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SPECIAL ISSUE EDITORIAL

Surpassing STEM's Gender Limitations: Structures, Interventions, and Systems Change

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This first of two *International Journal of Gender, Science, and Technology* special issues focuses on research that emerged from the Network Gender & STEM conference in Eugene, Oregon in the summer of 2018. The 2018 meeting centered on a re-imagining of "who does STEM," and featured scholars from an array of disciplines and perspectives from around the globe. This re-imagining serves a critical purpose, to develop a vision for a less gender-typed present and future that identifies challenges, tests pathways through them, and forges a theoretically- and empirically-grounded path through the decades ahead (see *also* Perez-Felkner, 2018). Can we be innovative in science and technology while furthering the education and career advancement of women of all backgrounds in these fields? The featured papers in this issue argue clearly, yes, they can. Authors also argue that systemic changes to reconfigure the powerful status quo need to be part of the work towards gender equity and socially just societies that position those of any gender as able and ready to do and in fact excel in STEM disciplines.

The first paper offers an overview of the Network Gender & STEM, which is entering its 10th year in response to the challenges gender inequity in STEM fields pose to women specifically and societies in general. [Helen M.G. Watt](#), [Judy Anderson](#), [Jenefer Husman](#), and [Noortje Jansen](#) offer historical perspectives on the Network, its aims, and the scholarship generated from previous convenings around the globe, the first of which met in European cities including Amsterdam, Berlin, and Newcastle. The 2018 meeting hosted by Husman and the University of Oregon conference team was the first held in the United States.

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From this meeting, an emergent theme was the importance of moving forward with intersectional analyses and a social justice lens while doing work on women in STEM (see Crenshaw, 2005; Gaston Gayles & Smith, 2019; Ireland, Freeman, Winston-Proctor, DeLaine, McDonald Lowe, & Woodson, 2018). The North American context offered an opportunity for some studies and sessions to explicitly attend to intersectional systems of power that have historically and presently constrained women from certain groups more than others on account of race and racism, school resource inequalities, and a range of identities and opportunity structures.

The [fifth biennial conference](#) will be held in 2021 at the University of Sydney, Australia, and will build on themes identified the meeting prior. Themes include the importance of highlighting the work of junior scholars, connecting with practitioners and change makers, and identifying and acting on what we can do to effect change, generate innovation, and enhance STEM programs. The move to Sydney offers the opportunity to build on past conferences with special focused attention to partnerships in action, such as the STEM Teacher Enrichment Academy. Overall, the issues raised in this special issue cohere around the imagined and actual possibilities of overcoming gender stereotypes and limitations, across a series of intersections between gender and other key identities.

Two keynote speakers from the 2018 Network meeting share their perspectives essays in this volume. Both essays set out a groundwork for the obstacles to STEM gender equity, in general and specifically, in certain fields and for specific groups of women who have encountered compounding disadvantages over time that have rendered the slope of change we have to climb so persistently steep. First, [Alice L. Pawley](#) draws from critical race and feminist theory – Black feminist theory in particular – to develop an argument for a shift from the gender and race inequalities common in engineering education and STEM in general. She makes the case that race and gender must necessarily be considered together irrespective of potential small sample sizes and comprehensive theoretical frameworks. She argues for research that foregrounds intersectionality in the methodological design and moving social justice to the fore across the research process, not just in sampling “research subjects” but also in the study motivation, design, and interpretation, to create a “new default” that shifts away from othering “underrepresented groups.” In doing so, we might attend our inquiry instead towards the institutional and societal structures that foster and reproduce gender, race, and other axes of inequality over time in the past and through the present.

The second paper building on a keynote address grounds its focus on labor inequality in the U.S. system, especially in the southern U.S., and its effects on STEM diversity and inclusion efforts for women of color. Keynote speaker [Kimberly Scott and her colleague Steve Elliot](#) connect contemporary efforts to eradicate inequality in computing and technology to the problems of the not so distant past: the sharecropping economy. They maintain that many women of color encounter as they pursue computing and technology careers, which are being marketed as desirable. Those pursuing these goals continue to be hindered by existing social and racial hierarchies that stratify their opportunities, the authors argue, given the reified hierarchies within these power structures and the accumulation of debt that women of color incur while training for success in the computing and technology. Specific suggestions are offered, building on Scott’s experience with such educational interventions.

To that end, the remaining manuscripts examine significant others' roles in and potential interventions to enhance access and equity in STEM fields. These interventions include professional development training for teachers, covered across two empirical studies. The first article manuscript is authored by [Jennifer L. Ruef](#), [Christopher Willingham](#), and [Shannon P. Sweeny](#). In response to research on the transmission of mathematics anxiety and even math trauma from elementary teachers to students, their case study essay draws on the trajectory of a single preservice teacher's "transformation" in her relationship to mathematics. Their analysis draws on multiple forms of data, including drawings, writing, and reflection to document how her relationship to math shifted over time. This malleability is promising for education training programs and professional development overall as potential interventions that could benefit teachers and students. Moving along the educational life course from elementary to secondary school teachers, the next case study focuses on computer science teachers' professional development in an online setting aimed to enhance gender inclusion. Authored by [Joanna Goode](#), [Kirsten Peterson](#), and [Gail Chapman](#), the article draws on multiple rounds of observational and survey data from a year-long online program. In describing the online professional development training's design, implementation, and results from teacher reflections, the authors offer a model for a potentially scalable intervention and then close with concrete recommendations to enhance the quantity and quality of content- and inclusivity-trained teachers for a "computer science for all" environment.

Next, and in line with the systems and equity concerns raised by [Scott and Elliot](#) as well as [Pawley](#), [Kayla Puente](#) and [Sandra D. Simpkins](#) investigate the effects of Latinx older siblings' support on their adolescent (9th grade) younger sibling's science motivational beliefs, and variation by gender and familism values. This study of 103 students from three public high schools in the southwestern United States had a 40% female and predominantly Mexican-origin Latinx sample. The quantitative study draws on original survey data and regression modeling with fixed effects to account for school variation. The authors find that older siblings' familism values – connection to family – positively predict sibling support, irrespective of gender, and that support positively predicts their Latinx adolescent sibling's science self-concept and task value when familism is high. This study offers a lens into how siblings and families shape science motivation and adds to the relative dearth of literature on Latinx students' pathways into science education and careers.

The next study also takes a close look at a historically understudied group of emerging scientists, focused on Indigenous traditional ecological knowledge of mathematics. [Jennifer L. Ruef](#), [Stephany Runninghawk Johnson](#), [Michelle M. Jacob](#), [Joana Jansen](#), and [Virginia Beavert](#) authored this case study of Ichishkíin and Yakama Tribal Elders' engagement in STEM education and research. It is important to not only include Indigenous people in STEM education and careers, but also to consider and learn from their approaches and knowledge, the authors argue. In doing so, they engage Native American feminist theories and frameworks, and build on past research finding that mathematics is not culture-free.

The next empirical study in this volume is authored by [Heather L. Perkins](#) and [colleagues](#), focusing on engineering graduate students' intersectional identities and academic relationships. Using a national stratified sample of Engineering graduate students, the author examines a series of relationships and identities, including cross-group comparisons around how graduate engineering identity is supported by relationships with peers and advisors. Students and Women of Color were centered in

these analyses, across a rich array of identities, with research designed to predict effects on graduate engineering identity as well as identify potentially malleable relationships and mechanisms that could affect engineering identity and recognition, especially for individuals historically marginalized on the basis of race, sexuality, and/or gender.

The issue closes with two additional empirical studies focused on computer science and IT. The first article assesses the experiences of adult learners in these fields, authored by [Helen Donelan, Clem Herman, Janet Hughes, Helen Jefferis, and Elaine Thomas](#). Using multiple approaches, the authors find that women and men vary in their motivations for and confidence about their future in IT and computing careers varies from that of men. [Silvia Maria Förtsch and Anja Gärtig-Daug](#)s report on a study of German computer science alumni in Germany as it relates to their self-confidence. The authors investigate the relative importance of technical content and coaching for women and men's on satisfaction and career development.

The manuscripts in this issue come from a variety of theoretical and disciplinary perspectives, methodologies, paradigms of inquiry, focal populations, and potential mechanisms for future change in 'Re-imagining Who Does STEM.' They share a common goal to identify mechanisms to broaden participation in STEM knowledge, education, careers, and societal benefits. This is a shared interest with a range of government agencies and organizations, such as the [National Science Foundation \(NSF\)](#) in the United States and [VHTO](#), the Dutch national expert organization on girls/women and science/technology, which co-founded the research Network Gender and STEM. Importantly, the scholarship produced in this issue is not limited to gender alone, but considers to varying degrees how power and inequality across identities and contexts can intersect with gender and compound its effects. From early education through adulthood, gender shapes how humans interface with science and technology. Therefore, some discussion of gender beyond the binary is undertaken, particularly in the latter manuscripts. This diverse scholarship would not have been possible without the service of peer reviewers who contributed their time and expertise. These manuscripts individually and as a set advance the conversation around what can be done across education and society to achieve those aims.

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