Please Join Me/Us/Them on My/Our/Their Journey to Justice in STEM

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ABSTRACT

Despite decades of effort to broaden participation in science, technology, engineering, and mathematics (STEM), many fields remain demographically skewed. Marginalized and minoritized people are still underrepresented in and underserved by the sciences. In this paper, the author considers the question, "How do we improve representation in STEM?" by reflecting on his own journey and themes such as imposter syndrome, decentering, meritocracy, and activism. Importantly, "underrepresentation" is not a mysterious happenstance but rather a predictable outcome of systemic inequity and systematic exclusion. By attending to the mechanisms of oppression, we can enact interventions that address root causes instead of symptoms. There are multiple ways that our research, teaching, and practice might change "the system" by making inclusion and equity the focus of our work, applying these principles to frame research questions and interpret findings, and adopting methods and practices that are inclusive and equitable.

I almost declined the invitation to address the Society for Text and Discourse on the topic of representation in STEM. Did I possess the right expertise or experience? Would a more esteemed scholar be a better choice? However, I recognized that I was experiencing *imposter syndrome*, defined as doubts about one's abilities and achievements despite valid experience and evidence (Langford & Clance, 1993). Individuals experiencing this phenomenon fear exposure as a "fraud" (Ramsey & Brown, 2018) and talk themselves out of opportunities (e.g., accepting invitations).

Although imposter syndrome is familiar to many people, research links this phenomenon to marginalizing and minoritizing experiences related to race, gender, sexuality, neurodivergence, disability, and more (Bravata et al., 2020; Cokley et al., 2017; Ramsey & Brown, 2018; Sverdlik et al., 2020). People feel like "intruders" and "fakes" when they lack representation or role models, experience microaggressions, and must constantly manage others' impressions while regulating their own emotions (Kim et al., 2018; McGee & Martin, 2011). These experiences are related to a *sense of belonging* (Strayhorn, 2018; Sverdlik et al., 2020) and *STEM identity* (Carlone & Johnson, 2007; Chen et al., 2021). Cumulative messages and interactions contribute to a sense of "who we are" in STEM – whether we are capable, whether we can make an impact, and whether our contributions will be valued. A positive STEM identity and an authentic sense of belonging mutually support each other (Chen et al., 2021; Kim et al., 2018). Imposter syndrome might thus be better conceptualized as *internalized exclusion*, whereby people are subtly, unsubtly, and consistently told that they "don't belong here" and gradually come to believe it.

Consequently, one reason that STEM is nonrepresentative is because unwelcoming communities push people out of STEM or encourage people to flee STEM (McGee et al., 2021; McGee & Martin, 2011). For instance, at the University of Virginia, two Black professors were denied tenure in cases

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mired in questionable processes that disparaged their accomplishments (Flaherty, 2020). In one such case, Dr Harris was an assistant professor of counselor education, where he studied career readiness, identity, and counselor preparation related to underserved students (P. C. Harris et al., 2020). He was well-published and award-winning but these achievements were not valued, and conflicting communications transformed the process into a morass. The university eventually reversed its decision but the damage was done. Dr Harris is now an associate professor of counselor education at Pennsylvania State University. Of his choice to move on, Harris said, "We began to take an inventory on the toll that it took on us. It was about our health – physically, psychologically, emotionally, and spiritually" (Hudson, 2021). Moreover, he was specifically drawn to PSU because "Having a dean explicitly state and emphasize an anti-racist vision and strategic plan for the entire college is very rare; that was huge for me in choosing to move my family to State College" (Carlton, 2021).

This problem extends beyond STEM. Another example is the saga of Dr Nikole Hannah-Jones (Hannah-Jones, 2019), who is the inaugural Knight Chair in Race and Journalism at Howard University. Those who followed the story (Cleland, 2021) know that despite an illustrious career in journalism, she was denied tenure at University of North Carolina-Chapel Hill due to politically motivated intervention. After public criticism and negative press, UNC offered her tenure, which she declined. In interviews (see Stancil, 2021), Dr Hannah-Jones explained:

> I have spent my entire life proving that I belonged in elite White spaces that weren't built for Black people. I got a lot of clarity through what happened with the University of North Carolina and I decided that I didn't want to do that anymore. . . . It's not my job to heal the University of North Carolina. That's the job of the people in power who created this situation in the first place.

The prior institutions of Drs Harris and Hannah-Jones became concretely *less* diverse and *less* representative because they were unwelcoming to worthy scholars of color. Underrepresentation was and is the product of a culture of exclusion.

In this paper, I consider the question: "How do we improve representation in STEM?" The preceding discussion about belonging and exclusion was a model for the remainder of the paper – a mixture of reflection and research with relevance to equity and justice. The paper will meander through three interconnected sections pertaining to (1) disfluency and decentering, (2) journeys and the myth of meritocracy, and (3) justice and activism. I will then conclude with a few thought-provoking answers to the overarching question.

Disfluency, discomfort, and decentering

The title of this paper was awkward on purpose. I sought to leverage the power of disfluency, which can influence attentional processes and comprehension (Faber et al., 2017; Ozuru et al., 2009) and disrupt biased reasoning (Hernandez & Preston, 2013). Disfluencies cause us to mentally stumble – to stop, think, and ask questions – and this is a crucial mindset for dialog about diversity, equity, and inclusion (DEI). This process can inspire discomfort and debate, and thus a sense of humility and open-mindedness is valuable.

Decentering

One necessary but uncomfortable process is *decentering*, which refers to shifting perspective from the self and internal world to other people and the external world. It is related to perspective taking (Duran & Dale, 2014; Krauss & Fussell, 2011; Wolgast et al., 2020) and relevant to metacognition and mental health (Bernstein et al., 2015). This transition was reflected in the progression of "me" to "us" to "them" in the title.

Humans instinctively think about the world from the perspective of the self (Steele, 1988; Sui & Humphreys, 2017). Considerations of *my* feelings, *my* needs, and *my* actions are psychologically easily accessible. It is also natural to extend these perceptions to people close to us (Clark et al., 2019; Kurzban

et al., 2015), who may be reflections of our self or "tribe." It is not overly difficult to consider *our* feelings, *our* needs, and *our* actions. By contrast, it requires more effort to consider people who are unknown or unfamiliar. Research on biased reasoning (e.g., correspondence bias, Gilbert & Malone, 1995; Hopthrow et al., 2017; and anchoring bias; Tversky & Kahneman, 1974; Lieder et al., 2018) demonstrates that humans commonly make faulty attributions about others' motives, overgeneralize our own beliefs, resist contradictory information, and resist changing initial assumptions. From a cognitive science or learning science perspective, one might consider decentering as a form of "far transfer" that involves analogical reasoning (Bassok et al., 2012; Gentner & Markman, 1997) or relational reasoning (Dumas et al., 2013) to understand how other people are meaningfully different from us while simultaneously sharing underlying connections. Our experiences provide a foundation for understanding others, which may lead to rapport with people who "look like us" or "live near us" and resistance to people who "don't look like us" or "live far away" (Gimpel et al., 2020). However, setting aside these self-oriented anchoring assumptions may reveal more substantive underlying differences or commonalities. Humans possess the cognitive tools to make these connections, but they may need appropriate cues, training, or encouragement.

In STEM, certain identities are historically centered (i.e., more typical, visible, and influential) – the people concentrated in positions of power and prestige tend to be White, male, heterosexual, cisgender, able-bodied, wealthier, and so on. Collectively, this long-standing centering of select identities creates "default" or anchoring prototypes (i.e., the "us" of STEM), which are partially captured by critiques of "WEIRD" science (Clancy & Davis, 2019; Henrich et al., 2010). WEIRD is an acronym that highlights how researchers and participants are dominated by individuals from "Western," "educated," "industrialized," "rich," and "democratic" nations and societies. Understanding and improving representation in STEM requires us to also focus attention on marginalized or minoritized people (i.e., the "them" of STEM) who may be outside of our own experience or STEM power structures. We must decenter both personally and organizationally.

Personal journeys and the myth of meritocracy

Various factors pull people into STEM or push them out, and personal experiences and events motivate people to join or leave STEM. This language of pulling, pushing, joining, and leaving evokes a sense of *movement*. Indeed, we employ a variety of metaphors to describe how people traverse STEM education and careers (Lee, 2019; Lord et al., 2019). Analogies are useful for highlighting key features and knowledge (Danielson et al., 2016), yet are constrained by prior knowledge (Braasch & Goldman, 2010) that can produce misconceptions (Chi et al., 2012; Jaeger & Wiley, 2015). Likewise, the language of "pipelines" and "pathways" entails subtle meanings that influence how we think about STEM representation and career trajectories (Lee, 2019).

Pipelines are fixed, unidirectional, and predetermined by others. Designers decide on pipe placement and then liquids (e.g., students) flow along that route. Metaphorically, we can imagine valves that restrict flow (e.g., "weed out" courses) and reservoirs (e.g., pools of talent). Importantly, liquids either flow through or "leak out," and there is no recourse for reclaiming leaked liquids. What happens to *people* who "leak out" of the STEM pipeline? Splat? In reality, leaving STEM is not an end. The career and contributions of Dr Ebony McGee (McGee et al., 2021; McGee & Martin, 2011; Robinson et al., 2016) provide a salient example. Dr McGee left electrical engineering to pursue a second career in education, and has leveraged her expertise to provide compelling analyses of inequitable STEM cultures and their impact on underrepresented groups.

Along these lines, the more popular "pathways" metaphor highlights that there are multiple viable routes into and through STEM. Individual paths form organically, can diverge or converge, and may be highly personal. Importantly, pathways are often nonlinear: people may move forward or back-track, get lost, find a different path, or blaze a new trail. This human-centered and dynamic view has advanced our understanding of STEM participation, such as work by faculty in the Arizona State University (ASU) Education and Systems Design Program, Dr Samantha Brunhaver (Korte et al., 2019), Dr Dina Verdín (Verdín, 2021), and Dr Mayra Artiles Fonseca (Artiles & Matusovich, 2020).

I use the term "journeys" to remind myself and others that *people* travel these pathways with *purpose*. Journeys involve effort as we explore, discover, adapt, and fail. A pathway can exist regardless of whether someone moves along it, but journeys are fundamentally person-powered. This elaboration is important because we must acknowledge peoples' journeys if we want to understand or improve representation in STEM. What factors push people to the margins or pull them into the center? How and why do some journeys lead people *toward* STEM, *away* from STEM, *into* STEM, or *out* of STEM?

My STEM journey

To illustrate how acknowledging journeys deepens our understanding of people, effort, and success, I will use myself as an example.

I am a queer and able-bodied(ish) person of the global majority. I hold undergraduate degrees in neuroscience and psychology, and a first-generation doctoral degree in cognitive psychology. Currently, I am a tenured associate professor in Human Systems Engineering, situated in a world-class engineering college and university, where I publish and have investigator roles on grants from different funding agencies. By these metrics, I might be considered a "success" while also increasing STEM diversity. I also worked hard to earn those degrees, jobs, publications, grants, and tenure. In some ways, I am an "existence proof." If someone like "me" can be successful in STEM, then perhaps so can "they." Right?

In fact, my journey began with a STEM-rich childhood. My parents frequently engaged me in authentic and fun STEM-related activities, such as building our cabin-in-the-woods vacation home and a go-cart (see Figure 1). Both of my parents were also college graduates with Master's degrees in education who became career educators in public schools. My mother taught elementary school, and my father taught middle school history before becoming a high school principal. My mother also authored a Grade 5 science textbook and won awards for teaching math. Thus, my parents were experts in the policies and procedures for succeeding in school.

Although I was accepted into several colleges, the University of Pittsburgh offered a full-tuition Helen Faison Scholarship. The award was named after Dr Helen Faison, a pioneer and champion for students who was both the first woman and first Black superintendent of the Pittsburgh Public Schools (Czebiniak, 2015). After graduation, I remained in Pittsburgh to join the lab of Dr Michelene Chi. I benefited from the expertise and wisdom of Dr Chi along with a host generous and accessible mentors, like Dr Robert Hausmann, Dr. Marguerite Roy, Dr Randi A. Engle, Dr Agnieszka Kristensen, Dr Kirsten Butcher, and Dr Scotty D. Craig (Butcher & Aleven, 2013; Chi et al., 2008; Craig et al., 2009).
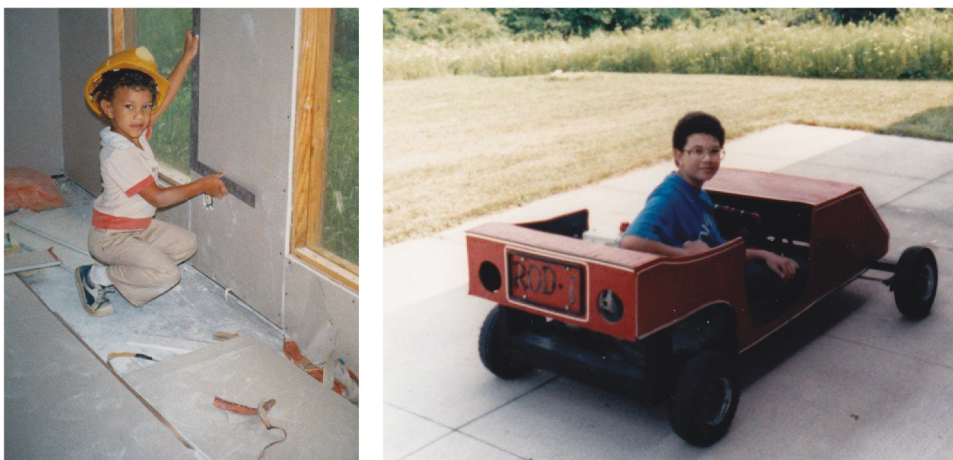
Figure 1. The author as a young child engaged in STEM activities, such as "helping" to build a house (left) and building a go-cart (right).

Attaining undergraduate and graduate degrees with zero debt is and was amazing in too many ways to count. Student debt is currently wrecking generations of learners, and these burdens are inequitably distributed by race, gender, and more (Goldrick-Rab & Steinbaum, 2020). Students from underserved and under-resourced populations are more likely to need assistance, to exit before graduating, encounter employment hurdles, and default on loans. A lack of debt afforded me more freedom and leeway than many of my peers.

After earning my doctorate, I held two postdoctoral research positions. At Vanderbilt University, I applied my expertise on learning by teaching (Roscoe, 2014) to the development of a teachable agent system (Roscoe et al., 2013). I then moved to the University of Memphis to work with Dr Danielle McNamara, who was and is an incredible mentor for every aspect of academia. This transition introduced me to automated writing evaluation and natural language processing topics that have shaped my text and discourse-related research (Roscoe et al., 2014, 2017). Dr McNamara's lab and Memphis colleagues provided me with another supportive and collaborative community. The crew who made the bold move from Memphis to ASU was particularly influential: Dr Tanner Jackson, Dr Laura Allen, Dr Jennifer Weston-Sementelli, and Russell Brandon. Dr Erica Snow is an honorary member of the club.

I could say more about my journey (e.g., assistant professorship and tenure), but my pre-professorial history probably offers enough substance to make my point. Specifically, I was born to awesome parents who could explain and guide me through every step of school, was immersed in early and continuous STEM activities, went to college and graduate school without debt, and benefitted from stimulating, well-funded labs with generous mentors. Could I have succeeded if I had floundered through the processes of publishing and grant-seeking instead of receiving expert mentorship? Could I have succeeded if I had needed to pause school to afford food or housing?

The myth of meritocracy

In addition to illustrating STEM journeys, my story allows us to confront a problematic ideology in academia: *meritocracy*. Meritocratic ideologies (Guinier, 2015; Liu, 2011; Markovits, 2019) argue that success is the result of ability, knowledge, and effort. As a corollary, apparent success is "proof" that a person possesses such traits. This belief is popular in academia, where we "objectively" evaluate people based on prestigious degrees, publishing in high impact journals, citation counts, grant expenditures, and so on. These metrics are heavily weighted in decisions about hiring, promotion, and tenure, and are considered "fair" because they are quantitative and public data. Meritocracy seems equitable because "everyone is treated the same" and "people get what they work for." Meritocratic attributions of success also feel good to those with power and privilege – it feels better to perceive achievements as earned rather than due to circumstance.

However, meritocratic policies are inequitable. For example, skewed faculty hiring may favor degrees earned from a narrow selection of "elite" United States universities (Clauset et al., 2015). Standardized testing favors culturally-biased knowledge, ways of thinking, and access to resources (Au, 2016; Dixon-Román et al., 2013; Guinier, 2015), and influences who graduates from high school, gains access to higher education, and receives financial aid. Thus, high-stakes, standardized testing can reinforce existing biases and barriers. Only students who already "fit the mold" can access the tools needed to further advance in the meritocracy.

I have worked hard in my career, but my journey demonstrates the range and depth of factors that powerfully enabled my hard work to matter. Meritocratic structures and policies adversely ignore such journeys in STEM (Cech, 2013; Cech & Blair-Loy, 2010; Liu, 2011; Slaton, 2015) – the variations in opportunity, obstacles, and resources that influence our success separately from "effort" or "talent." Importantly, even when resources are provided, people vary in how and whether they can leverage them (e.g., the digital divide, Warschauer, 2004). By ignoring journeys, meritocracy rewards existing power and privilege as much as actual success. In turn, this contributes to underrepresentation in STEM by gatekeeping who "deserves" to be in STEM.

Joining together as fill-in-the-blank activists

Underrepresentation is the predictable product of systemic inequity in STEM fields, which arises from unwelcoming cultures of exclusion, meritocratic mismeasurement of achievement, ignoring journeys, and other aspects of injustice. Therefore, improving representation in STEM requires *attention to injustice* followed by *intentional acts of justice*. "Representation" and "diversity" refer to compositional diversity (i.e., who is present), and "inclusion" and "belonging" build upon these ideas to emphasize feeling and being welcomed, integrated, and valued (Tienda, 2013). The term "justice" entails actively identifying and removing barriers that hinder inclusion. Justice is a form of "problem solving," and cognitive science and learning sciences have shown that solving problems requires mapping problem spaces, (re)framing (Svihla & Reeve, 2020), or (re)structuring (Cushen & Wiley, 2012). We can map out the actions, policies, and ideologies that produce and maintain inequity, and then we can determine how and where to take action.

Activism involves seeking such understanding and taking action to dismantle systemic inequities. The phrase "fill-in-the-blank activism" highlights that any role can contribute to this work, such as scholar-activism (Quaye et al., 2017), teacher-activism (Picower, 2012), practitioner-activism, and developer-activism. DEI issues can serve as the *focus* of our research, teaching, practice, or service; can serve as a *lens* for interpretation and communication of our work; and should be a *commitment* we make in all of our methods and procedures (Chiou & Roscoe, 2021). The following sections illustrate these themes in four different settings.

Arizona State University

At ASU, I have learned about asset-based approaches and sociopolitical aspects of education from rising scholars such as Madeleine Jennings (Jennings et al., 2020) and Dr Areej Mawasi (Mawasi et al., 2022). And, as someone who benefited from rewarding postdoctoral experiences, I was excited to welcome two postdoctoral fellows to my own lab. Dr Amin Alhashim (Alhashim et al., 2020) and Dr Maria Goldshtein (Tanner et al., 2018) are studying inclusive language analytics with our Learning Agency Lab partners Ulrich Boser, Aigner Picou, and Perpetual Baffour.

I also serve on the ASU Committee for Campus Inclusion that coordinates, communicates, and builds coalitions to support inclusive campus environments. The committee was honored with the City of Tempe 2020 MLK Diversity Award (Garrison, 2020). However, more important than *receiving* awards, the CCI also *gives* them. Via the Catalyst Award, we recognize students, staff, faculty, student organizations, staff and faculty teams, and university programs who catalyze inclusion. One recent exemplar recipient is Dr Sara Brownell, who studies issues of gender, sexuality, disability, religious identity, and more in biology education (e.g., Mead et al., 2020).

ASU also hosts several centers that organize research, education, and communities related to equity. The Center for Gender Equity in STEM advocates with and for women and girls of color in STEM through a variety of culturally responsive interventions like COMPUGIRLS (Scott, 2021). Recent proposals have brought together scholars like CGEST Director Dr Kimberly Scott (Scott, 2021; Scott & Garcia, 2016), Dr Tara Nkrumah (Morton & Nkrumah, 2021), Dr Brooke Coley (Boklage et al., 2018), and Dr Lois Brown (Brown, 2008) to discuss systems mapping, interventions for improving STEM equity, and extending COMPUGIRLS using virtual reality.

Human Factors and Ergonomics Society

The Human Factors and Ergonomics Society (HFES) has witnessed a meaningful rise in DEI-related work, including a Diversity and Inclusion Committee (chaired by Dr Carolyn Sommerich) and multiple affinity groups. This transformation has emerged from the hard work of members to organize panels, workshops, publications, and seed grants (Chiou & Roscoe, 2021). With my colleagues, Dr Erin Chiou (Chiou & Lee, 2021) and Dr Abigail Woolridge (Wooldridge & Rogers, 2021), I also co-edited a volume

on how human factors and user-centered design can contribute to DEI (Roscoe et al., 2019). For example, chapters discussed how human systems engineering can inform equitable health-care (Holden et al., 2019), design for older adults (M. T. Harris et al., 2019), and conduct research with autistic participants (Williams & Gilbert, 2019). This book was named an Outstanding Academic Title for 2020 by *Choice*, a publication of the Association of College and Research Libraries American Library Association.

International Society of the Learning Sciences

The International Society of the Learning Sciences (ISLS) hosts two committees related to equity and inclusion. The Equity and Justice Committee (co-chaired Dr Kris Gutiérrez and Dr Shirin Vossoughi) focuses on issues of representation, marginalization, and justice at all levels. In 2020, ISLS President Dr Victor Lee (Lee et al., 2021) received a grant to support underrepresented scholars in the learning sciences. The resulting Emerging Scholars Committee, co-chaired by Dr Maxine McKinney de Royston (McKinney de Royston, 2020; Sengupta-Irving & McKinney de Royston, 2021) and Dr Leema Berland (Miller et al., 2021), included Dr Roberto Santiago de Roock (de Roock, 2021), Dr Dengting Boyanton (Sullivan et al., 2021), Dr Mmantsetsa Marope (Marope et al., 2013), and myself. The 2021 ISLS annual meeting also featured the Presidential Session, "Celebrating Black Excellence in the Learning Sciences," with speakers Dr Sherice Clarke (Clarke et al., 2018) and Dr Christopher Wright (Wright & Riley, 2021).

International Artificial Intelligence in Education Society

The 2021 Artificial Intelligence in Education (AIED) conference theme was "Mind the Gap: AIED for Equity and Inclusion," thus bringing direct attention to equity in AI-based approaches to teaching and learning. One signature event was a panel on "The Bidirectional Relationship between Diversity, Equity, and Inclusion (DEI) and Artificial Intelligence (AI)." The panel was co-chaired by Dr Shima Salehi (Salehi et al., 2020) and myself, and featured panelists Dr Nia Dowell (Dowell et al., 2021), Dr Chris Piech (Piech et al., 2020), Dr.Rose Luckin (Luckin & Cukurova, 2019), and Dr.Marcelo Worsley (Worsley & Bar-El, 2020). DEI perspectives contribute valuable tools for conceptualizing, developing, and understanding AI while potentially avoiding or mitigating biases (i.e., DEI for AI). Synergistically, AI provides tools for exploring complex and contextualized person-centered data (i.e., AI for DEI). The panelists argued that this bidirectional relationship represents an important paradigm shift for the field of AIED.

Thought-provoking answers

This reflection began with the question of "How do we improve representation in STEM?" that I extended to ask, "How and why do some journeys lead people to STEM, away from STEM, into STEM, and/or out of STEM?" In this section, I offer thought-provoking answers for confronting the inequitable systems and ideas that create and maintain STEM underrepresentation.

Build cultures of belonging

People go and stay where they are wanted, valued, and supported. To improve representation in STEM, we must evaluate how current cultures enact unwelcoming ideologies, policies, and practices. What factors undermine authentic belonging and result in marginalization, imposter syndrome, internalized exclusion, and people fleeing STEM? In response, we must understand the experiences and actions that contribute to belonging (Chen et al., 2021; Dasgupta & Stout, 2014; Kim et al., 2018; McGee & Martin, 2011; Strayhorn, 2018) and *do* those things. As Dr Hannah-Jones noted, this is "the job of the people in power who created this situation in the first place" (Stancil, 2021). Administrators, advisors, instructors, program officers, and others in positions of authority have significant responsibility for shaping or transforming organizational cultures.

Recall that certain identities (e.g., White, male, able-bodied, etc.) have been traditionally centered in STEM, meaning that representatives of these identities are more common, visible, and likely to hold power (Clancy & Davis, 2019). The extent to which a narrow range of identities are centered in STEM communicates that people who do not hold those identities do not belong (Bonilla-Silva & Peoples, 2022). Creating a culture of belonging thus begins with challenging these "defaults" (Pawley, 2019) by concretely examining who has held power within our specific fields or organizations (e.g., governance, editors, program officers, grantees, and awardees). We can partially counteract exclusion by better promoting and celebrating the work of diverse or marginalized scholars. This positive visibility uplifts more members and welcomes them into the center while simultaneously exciting newcomers and outsiders.

Building cultures of belonging continues with proactive and sincere invitations to participate. Invitations simultaneously advertise opportunities while communicating a sense of welcome. Lessons learned from broadening participation (McNeely & Fealing, 2018; Wilson-Kennedy et al., 2019) and research recruitment (George et al., 2014) are useful. It is necessary to eliminate barriers to joining, such as restrictive eligibility requirements (e.g., only certain degrees or appointments are valid credentials) or costs (e.g., membership or application fees). Similarly, we must confront reasons why individuals may distrust an invitation, such as a legacy of discrimination in the organization. If a culture has been exclusive, inequitable, or harmful in the past, why should prospective members believe that things are different now?

Invitations must thus be accompanied by practices that promote belonging for newcomers and existing members. Journeys continue after joining, and cultures of belonging must offer ongoing support. One strategy is to promote diverse role models who embody organizational expertise, goals, and values. Role models allow prospective members to "see themselves" in the community and envision a pathway for joining and succeeding. And, the models themselves benefit from the prestige and validation of their role (Fuesting & Diekman, 2017; Kricorian et al., 2020). In addition, people and journeys should be supported via mentorship (Dawson et al., 2015; Kricorian et al., 2020). Mentors reveal the inner workings of the field and help others strategically navigate milestones and barriers. Moreover, having mentors and role models who share your background further contributes to a sense of belonging (Kricorian et al., 2020). Finally, it is crucial to continuously solicit peoples' needs and hold ourselves accountable to meeting those needs. Belonging is fostered when needs are met on both a personal and institutional level. For instance, Ayala et al., (2021) outlined a two-stage process for research labs that might generalize to larger organizations. First, *individual* lab members can anonymously articulate their identities, needs, and sense of belonging. Second, the team reviews these assessments and determines *collective* changes needed to achieve inclusion and equity goals. Thus, the journeys of individuals are uplifted but the entire community is accountable for problem-solving and change.

Adopt a "journeyocracy"

Another legacy of historically homogenous STEM fields pertains to defining and measuring success. Current meritocratic ideologies (Guinier, 2015; Liu, 2011; Markovits, 2019) reward experiences and accomplishments that center specific (e.g., WEIRD) credentials, making it more difficult to recruit, retain, and reward diverse people. Meritocratic policies contribute to underrepresentation by ignoring variations in resources and luck that influence how and whether our hard work manifests as success (Cech, 2013; Liu, 2011; Slaton, 2015). By ignoring journeys, meritocracy primarily builds upon existing power and privilege while inequitably gatekeeping who can "earn" their way in (Au, 2016). To improve representation in STEM, we need to innovate methods for assessing and anticipating success that (a) acknowledge peoples' journeys and assets, and (b) meet peoples' needs prior to evaluation – I refer to this as *journeyocracy*. We must stop reducing people to publication counts, degrees, grants, and awards. Instead, we must value how we get there and not only whether we got there.

Acknowledging journeys refers to respecting how diverse individuals traverse STEM experiences, opportunities, and challenges. For example, Binning et al., (2020) have advocated for normalizing narratives related to academic diversity and adversity. In their study, students reflected on their own experiences, read peer narratives, and openly discussed each others' journeys. Findings indicated that participating students were more engaged, performed better, and felt a stronger sense of belonging. This strategy might be particularly important for people who have begun to internalize exclusion (Chen et al., 2021; Ramsey & Brown, 2018; Sverdlik et al., 2020). Individuals who suspect that they "do not belong" in STEM may interpret setbacks as confirmatory "proof" rather than normal and expected steps of any journey.

From our journeys – our diverse living and learning experiences – also derive rich assets. "Underrepresented minorities" or "marginalized populations" are often discussed in deficit terms (e.g., "at risk"), and cultural resources that diverge from WEIRD norms are dismissed (e.g., indigenous knowledge, Battiste 2018). These perspectives are challenged by a growing literature that emphasizes *funds of knowledge* (Calabrese Barton & Tan, 2009; González et al., 2005) and *agency* (Ashcraft et al., 2017; Calabrese Barton & Tan, 2010; Scott & Garcia, 2016). These approaches reveal that learners, educators, and researchers – in addition to formal curricula and training – possess valuable knowledge, skills, and goals rooted in our cultures, families, and everyday lives. These myriad resources can and should be creatively applied to understand STEM concepts, define STEM problems, brainstorm STEM solutions, evaluate STEM impact, and innovate in STEM.

Journeys also provide context that enriches our understanding of accomplishments without detracting from or "explaining away" those achievements. If a person has been "highly productive" within a supportive network of ample opportunities and resources, then their success is evidence of what they can achieve when their needs are met. In contrast, other individuals may have been "only moderately productive," but within environments of fewer resources (e.g., lack of funding), less support (e.g., lack of mentors), challenges (e.g., heavy teaching load), or adversity (e.g., health issues). From a meritocratic perspective, the former person is "better" (i.e., longer curriculum vitae). However, the latter candidate has shown what they can do even when their needs are not met (i.e., proverbially spinning straw into gold). They have likely shown deep resilience and creativity. Thus, a "journeyocratic" perspective might ask: what greatness could this person achieve if their needs *were* met? An equity-oriented organization might be excited to find out.

A "journeyocracy" might even redefine the concept of merit (Guinier, 2015; Sen). Some scholars advocate for aligning merit to institutional values. If an organization seeks equity, then the most meritorious faculty applicant is not necessarily the person with the most publications, grants, or awards. Rather, the ideal hire is the person who can perform the job (e.g., conduct research or teach) and contribute perspectives and assets that are missing. This recentering of merit does not "lower standards" but rather raises them. There are more criteria to satisfy: both traditional "qualifications" and justice. Similarly, when evaluating faculty and staff, meritorious performance should require activities that promote cultures of belonging, such as serving on DEI committees, spearheading DEI initiatives, serving as a role model or mentor, and more. Moreover, instead of categorizing these efforts as "service" – traditionally undervalued compared to other job roles – they might be given equal weight. Perhaps building cultures of belonging should count as much as receiving a grant. If a system fails to view these efforts as "merit," then the system communicates that inclusivity and equity are not achievements.

Build coalitions of fill-in-the-blank activists

Meaningful activism – working to identify and solve problems of inequity – requires *learning* about the systemic factors that exclude versus include people from STEM and then, armed with such knowledge, *taking action*. Fortunately, threads of inclusion, equity, and justice can be woven into all work: research, teaching, service, and administration (Picower, 2012; Quaye et al., 2017). Aspiring

activists might contact some of the many folks cited in this paper, join local committees and centers, partner with other organizations, or submit collaborative grants. An essential step is to personally embrace systemic threats and injustices as problems that we have the responsibility and tools to address. In this paper, I noted how concepts such as disfluency, decentering, problem solving, and more could be linked to popular topics in cognitive science and learning science. The sciences are prone to perceiving a separation from society or politics, but this is a fallacy (Cech, 2013; Sengupta-Irving & McKinney de Royston, 2020).

Notably, administrators and other leaders have a powerful role to play in supporting activism or building cultures of belonging. Individuals with institutional authority can establish policies that enable or incentivize involvement (e.g., paid time for staff to engage in community service and professional development), ensuring that threats to inclusivity and accessibility are never ignored, or by changing promotion and tenure guidelines to recognize journeys and DEI efforts. Training and workshops are also a common tactic for making organizations more welcoming and inclusive, but their success depends on whether the leaders themselves enact the lessons and continuously reinforce DEI as institutional principles (Ninan et al., 2019).

Finally, there are many experts, committees, initiatives, and organizations that are working toward equity in STEM. In this paper, I briefly described activities that I am aware of and involved in at ASU, HFES, ISLS, and AIED – an incomplete list and only the tip of multiple icebergs. However, many of these groups have been working in parallel but not often *together*. There is a need and opportunity to form coalitions that share resources, strategies, and wisdom – our efforts can then become synergistic rather than merely simultaneous. Robust coalitions (see Christens et al., 2019) can enact systemic change at larger scales while resisting divisive rhetoric and tactics. Every organization contributes distinct expertise, methods, and perspectives, and thus interdisciplinary scholarship can be aligned to interdisciplinary activism. "Outsiders" to one community may be "insiders" in another, but joining together makes us all insiders who belong.

Conclusion

Overall, I am glad I agreed to give a talk on representation in STEM. It was a rewarding opportunity to articulate my thoughts on topics I care about while also uplifting a few colleagues whose journeys have intersected with mine. It is in that spirit that I warmly invite readers to please join me/us/them on my/our/their journey to justice in STEM.

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References

Alhashim, A. G., Marshall, M., Hartgon, T., Jonczy, K., Dickson, D., & Siddique, Z. (2020). Work in progress: Assessing creativity of alternative uses task responses: A detailed procedure. *Proceedings of the 2020 ASEE Annual Conference*. Virtual, Online: ASEE. (Paper #30955).

Artiles, M. S., & Matusovich, H. M. (2020). Examining doctoral degree attrition rates: Using expectancy-value theory to compare student values and faculty supports. *International Journal of Engineering Education*, *36*(3), 1071–1081. https://www.ijee.ie/contents/c360320.html

Ashcraft, C., Eger, E. K., & Scott, K. A. (2017). Becoming technosocial change agents: Intersectionality and culturally responsive pedagogies as vital resources for increasing girls' participating in computing. *Anthropology & Education Quarterly*, *48*(3), 233–251. https://doi.org/10.1111/aeq.12197

Au, W. (2016). Meritocracy 2.0: High-stakes, standardized testing as a racial project of neoliberal multiculturalism. *Educational Policy*, *30*(1), 39–62. https://doi.org/10.1177/0895904815614916

Ayala, M. J., Carter, J. K., Fachon, A. S., Flaxman, S. M., Gil, M. A., Kenny, H. V., Laubach, Z. M., Madden, S. A., McDermott, M. T., Medina-García, A., Safran, R. J., Scherner, E., Schield, D. R., Vasquez-Rey, S., & Volckens, J. (2021). Belonging in STEM: An interactive, iterative approach to create and maintain a diverse learning community. *Trends in Ecology and Evolution*, *36*(11), 964–967. https://doi.org/10.1016/j.tree.2021.08.004

Bassok, M., Dunbar, K. N., & Holyoak, K. J. (2012). Introduction to the special section on the neural substrate of analogical reasoning and metaphor comprehension. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *38*(2), 261–263. https://doi.org/10.1037/a0026043

Battiste, M. (2018). Reconciling Indigenous Knowledge in education: Promises, possibilities, and imperatives. In M. Spooner & J. McNinch (Eds.), *Dissident knowledge in higher education* (pp. 123–148). Regina, Saskatchewan, Canada: University of Regina Press.

Bernstein, A., Hadash, Y., Lichtash, Y., Tanay, G., Shepherd, K., & Fresco, D. M. (2015). Decentering and related constructs: A critical review and metacognitive processes model. *Perspectives on Psychological Science*, *10*(5), 599–617. https://doi.org/10.1177/1745691615594577

Binning, K. R., Kauffman, N., McGreevy, E. M., Fotuhi, O., Chen, S., Marshman, E., Kalender, Z. Y., Limeri, L. B., Betancur, L., & Singh, C. (2020). Changing social contexts to foster equity in college science courses: An ecological-belonging intervention. *Psychological Science*, *31*(9), 1059–1070. https://doi.org/10.1177/0956797620929984

Boklage, A., Coley, B., & Kellam, N. (2018). Understanding engineering educators' pedagogical transformations through the Hero's Journey. *European Journal of Engineering Education*, *44*(6), 923–938. https://doi.org/10.1080/03043797.2018.1500999

Bonilla-Silva, E., & Peoples, C. E. (2022). Historically White colleges and universities: The unbearable whiteness of (most) colleges and universities in America. *American Behavioral Scientist*, 000276422110660. https://doi.org/10.1177/00027642211066047

Braasch, J. L. G., & Goldman, S. R. (2010). The role of prior knowledge in learning from analogies in science texts. *Discourse Processes*, *47*(6), 447–479. https://doi.org/10.1080/01638530903420960

Bravata, D. M., Watts, S. A., Keefer, A. L., Madhusudhan, D. K., Taylor, K. T., & Hagg, H. K. (2020). Prevalence, predictors, and treatment of impostor syndrome: A systematic review. *Journal of General Internal Medicine*, *35*(4), 1252–1275. https://doi.org/10.1007/s11606-019-05364-1

Brown, L. (2008). *Pauline Elizabeth Hopkins: Black daughter of the revolution*. University of North Carolina Press.

Butcher, K. R., & Aleven, V. (2013). Using student interactions to foster rule-diagram mapping during problem solving in an intelligent tutoring system. *Journal of Educational Psychology*, *105*(4), 988–1009. https://doi.org/10.1037/a0031756

Calabrese Barton, A., & Tan, E. (2009). Funds of knowledge and discourses and hybrid space. *Journal of Research in Science Teaching*, *46*(1), 50–73. https://doi.org/10.1002/tea.20269

Calabrese Barton, A., & Tan, E. (2010). We be burnin'! Agency, identity and science learning. *Journal of the Learning Sciences*, *19*(2), 187–229. https://doi.org/10.1080/10508400903530044

Carlone, H. B., & Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching*, *44*(8), 1187–1218. https://doi.org/10.1002/tea.20237

Carlton, J. (2021, November 16). His 'own story' prompted Paul Harris to help Black youth find sense of self. *PSU.edu: Education*. https://www.psu.edu/news/education/story/his-own-story-prompted-paul-harris-help-black-youth-find-sense-self/

Cech, E. A., & Blair-Loy, M. (2010). Perceiving glass ceilings? Meritocratic versus structural explanations of gender inequality among women in science and technology. *Social Problems*, *57*(3), 371–397. https://doi.org/10.1525/sp.2010.57.3.371

Cech, E. A. (2013). The (mis)framing of social justice: Why ideologies of depoliticization and meritocracy hinder engineers' ability to think about social injustices. In J. Lucena (Ed.), *Engineering education for social justice. Philosophy of engineering and technology* (pp. 67–84). Springer. https://doi.org/10.1007/978-94-007-6350-0_4

Chen, S., Binning, K. R., Manke, K. J., Brady, S. T., McGreevy, E. M., Betancur, L., Limeri, L. B., & Kaufmann, N. (2021). Am I a science person? A strong science identity bolsters minority students' sense of belonging and performance in college. *Personality and Social Psychology Bulletin*, *47*(5), 593–606. https://doi.org/10.1177/0146167220936480

Chi, M. T. H., Roscoe, R. D., Slotta, J. D., Roy, M., & Chase, C. (2012). Misconceived causal explanations for emergent processes. *Cognitive Science*, *36*(1), 1–61. https://doi.org/10.1111/j.1551-6709.2011.01207.x

Chi, M. T. H., Roy, M., & Hausmann, R. G. M. (2008). Observing tutorial dialogues collaboratively: Insights about human tutoring effectiveness from vicarious learning. *Cognitive Science*, *32*(2), 301–341. https://doi.org/10.1080/03640210701863396

Chiou, E. K., & Lee, J. D. (2021). Trusting automation: Designing for responsivity and resilience. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, *Human Factors*, 001872082110099. https://doi.org/10.1177/00187208211009995

Chiou, E. K., & Roscoe, R. D. (2021). Assessing authentic diversity in the human factors and ergonomics society: Part 1. *Ergonomics in Design*. https://doi.org/10.1177/10648046211015749

Christens, B. D., Butterfoss, F. D., Minkler, M., Wolff, T., Francisco, V. T., & Kegler, M. C. (2019). Learning from coalitions' efforts to promote equity and justice. *Health Education & Behavior*, *46*(1), 110S–114S. https://doi.org/10.1177/1090198119871551

Clancy, K. B., & Davis, J. L. (2019). Soylent is people, and WEIRD is white: Biological anthropology, whiteness, and the limits of the WEIRD. *Annual Review of Anthropology*, *48*, 169–186. https://doi.org/10.1146/annurev-anthro-102218-011133

Clark, C. J., Liu, B. S., Winegard, B. M., & Ditto, P. H. (2019). Tribalism is human nature. *Current Directions in Psychological Science*, *28*(6), 587–592. https://doi.org/10.1177/0963721419862289

Clarke, S. N., Resnick, L. B., & Rosé, C. P. (2018). Discourse analytics for classroom learning. In D. Niemi, R. D. Pea, B. Saxberg, & R. E. Clark (Eds.), *Learning Analytics in Education* (pp. 139–153). Information Age.

Clauset, A., Arbesman, S., & Larremore, D. B. (2015). Systematic inequality in faculty hiring networks. *Science Advances*, *1*(1), e140000. https://doi.org/10.1126/sciadv.1400005

Cleland, A. (2021, July 7). Nikole Hannah-Jones hits racist UNC tenure decision with epic plot twist and a list of suggestions. *Medium: Age of Awareness*. https://medium.com/age-of-awareness/nikole-hannah-jones-hits-racist-unc-tenure-decision-with-epic-plot-twist-and-a-list-of-suggestions-90c08354b0a1

Cokley, K., Smith, L., Bernard, D., Hurst, A., Jackson, S., Stone, S., Awosogba, O., Saucer, C., Bailey, M., & Roberts, D. (2017). Impostor feelings as a moderator and mediator of the relationship between perceived discrimination and mental health among racial/ethnic minority college students. *Journal of Counseling Psychology*, *64*(2), 141–154. https://doi.org/10.1037/cou0000198

Craig, S. D., Chi, M. T. H., & VanLehn, K. (2009). Improving classroom learning by collaborative observing human tutoring videos while problem solving. *Journal of Educational Psychology*, *101*(4), 779–789. https://doi.org/10.1037/a0016601

Cushen, P. J., & Wiley, J. (2012). Cues to solution, restructuring patterns, and reports of insight in creative problem solving. *Consciousness and Cognition*, *21*(3), 1166–1175. https://doi.org/10.1016/j.concog.2012.03.013

Czebiniak, M. (2015, July 17). Obituary: Helen Faison: Pioneering educator at Pittsburgh schools. *Pittsburgh Post-Gazette*. https://www.post-gazette.com/news/obituaries/2015/07/17/Obituary-Helen-Faison-Educator-civil-rights-leader/stories/201507170292

Danielson, R. W., Sinatra, G. M., & Kendeou, P. (2016). Augmenting the refutation text effect with analogies and graphics. *Discourse Processes*, *53*(5–6), 392–414. https://doi.org/10.1080/0163853X.2016.1166334

Dasgupta, N., & Stout, J. G. (2014). Girls and women in science, technology, engineering, and mathematics: STEMing the tide and broadening participation in STEM careers. *Policy Insights from the Behavioral and Brain Sciences*, *1*(1), 21–29. https://doi.org/10.1177/2372732214549471

Dawson, A. E., & Bernstein, B. L., & Bekki, J. M. (2015). Providing the psychosocial benefits of mentoring to women in STEM: CareerWISE as an online solution. *New Directions for Higher Education*, *2015*(171), 53–62. https://doi.org/10.1002/he.20142

de Roock, R. S. (2021). On the material consequences of (digital) literacy: Digital writing with, for, and against racial capitalism. *Theory into Practice*, *60*(2), 183–193. https://doi.org/10.1080/00405841.2020.1857128

Dixon-Román, E. J., Everson, H. T., & McArdle, J. J. Race, poverty and SAT scores: Modeling the influences of family income on Black and White high school students' SAT performance. (2013). *Teachers College Record*, *115*(4), 1–33. Article 040306. https://doi.org/10.1177/016146811311500406

Dowell, N., McKay, T., & Perrett, G. (2021). It's not that you said it, it's how you said it: Exploring the linguistic mechanisms underlying values affirmation interventions at scale. *AERA Open*, *7*(1), 1–19. https://doi.org/10.1177/23328584211011611

Dumas, D., Alexander, P. A., & Grossnickle, E. M. (2013). Relational reasoning and its manifestations in the educational context: A systematic review of the literature. *Educational Psychology Review*, *25*(3), 391–427. https://doi.org/10.1007/s10648-013-9224-4

Duran, N. D., & Dale, R. (2014). Perspective-taking in dialogue as self-organization under social constraints. *New Ideas in Psychology*, *32*(1), 131–146. https://doi.org/10.1016/j.newideapsych.2013.03.004

Faber, M., Mills, C., Kopp, K., D'Mello, & D'Mello, S. (2017). The effect of disfluency on mind wandering during text comprehension. *Psychonomic Bulletin and Review*, *24*(3), 914–919. https://doi.org/10.3758/s13423-016-1153-z

Flaherty, C. (2020, June 22). Botched. *Inside Higher Ed*. https://www.insidehighered.com/news/2020/06/22/two-black-scholars-say-uva-denied-them-tenure-after-belittling-their-work

Fuesting, M. A., & Diekman, A. B. (2017). Not by success alone: Role models provide pathways to communal opportunities in STEM. *Personality and Social Psychology Bulletin*, *43*(2), 163–176. https://doi.org/10.1177/0146167216678857

Garrison, J. (2020, January 15). ASU's committee for campus inclusion honored with city of tempe's diversity award. *ASU News: Arizona State University*. https://news.asu.edu/20200115-arizona-impact-asu-committee-campus-inclusion-honored-city-tempe-diversity-award

Gentner, D., & Markman, A. B. (1997). Structure mapping in analogy and similarity. *American Psychologist*, *52*(1), 45–56. https://doi.org/10.1037/0003-066X.52.1.45

George, S., Duran, N., & Norris, K. (2014). A systematic review of barriers and facilitators to minority research participation among African Americans, Latinos, Asian Americans, and Pacific Islanders. *American Journal of Public Health*, *104*(2), e16–31. https://doi.org/10.2105/AJPH.2013.301706

Gilbert, D. T., & Malone, P. S. (1995). The correspondence bias. *Psychological Bulletin*, *117*(1), 21–38. https://doi.org/10.1037/0033-2909.117.1.21

Gimpel, J. G., Lovin, N., Moy, B., & Reeves, A. (2020). The urban-rural gulf in American political behavior. *Political Behavior*, *42*(4), 1343–1668. https://doi.org/10.1007/s11109-020-09601-w

Goldrick-Rab, S., & Steinbaum, M. (2020). What is the problem with student debt? *Journal of Policy Analysis and Management*, *39*(2), 534–540. https://doi.org/10.1002/pam.22208

González, N., Moll, L. C., & Amanti, C. (Eds.). (2005). *Funds of knowledge: Theorizing practices in households, communities, and classrooms*. Erlbaum.

Guinier, L. (2015). *The tyranny of the meritocracy: Democratizing higher education in America*. Beacon Press.

Hannah-Jones, N. (2019, August 14). Our democracy's founding ideals were false when they were written. Black Americans have fought to make them true. *New York Times Magazine*. https://www.nytimes.com/interactive/2019/08/14/magazine/black-history-american-democracy.html

Harris, P. C., Mayes, R. D., Freeman, C., Eberly, B., Tatby, Wiener, S., & Weiner, N. (2020). Men passionately pursuing purpose (MP3): A group counseling intervention for Black male student athletes. *The Journal for Specialists in Group Work*, *42*(2), 146–164. https://doi.org/10.1080/01933922.2019.1679931

Harris, M. T., Nie, Q., & Rogers, W. A. (2019). Guiding technology design to empower older adults to actively engage in society. In R. D. Roscoe, E. K. Chiou, & A. R. Wooldridge (Eds.), *Advancing diversity, inclusion, and social justice through human systems engineering* (pp. 151–170). CRC Press. https://doi.org/10.1080/00140139.2020.1818431

Henrich, J., Heine, S., & Norenzayan, A. (2010). The weirdest people in the world? *Behavioral and Brain Sciences*, *33*(2–3), 61–83. https://doi.org/10.1017/S0140525X0999152X

Hernandez, I., & Preston, J. L. (2013). Disfluency disrupts the confirmation bias. *Journal of Experimental Social Psychology*, *49*(1), 178–182. https://doi.org/10.1016/j.jesp.2012.08.010

Hopthrow, T., Hooper, N., Mahmood, L., Meier, B. P., & Weger, U. (2017). Mindfulness reduces the correspondence bias. *Quarterly Journal of Experimental Psychology (2006)*, *70*(3), 351–360. https://doi.org/10.1080/17470218.2016.1149498

Hudson, W. (2021, May 18). After fighting to gain tenure, Dr. Paul Harris leaves UVA on his own terms. *Diverse Issues in Higher Education*. https://www.diverseeducation.com/tenure/article/15109207/after-fighting-to-gain-tenure-dr-paul-harris-leaves-uva-on-his-own-terms

Jaeger, A. J., & Wiley, J. (2015). Reading an analogy can cause the illusion of comprehension. *Discourse Processes*, *52*(5–6), 376–405. https://doi.org/10.1080/0163853X.2015.1026679

Jennings, M. F., Roscoe, R. D., Kellam, N. N., & Jayasuriya, S. (2020, June). A review of the state of LGBTQIA+ student research in STEM and engineering education. *Proceedings of the 127th ASEE Annual Conference* (Paper ID #30308). https://doi.org/10.18260/1-2–34045

Kim, A. Y., Sinatra, G. M., & Seyranian, V. (2018). Developing a STEM identity among young women: A social identity perspective. *Review of Educational Research*, *88*(4), 589–625. https://doi.org/10.3102/0034654318779957

Korte, R., Brunhaver, S., & Zehr, S. M. (2019). The socialization of STEM professionals into STEM careers: A study of newly hired engineers. *Advances in Developing Human Resources*, *21*(1), 92–113. https://doi.org/10.1177/1523422318814550

Krauss, R. M., & Fussell, S. R. (2011). Perspective-taking in communication: Representations of others' knowledge in reference. *Social Cognition*, *9*(1), 2–24. https://doi.org/10.1521/soco.1991.9.1.2

Kricorian, K., Seu, M., Lopez, D., Ureta, E., & Equils, O. (2020). Factors influencing participation of underrepresented students in STEM fields: Matched mentors and mindsets. *International Journal of STEM Education*, *7*(1), Article 16. https://doi.org/10.1186/s40594-020-00219-2

Kurzban, R., Burton-Chellew, M. N., & West, S. A. (2015). The evolution of altruism in humans. *Annual Review of Psychology*, *66*(1), 575–599. https://doi.org/10.1146/annurev-psych-010814-015355

Langford, J., & Clance, P. R. (1993). The impostor phenomenon: Recent research findings regarding dynamics, personality and family patterns and their implication for treatment. *Psychotherapy: Theory, Research, Practice, Training*, *30*(3), 495–501. https://doi.org/10.1037/0033-3204.30.3.495

Lee, W. C. (2019). Pipelines, pathways, and ecosystems: An argument for participation pathways. *Journal of Engineering Education*, *108*(1), 8–12. https://doi.org/10.1002/jee.20241

Lee, V., Drake, J., Cain, R., & Thayne, J. (2021). Remembering what produced the data: Individual and social reconstruction in the context of a *quantified self* elementary data and statistics unit. *Cognition and Instruction*, *39* (4), 367–408. https://doi.org/10.1080/07370008.2021.1936529

Lieder, F., Griffiths, T. L., Huys, Q. J. M., & Goodman, N. D. (2018). The anchoring bias reflects rational use of cognitive resources. *Psychonomics Bulletin & Review*, *25*(1), 322–349. https://doi.org/10.3758/s13423-017-1286-8

Liu, A. (2011). Unraveling the myth of meritocracy within the context of US higher education. *Higher Education*, *62*(4), 383–397. https://doi.org/10.1007/s10734-010-9394-7

Lord, S. M., Ohland, M. W., Layton, R. A., & Camacho, M. M. (2019). Beyond pipeline and pathways: Ecosystem metrics. *Journal of Engineering Education*, *108*(1), 32–56. https://doi.org/10.1002/jee.20250

Luckin, R., & Cukurova, M. (2019). Designing educational technologies in the age of AI: A learning sciences-driven approach. *British Journal of Educational Technology*, *50*(6), 2824–2838. https://doi.org/10.1111/bjet.12861

Markovits, D. (2019). *The meritocracy trap: How America's foundational myth feeds inequality, dismantles the middle class, and devours the elite*. NY: Penguin Random House.

Marope, P. T. M., Wells, P. J., & Hazelkorn, E. (Eds.). (2013). *Rankings and accountability in higher education: Uses and misuses*. United Nations Educational, Scientific and Cultural Organization (UNESCO).

Mawasi, A., Nagy, P., Finn, E., & Wylie, R. (2022). Narrative-based learning activities for science ethics education: an affordance perspective. *Journal of Science Education and Technology*, *31*(1), 16–26. https://doi.org/10.1007/s10956-021-09928-x

McGee, E. O., Main, J. B., Miles, M. L., & Cox, M. F. (2021). An intersectional approach to investigating persistence among women of color tenure-track engineering faculty. *Journal of Women and Minorities in Science and Engineering*, *21*(1), 57–84. https:.//doi.org/10.1615/JWomenMinorScienEng.2020035632

McGee, E. O., & Martin, D. B. (2011). "You would not believe what I have to go through to prove my intellectual value!" Stereotype management among academically successful Black mathematics and engineering students. *American Educational Research Journal*, *48*(6), 1347–1389. https://doi.org/10.3102/0002831211423972

McKinney de Royston, M. (2020). Black womanist teachers' political clarity in theory and practice. *Theory Into Practice*, *59*(4), 379–388. https://doi.org/10.1080/00405841.2020.1773186

McNeely, C. L., & Fealing, K. H. (2018). Moving the needle, raising consciousness: The science and practice of broadening participation. *American Behavioral Scientist*, *62*(5), 551–562. https://doi.org/10.1177/0002764218768874

Mead, C., Supriya, K., Zheng, Y., Anbar, A. D., Collins, J. P., & Brownell, S. E. (2020). Online biology degree programs broaden access for women, first-generation to college, and low-income students, but grade disparities remain. *PloS One*, *15*(12), e0243916. https://doi.org/10.1371/journal.pone.0243916

Miller, E. C., Reigh, E., Berland, L., & Krajcik, J. (2021). Supporting equity in virtual science instruction through project-based learning: Opportunities and challenges in the era of COVID-19. *Journal of Science Teacher Education*, *32*(6), 642–663. https://doi.org/10.1080/1046560X.2021.1873549

Morton, T. R., & Nkrumah, T. (2021). *A day of reckoning for the White academy: Reframing success for African American women in STEM*. Cultural Studies of Science Education. https://doi.org/10.1007/s11422-020-10004-w

Outstanding academic titles 2020: Diversity, equity, and inclusion (2021, March 26). *Choice Magazine*. https://www.choice360.org/choice-pick/outstanding-academic-titles-2020-diversity-equity-and-inclusion/

Ozuru, Y., Briner, S., Best, R., & McNamara, D. S. (2009). Contributions of self-explanation to comprehension of high- and low-cohesion texts. *Discourse Processes*, *47*(80), 641–667. https://doi.org/10.1080/01638531003628809

Pawley, A. L. (2019). Shift the default in "broadening participation" in STEM equity research. *International Journal of Gender, Science and Technology*, *11*(3), 365–373. http://genderandset.open.ac.uk/index.php/genderandset/article/view/668

Picower, B. (2012). Teacher activism: Enacting a vision for social justice. *Equity & Excellence in Education*, *45*(4), 561–574. https://doi.org/10.1080/10665684.2012.717848

Piech, C., Yan, L., Einstein, L., Saavedra, A., Bozkurt, B., & McKeown, N. (2020, August). Co-teaching computer science across borders: Human-centric learning at scale. In *Proceedings of the 7ᵗʰ ACM Conference on Learning @ Scale* (pp. 103–113). (Virtual). https://doi.org/10.1145/3386527.3405915

Quaye, S. J., Shaw, M. D., & Hill, D. C. (2017). Blending scholar and activist identities: Establishing the need for scholar activism. *Journal of Diversity in Higher Education*, *10*(4), 381–399. https://doi.org/10.1037/dhe0000060

Holden, R. J., Toscos, T., Daley, C. N. (2019). Research reflections on human factors and health equity. In R.D. Roscoe, E. K. Chiou, & A.R., Wooldridge (Eds.), *Advancing diversity, inclusion, and social justice through human systems engineering* (pp. 51–62). CRC Press. https://doi.org/10.1080/00140139.2020.1818431

Ninan, P., Feitosa, J., Delice, F. (2019). Developing an effective diversity training intervention: Best practices and challenges. In R.D. Roscoe, E.K. Chiou, & A.R. Wooldridge (Eds.),*Advancing diversity, inclusion, and social justice through human systems engineering* (pp. 247–265). CRC Press. https://doi.org/10.1080/00140139.2020.1818431

Wooldridge, A. R., & Rogers, W. A. (2021). Understanding the patient, wellness, and caregiving work of older adults. In R.S. Valdez, & R.J. Holden(Eds.), *The patient factor*. CRC Press. https://doi.org/10.1201/9780429293009

Ramsey, E., & Brown, D. (2018). Feeling like a fraud: Helping students renegotiate their academic identities. *College & Undergraduate Libraries*, *25*(1), 86–90. https://doi.org/10.1080/10691316.2017.1364080

Robinson, W. H., McGee, E. O., Bentley, L. C., Houston, S. L., & Botchway, P. K. (2016). Addressing negative racial and gendered experiences that discourage academic careers in engineering. *Computing in Science and Engineering*, *18*(2), 29–39. https://doi.org/10.1109/MCSE.2016.38

Roscoe, R. D. (2014). Self-monitoring and knowledge-building in learning by teaching. *Instructional Science*, *42*(3), 327–351. https://doi.org/10.1007/s11251-013-9283-4

Roscoe, R. D., Allen, L. K., Weston, J. L., Crossley, S. A., & McNamara, D. S. (2014). The writing Pal intelligent tutoring system: Usability testing and development. *Computers and Composition*, *34*, 39–59. https://doi.org/10.1016/j.compcom.2014.09.002

Roscoe, R. D., Chiou, E. K., & Wooldridge, A. R. (2019). *Advancing diversity, inclusion, and social justice through human systems engineering*. CRC Press. https://doi.org/10.1201/9780429425905

Roscoe, R. D., Segedy, J. R., Sulcer, B., Jeong, H., & Biswas, G. (2013). Shallow strategy development in a teachable agent environment designed to support self-regulated learning. *Computers & Education*, *62*, 286–297. https://doi.org/10.1016/j.compedu.2012.11.008

Roscoe, R. D., Wilson, J., Johnson, A. C., & Mayra, C. R. (2017). Presentation, expectations, and experience: Sources of student perceptions of automated writing evaluation. *Computers in Human Behavior*, *70*, 207–221. https://doi.org/10.1016/j.chb.2016.12.076

Slaton, A. E. (2015). Meritocracy, technocracy, democracy: Understandings of racial and gender equity in American engineering education.In S. Christensen, C. Didier, A. Jamison, M. Meganck, C. Mitcham, & B. Newberry(Eds.), *International perspectives on engineering education. Philosophy of engineering and technology*. (pp. 171–189). Springer. https://doi.org/10.1007/978-3-319-16169-3_8

Salehi, S., Cotner, S., & Ballen, C. J. (2020). Variation in incoming academic preparation: Consequences for minority and first-generation students. *Frontiers in Education*, *5*. Article 552364. https://doi.org/10.3389/feduc.2020.552364

Scott, K. A. (2021). *Compugirls: How girls of color find and define themselves in the digital age*. University of Illinois Press.

Scott, K. A., & Garcia, P. (2016). Techno-social change agents: Fostering activist dispositions among girls of color. *Meridians*, *15*(1), 65–85. https://doi.org/10.2979/meridians.15.1.05

Sengupta-Irving, T., & McKinney de Royston, M. (2021). *STEM and the social good: Forwarding political and ethical perspectives in the learning sciences*. Routledge.

Stancil, S. (2021, July 6). Nikole Hannah-Jones' remarks about going where you're wanted might be a rallying cry for Black professionals. *Blavity.com*. https://blavity.com/nikole-hannah-jones-remarks-about-going-where-youre-wanted-is-a-rallying-cry-for-black-professionals

Steele, C. M. (1988). The psychology of self-affirmation: Sustaining the integrity of the self. *Advances in Experimental Social Psychology*, *21*, 261–302. https://doi.org/10.1016/S0065-2601(08)60229-4

Strayhorn, T. L. (2018). *College students' sense of belonging: A key to educational success for all students*. Routledge. https://doi.org/10.4324/9780203118924

Sui, J., & Humphreys, G. W. (2017). The ubiquitous self: What the properties of self-bias tell us about the self. *Annals of the New York Academy of Sciences*, *1396*(1), 222–235. https://doi.org/10.1111/nyas.13197

Sullivan, J., Zhu, Q., Wang, C., & Boyanton, D. (2021). Relations among peer victimization, aggression, and school climate among elementary school students in China. *School Psychology Review, School Psychology Review*. https://doi.org/10.1080/2372966X.2021.1898290

Sverdlik, A., Hall, N. C., & McAlpine, L. (2020). PhD imposter syndrome: Exploring antecedents, consequences, and implications for doctoral well-being. *International Journal of Doctoral Studies*, *15*, 737–758. https://doi.org/10.28945/4670

Svihla, V., & Reeve, R. (2020). Facilitating problem framing in project-based learning. In S. M. Bridges & R. Imafuku (Eds.), *Interactional research into problem-based learning* (pp. 129–164). In Purdue University Press.

Tanner, D., Goldshtein, M., & Weissman, B. (2018). Individual differences in the real-time neural dynamics of language comprehension. In K. D. Federmeier & D. G. Watson (Eds.), *Psychology of learning and motivation* (pp. 299–335). Academic Press. https://doi.org/10.1016/bs.plm.2018.08.007

Tienda, M. (2013). Diversity ≠ inclusion: Promoting integration in higher education. *Educational Researcher*, *42*(9), 467–475. https://doi.org/10.3102/0013189X13516164

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science*, *185*(4157), 1124–1131. https://doi.org/10.1126/science.185.4157.1124

Verdín, D. (2021). The power of interest: Minoritized women's interest in engineering fosters persistence beliefs beyond belongingness and engineering identity. *International Journal of STEM Education*, *8*(33), 1–19. https://doi.org/10.1186/s40594-021-00292-1

Warschauer, M. (2004). *Technology and social inclusion: Rethinking the digital divide.* MIT Press.

Williams, R. M., & Gilbert, J. E. (2019). Nothing about us without us': Transforming participatory research and ethics in human systems engineering. In R. D. Roscoe, E. K. Chiou, & A. R. Wooldridge (Eds.), *Advancing diversity, inclusion, and social justice through human systems engineering* (pp. 113–134). CRC Press. https://doi.org/10.1080/00140139.2020.1818431

Wilson-Kennedy, Z. S., Byrd, G. S., Kennedy, E., & Frierson, H. T. (Eds.). (2019). *Broadening participation in STEM: Effective methods, practices, and programs.* Emerald.

Wolgast, A., Tandler, N., Harrison, L., & Umlauft, S. (2020). Adults' dispositional and situational perspective-taking: A systematic review. *Educational Psychology Review*, *32*(2), 353–389. https://doi.org/10.1007/s10648-019-09507-y

Worsley, M., & Bar-El, D. (2020). Inclusive making: Designing tools and experiences to promote accessibility and redefine making. *Computer Science Education*, . https://doi.org/10.1080/08993408.2020.1863705

Wright, C. G., & Riley, R. (2021). Mitigating the need for resiliency for Black girls: Reimagining the cultural brokering through a lens of science as White property. *Cultural Studies of Science Education. 16*, 495–500. https://doi-org.ezproxy1.lib.asu.edu/10.1007/s11422-020-10005-9