest in physics careers.

VI. FUTURE DIRECTIONS

Studying issues of gender in physics has been a topic of interest in the PER community over the past several decades. With this collection we hope to have acknowledged the rich body of work that has existed while outlining potential directions moving forward. It is our intention that this collection has emphasized the importance for research on gender and highlighted gender as an area for future research.

In this collection we have highlighted work that takes some steps in moving the research community beyond documenting gender gaps on performance measures. It is our intention that these works provide examples to the community on ways to push beyond simply documenting gaps on a variety of outcomes. Some of the works in this collection provide sociocultural perspectives for understanding traditional gender gaps—including work on social cognitive career theory, sense of belonging, and identity. We hope by highlighting these pieces, it opens pathways for empirical studies to be conducted using these sociocultural perspectives.

From the inception of this Focused Collection, part of our goal has been to raise awareness in the PER community of the modern perspectives that guide gender work in other areas of science education. The review article from Traxler *et al.* [3] presents a clear argument for why these different perspectives are sorely needed in the PER community. In this collection we pair this argument with several articles that provide examples of how researchers can take these more nuanced perspectives in doing empirical work. It is our hope that this collection provides a starting point for researchers to extend beyond traditional ways of studying gender in physics and to explore ways of incorporating these nuanced perspectives into empirical work. It is our perspective that these tools provide insights for understanding both the representation issues and the climate issues for physics that have been missing from the documenting gaps work.

We also acknowledge that this collection largely misses two key pieces of doing gender work—the intersection of gender with race and understanding transgender issues. Rosa and Mensah [7] provide a careful analysis using

critical race theory to examine the intersection of race and gender, but we call attention to the lack of other work in the collection that addresses questions of race and ethnicity. It is our hope that pointing to these holes in the literature provides impetus for researchers to consider these perspectives when conducting gender work.

It is our hope that as the PER community continues to move in directions of studying issues of inclusion and diversity, that this Focused Collection will play an important role in guiding new research designs and pointing to ways that researchers might interpret their data.

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