Improving Gender Equity in Engineering—Perspectives from Academia and Literature

Brianna N. Griffith, University of Arkansas

Brianna Griffith currently serves as a graduate research assistant at the University of Arkansas while pursuing a M.S. in Engineering Management. She received a B.S. in Biomedical Engineering from the University of Arkansas in May 2022. .

Dr. Eric Specking, University of Arkansas

Dr. Eric A. Specking serves as the Assistant Dean for Enrollment Management and Retention for the College of Engineering at the University of Arkansas. Specking received a B.S. in Computer Engineering, a M.S. in Industrial Engineering, and a Ph.D. in Engineering from the University of Arkansas. His research interest includes decision quality, resilient design, set-based design, engineering and project management, and engineering education. During his time at the University of Arkansas, Eric has served as Principal Investigator, Co-Principal Investigator, or Senior Personnel on over 40 research projects totaling over $6.6 Million, which produced over 50 publications (journal articles, book chapters, conference proceedings, newsletters, and technical reports). He is an active member of the American Society for Engineering Education (ASEE) and International Council on Systems Engineering (INCOSE) where he has served in various leadership positions.

Dr. Jena Shafai Asgarpoor, University of Nebraska, Lincoln

Jena Asgarpoor has been a faculty at the University of Nebraska – Lincoln since August 2017. She is a Professor of Practice and the Director for the Master of Engineering Management Program in the College of Engineering. Dr. Asgarpoor received her Ph. D. and M.S. in Industrial Engineering, specializing in Engineering Management, from Texas A and M University in College Station, where she had previously earned a B.A. in Political Science (Summa Cum Laude). Prior to UNL, she was a professor at Bellevue University (Bellevue, Nebraska) for 26 years. She has served as an officer in the Engineering Leadership Development (LEAD) and Engineering Management (EMD) divisions of ASEE, currently serving as Program Chair for EMD. She is also active in the American Society for Engineering Management (ASEM) and serving as 2022-2023 Secretary for that Society. Her interests lie in scholarship of teaching and learning specifically in asynchronous online space, assessment of learning, engineering management, and quality management.

Dr. Stephanie G. Adams, University of Texas, Dallas

Dr. Stephanie G. Adams is the 5th Dean of the Eric Jonsson School of Engineering and Computer Science at the University of Texas, Dallas and Past President of the American Society of Engineering Education. Previously Dr. Adams served as the Dean of the Frank Batten College of Engineering and Technology at Old Dominion University (2016–2019), Department Head and Professor of Engineering Education at Virginia Tech (2011–2016) and held faculty and administrative positions at Virginia Commonwealth University (2008–2011) and the University of Nebraska-Lincoln (1998–2008).

Her research interests include: Broadening Participation, Faculty and Graduate Student Development, International/Global Education, Teamwork and Team Effectiveness, and Quality Control and Management. In 2003, she received the CAREER award from the Engineering Education and Centers Division of the National Science Foundation. Dr. Adams is a leader in the advancement and inclusion of all in science, technology, engineering, and mathematics (STEM) education. She has worked with a number of colleges and universities, government agencies and non-profit organizations on topics related to graduate education, mentoring, faculty development and diversifying STEM.

Dr. Adams is an honor graduate of North Carolina A&T State University, where she earned her BS in Mechanical Engineering, in 1988. In 1991, she was awarded the Master of Engineering degree in Systems Engineering from the University of Virginia. She received her Ph.D. in Interdisciplinary Engineering from Texas A&M University in 1998, where she concentrated on Industrial Engineering and Management.

Dr. Meagan C. Pollock, Engineer Inclusion

As an engineer turned educator, through her company, Engineer Inclusion, Dr. Meagan Pollock focuses on helping others intentionally engineer inclusion™ in education and the workforce.

Dr. Adrienne Minerick, Michigan Technological University

Adrienne R. Minerick is a Professor of Chemical Engineering and Director of ADVANCE at Michigan Technological University. She earned her B.S. from Michigan Tech and her M.S. and Ph.D. from the University of Notre Dame. Her administrative experience has included Associate Dean for Research and Innovation in the College of Engineering, Assistant to the Provost for Faculty Development, Dean of the School of Technology, founding Dean of the College of Computing, and Interim Dean of the Pavlis Honors College. Adrienne is completing her Presidential terms with the American Society for Engineering (ASEE) in June 2023. She is a fellow of the American Association for the Advancement of Science (AAAS), ASEE, and most recently, the American Institute of Chemical Engineers (AIChE). She earned the AES Electrophoresis Society's Lifetime Achievement Award in 2022 and was a prior Michigan Professor of the Year Nominee, which illustrate her dual passion for leveraging research and education for student growth and societal advances. While directing the Micro Medical Device Engineering Research Laboratory (M.D. – ERL), she has managed, as PI or co-PI, ˜$11 million, yielding 93 research graduates*, a patent, and >100 publications [*12 PhDs (64% women, 18%UR)]. Her favorite quote is by Ray McDermott, "Culture is not a past cause to a current self. Culture is the current challenge to possible future selves."

Patrice Nicole Storey

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Abstract

The underrepresentation of women in engineering is well-known and well-documented. Women have experienced harmful discrimination due to bias, stereotypes, and an overall lack of institutional support. This paper aims to provide a platform focused on educating to empower individuals to continue to address gender inequity in engineering and computer science in academia. A structured literature review was conducted to focus on the disparities that exist for women, explore why those disparities exist, and discuss solutions that could help close the gender gap. The results of the literature review are coupled with the discussion outcomes from a panel on gender and racial equity in engineering conducted at the 2022 ASEE Annual Conference & Exposition. This paper is also meant to serve as a record of the panel and discussion that was generated. The panelist perspectives include faculty, administrative, and student roles in engineering at institutions of higher education who shared their experiences, insights, knowledge, and wisdom on what has contributed to the imbalance and what must be done to overcome it. The common thematic elements between the literature review and the panel are analyzed and discussed.

Keywords: gender, equity, underrepresentation, disparity, bias, engineering

Introduction

Women in engineering in academia have consistently been underrepresented, discredited, and underpaid, and these disparities are further amplified for women from marginalized groups. In 2021, women were awarded the following from the total number of degrees earned: 24% of bachelor's degrees, 28.9% of master's degrees, and 25.5% of doctoral degrees. Faculty statistics reveal that women represent 19.2% of all tenured/tenure-track engineering faculty. More specifically, women represent 14.2% of all full professors, 21.4% of all associate professors, and 26.5% of all assistant professors in engineering [1]. This data suggests that even as women come into positions as tenured/tenure-track faculty members, their progress to higher ranks does not occur at an equivalent rate to men. The National Center for Science and Engineering Statistics 2019 Survey of Doctorate Recipients found that 35,900 people in the United States were employed by 4-year colleges in an engineering occupation and 5,950 (16.6%) were women; of those, 3,500 (9.7%) were white, 1,850 (5.2%) were Asian, 250 (0.7%) were Black or African American, 300 (0.8%) were Hispanic or Latino, and 100 (0.3%) were more than one race. Statistics on Indigenous women were not reported to avoid the disclosure of confidential information. From the same report, it was noted that the median salary for men full-time employed doctoral scientists and engineers at a 4-year college was $108k, while for women it was $100k [2].

These statistics shine a light on the underrepresentation women face in both faculty and student roles. This paper serves to provide a platform for discussing multiple dimensions of gender

inequity in engineering in academia. Three key research questions shaped the scope of the analysis. A structured literature review was conducted to focus on the disparities that exist for women in engineering, uncover why those disparities exist, examine possible solutions, and identify what an inequitable environment looks like for women in engineering and why it harms all of academia. At the 2022 ASEE Annual Conference and Exposition, a panel was conducted with a DEI consultant and faculty, administrative, and students from institutions of higher education who shared their experiences and wisdom regarding gender and racial equity in engineering from an academic perspective. The panelists identified specific challenges that women and racial/ethnic individuals face in engineering and organizational practices that can be implemented to promote gender and racial equity. The common thematic elements between the literature review and panel will be analyzed and discussed, as well as the reasons why some ideas only appeared in either the review or panel. This paper also serves as a record of the panel and discussion that was generated. Comparing the results of the literature review with the subject matter expert responses from the panel emphasizes the importance and significance of the findings.

Research Questions

The following research questions were formulated to shape the scope of the paper.

- What has the literature documented as causes of disparities and inequitable environments for women in engineering in academia?
- What are organizational practices identified by subject matter experts and stakeholders that could promote gender and racial equity for women in engineering?
- What are the common thematic elements between the findings in the literature review and panel? What accounts for the differences?

Literature Review

Literature was identified by searching various databases (Web of Science Core Collection, Web of Science Inspec, and ASEE Peer) for keywords, which included “disparities”, “academia”, “women”, “engineering”, “inequities”, and “gender”. The identified records were screened for relevance, availability, and duplicates. In total, 110 papers were selected to be analyzed from all areas of academia in a full-text analysis. 30 papers were disqualified after review for not fitting the scope of the study. Some of those reasons included a focus on undergraduate students and a focus on women in engineering in the industry. 18 papers focused on engineering and were analyzed to identify disparities for women, the causes of those disparities, what an inequitable environment looks like for a woman in engineering, and possible solutions. Institutions have different ways of classifying what college computer science belongs to. For this study, we consider computer science to be included in engineering. The results are summarized in tables 1 through 4 and include the identifier, how many papers it appeared in, and specific examples from the literature. Future studies will utilize the other analyzed papers (not used in this study) to focus on women in STEM and other areas of academia. The literature identified disparities which are summarized in Table 1.

Table 1. Examples of disparities identified in the literature.

Disparity	# Identified	Examples
Underrepresentation	10	• Higher faculty ranks [3]–[9] • Postdoctoral positions [7] • Marginalized groups [6], [8], [10], [11]
Faculty status/rank	7	• Less senior faculty [5], [7]–[9], • Fewer leadership positions [9], [12] • Overrepresented in lower ranks [8], [13] • Pay gap [8], [12] • Barriers to obtaining promotion/tenure [12], [14]
Discrimination	5	Against women [5], [13], [15], [16] and women from historically underrepresented groups [6]
Not specified	2	[17], [18]
Related to research	1	Less work in commercialization, fewer publications, and women are concentrated in non-research-intensive universities [13]
Changing careers	1	[13]
Family sacrifices	1	[19]
Receive fewer accolades	1	[12]

The biggest disparity identified in the literature was the underrepresentation of women in faculty positions, specifically the lack of women in higher faculty ranks [3]–[9] and postdoctoral positions [7]. However, once women are in higher faculty ranks, they are not exempt from the disparities that women in lower ranks face [14]. Women from marginalized groups are especially subject to underrepresentation [6], [8], [10], [11] and discrimination [6]. The absence of women of color faculty and mentors can have a negative effect on young women of color wanting to pursue a career in engineering [11]. Women face disparities related to research, in which they are found to be concentrated in non-research-intensive universities, which results in them producing fewer publications than men and doing less work in commercialization [13]. Women receive fewer awards and accolades for their work [12]. Young women faculty who intend to start a family are placed in an arduous position where their career competence is viewed as at odds with family responsibilities [19]. Based on traditional and persistent gender roles, men are not thought to experience these challenges, or at least not to the same degree as women [5], [14].

Next, we examined what the literature identifies as causes of disparities. Our findings are summarized in Table 2.

Table 2. Examples of causes of disparities for women identified in the literature.

Disparity Cause	# Identified	Examples
Bias	10	• Gender bias [5], [6], [8], [9], [12], [13], [16] • Biased evaluations [6], [7], [12], [14] • Implicit bias [5], [7], [12] • Racial bias [6], [16]

		• Explicit bias [7]
Preconceived notions about women (not including bias)	8	• Stereotypes [4], [6], [7], [12] • Gender schemas [4], [10] • Cultural norms [3], sexism [17], stigma [9]
Institutional issues	8	• More teaching and service roles [7]–[9], [12], [14] • Lack of mentors [7], [9], [14] • Lack of support [6], [7], [11] • Lack of clarity on tenure/promotion [7], [14] • Higher expectations and less networking [7] • Tenure system structure [19]
Personal concerns	3	• Family issues (parental status, childcare, caregiving, household responsibilities, family planning) [5], [14] • Low self-confidence [12]
Not specified	1	[15]

From the literature, institutional and interpersonal bias is the overwhelming barrier that women face that causes disparities. Many different types of bias come into play. The most notable one is gender bias [5], [6], [8], [9], [12], [13], [16], where women are held to different standards and do not receive equal treatment because of their gender. Explicit bias or conscious bias is when individuals are aware that their actions and thoughts are different for certain groups [7]. Implicit bias, or unconscious bias, occurs when individuals do not realize that their actions or thoughts are clouded by biases [5], [7], [12]. For women in engineering, this can present itself as being excluded from informal networking [7], [14]. Women-identifying teachers receive biased evaluations [6], [7], [12], [14], either from students in a teaching setting or colleagues. Studies have shown that men receive higher evaluation rates than women, even when they exhibit the same attributes [12]. Women of color are subject to racial bias [6], [16] in which they can receive harsher teaching evaluations or less pay.

Women in engineering in academia are subject to all the aforementioned biases, and in these cases, bias awareness initiatives can be helpful to combat these issues [18]. For the sake of being precise, we have separated bias from other preconceived notions about women, which include stereotypes [4], [6], [7], [12], cultural norms [3], sexism [17], and stigma [9]. Gender schemas were mentioned in the literature, and the theory was first proposed by Bem in 1981 which says individuals tend to process information in terms of sex-linked associations. In the context of female engineering faculty, gender schemas negatively affect expectations for teaching, research, leadership, etc. [6], [18], [20]. There are also institutional issues that arise. Women are given more teaching and service roles than their men colleagues [7]–[9], [12], [14], yet these additional responsibilities are not valued to the same extent as merits that are considered for tenure and promotion and require women to sacrifice time that could be spent researching. Women feel that institutions have higher expectations for them than men and there is an overall lack of clarity on the tenure and promotion process [7], [14] and the tenure system structure [19]. There is a lack of mentors available for women faculty [7], [9], [14] and an overall lack of support [7], which includes research barriers such as insufficient lab space and supplies [6], [7], [11].

It is important to recognize what contributes to inequitable environments and to identify the characteristics of such workplaces. Table 3 summarizes findings from the literature that describe inequitable environments.

Table 3. Descriptions of inequitable environments for women in the literature.

Characteristics of an Inequitable Environment	# Identified	Examples
Gendered institutions	6	• Men-dominated work environments [7], [13], [15], [17], [18] • The tenure system is designed for men [19]
Not specified	6	[3], [4], [6], [12], [16], [21]
Work-life balance issues	6	• Work-life imbalance [5], [9], [11], [13], [14] • Long work hours [5]
Exclusion	3	Exclusion from informal networks and isolation [7], [9], [14]
Organizational problems	4	• Lack of respect [8], [14] • Chilly climate and lack of belonging [14] • Lack of support [10], • Low job satisfaction [7]
Harassment	2	Sexual harassment, inappropriate comments, and verbal harassment [7], [8]

An inequitable environment can take many different forms. The underrepresentation of women causes work environments to be heavily men-dominated [7], [13], [15], [17], [18]. This can bring forth a plethora of problems, including harassment, isolation, and a lack of respect [7]–[9], [14]. Since the environments are so heavily dominated by men, it is also evident that the tenure system was designed for men's constraints and needs [19]. One of the ways this presents itself is that the timelines in one's early career in which they are trying to get on a tenure track path often coincide with when partners want to start a family. One of the most reported issues that women face is a work-life imbalance [5], [9], [11], [13], [14] in which sometimes they must work long hours in a work-intensive environment that lacks an understanding of family commitments [5]. This imbalance coupled with a chilly work climate, lack of respect, and lack of belonging can bring forth an overall low level of job satisfaction [7], [8], [14].

The literature identifies several solutions to gender inequity and Table 4 summarizes those findings.

Table 4. Solutions for addressing gender inequity identified in the literature.

Solution	# Identified	Examples
Institutional evaluations	9	• Family-friendly policies [3], [5], [6], [9], [13], [14], [19] • Policy evaluations [5]–[8], • Changing the promotion process [7], [14], [19]

Institutional support	8	• Address bias [6], [7], [11], [13], • Mentoring [6], [7], [9], [14], • Increase diversity [11], [18], • Networking [6], [7], • Invest in research to help address problems [8]
Faculty involvement	5	• Faculty training [16], [18] • Men faculty advocacy [9]
Support from early education and recruitment	2	[3], [19]
Not provided	3	[4], [12], [15]
Women leaders	1	[7]

The literature presented several solutions that could help combat gender equity issues for women academics in engineering. The most frequently mentioned solution was the implementation of family-friendly policies [3], [5], [6], [9], [13], [14], [19]. This could include longer maternity leave and the implementation of paternity leave, which would especially be helpful if both parents are faculty members. This can also include the option to "stop the tenure clock" to allow women to navigate through pregnancy/starting a family without the pressures of tenure. These policies can also extend to accommodate women who are parents and/or caregivers and have many responsibilities at home. Men need to support women and be advocates for them [9]. There is also a need for women to support other women, as evidenced by the "Queen Bee Syndrome", which implies that women in men-dominated environments perpetuate gender stereotypes under the assumption that it will improve their standing [22]. Addressing bias is the first step in understanding how to navigate promoting gender equity in a work environment [6], [7], [11], [13]. Faculty training can be helpful to set the tone for what is and is not acceptable behavior in a work environment [16], [18].

From a young age, girls do not receive the same encouragement to pursue an engineering career as boys do, and there are also active messages that they do not belong. Promoting engineering in early education is essential to recruiting more women into the field. Encouragement and support must continue throughout their education to allow them to feel confident in their careers [3], [19]. The presence of women leaders and mentors is important for the recruitment and retention of women in faculty positions so that they feel as if they are in a supportive environment [6], [7], [9], [14].

The main takeaways from the literature review are the following:

- There are disparities among women engineering faculty of all ranks [14].
- Institutions are lacking representation of women and women from marginalized groups [6], [8], [10], [11].
- Women are subject to discrimination due to bias, racism, stigma, sexism, and gender roles [4]–[6], [9], [10], [13], [15], [16].
- Women face many systemic obstacles to getting a promotion and tenure [12], [14].

- To recruit and retain women faculty in engineering, institutions need to address bias and chilly environments within all ranks, evaluate and make necessary policy changes, and offer more support through networking, mentoring, and equal distribution of teaching and service roles [5]–[7], [9], [11], [13], [14].

Panel Methodology

The ASEE Board of Directors designated 2021 – 2022 as the Year of Impact on Racial Equity with three areas of focus: The Faculty and Administrators Pillar, The Engineering Design Teams Pillar, and The P-12 Parents and Guardians Pillar. The first pillar serves as the impetus for this paper. In response to the Year of Impact, the Program Chairs of four ASEE divisions (Engineering Management, Engineering Economy, Industrial Engineering, and Systems Engineering) agreed to organize a Special Session at the 2022 ASEE annual conference and distributed a call for abstracts and panels related to DEI.
In response, the authors proposed a panel session dedicated to discussing racial and gender equity in academia for women in engineering and a corresponding paper to document experiences, perspectives, and recommendations from the expert panel. The goals for this panel were the following:

- Discuss the most prevalent challenges, stereotypes, or barriers and how they change with one's career stage/progression.
- Identify ways that men and those in leadership roles can advocate for and help with gender and racial equity.
- Propose opportunities and barriers to individual-level and organization-level advocacy.
- Explain characteristics indicative of organizational success, failure, and progress toward gender and racial equity.

While a panel discussion can entice interest, engage the audience in conversation, promote the exchange of ideas, and surface unique perspectives, the wealth of wisdom and insights cannot be available to future scholars and practitioners as the contributions of the panelists during the event are not recorded and documented [23]. Hence, for the present study, the responses of each panelist were collected in written form and the entirety of their collective thoughts and perspectives coalesced in the form of an edited paper.

The goal was to identify women from academia who have experience on the subject and are individuals in positions who can speak to the intricacies of the matter, not just the quantified disparities and inequalities that exist for women but also individual and institutional solutions to remove barriers and actively position women for success. It was agreed that women from various ranks and serving in different roles should be represented on the panel, including student, faculty, and dean. It was also agreed that an expert with DEI consulting experience in the engineering industry and academia would be an asset to the panel.

The individuals invited to participate in this paper and panel project are:

- Dr. Stephanie Adams, Dean (School of Engineering and Computer Science, UT – Dallas), Past President of ASEE
- Dr. Adrienne Minerick, Professor (Chemical Engineering, Michigan Tech and Past Dean of the College of Computing); and Past President of ASEE

- Dr. Meagan Pollock, Founder and Chief Inclusion Engineer (Engineer Inclusion)
- Patrice Storey, Ph. D. student and Assistant Director of DEI (University of Arkansas – College of Engineering)
- Dr. Jena Asgarpoor – Professor of Practice and Director & Chair, MEM Program (University of Nebraska – Lincoln), Moderator

The moderator reviewed the literature for studies that looked at disparities for women in academia, STEM, and engineering, as well as what an inequitable environment looks like. Verbatim responses from the panel were collected, summarized, and the responses to each question drew on findings from the literature to inform holistic discussion, recommendations, and conclusions. This paper serves as a record of the panel discussion. The entire team collaboratively edited the final paper and while responses from the panelists mainly represent original wording, minor edits were performed to ensure clarity and conciseness in writing. The paper represents the collective views of all authors and was deemed IRB exempt status.

Panel Results

The Panel Results section is organized by question. The panelists' responses, as well as their rank/title, are given immediately following the question. The rank/title of each panelist was listed to provide additional context and insight into their answers and perspectives. A summary paragraph of the key points is located after the panelists' responses to each question, which also relates their points to the papers that were identified in the literature review.

Question 1: What would you say is the most prevalent challenge, stereotype, or barrier to women (and racial/ethnic individuals) in engineering? How do these barriers change with the disadvantaged individual's career stage/progression?

Adrienne Minerick (Professor and Past Dean)

It changes with career stage. The best description that I've read about is the "Pet to Threat". Academia has had this focus on diversity defined as, "We need to improve our numbers", resulting in a push to heavily recruit these different identity individuals into our ranks. There has not been a focus on the inclusion aspect. It's cool to see you here, it's not so cool if you show your authentic self in this space. When individuals are at a junior rank, they are treated like a nice "pet" to have around, but when they demonstrate being highly competent and are moving forward and getting accolades it is suddenly, "Wow, this person's kind of a threat." The dynamics do start to change, and competitiveness comes into play as an individual progresses up in rank. As individuals move into leadership, there's another whole set of biases they encounter. There's a perception of how they should behave in that leadership role and of what they should be doing and not doing, which is a barrier that leads to additional friction. Depending on the individual's identities, they're given less space, less runway, and less benefit of the doubt to do what they need to do for the job.

Another thing to add to the "Pet to Threat" thing is this notion of likability. If I show up and I act as my authentic self, which is sort of a little bold and assertive, I don't get to be called a bold, assertive leader. I get to be called other words that start with B. There's this complicated thing that both women and women of color face – it's a bind in the way we're perceived and the stereotypes that get assigned to us. I may be excellent, and I may have earned all the credentials

to get to that position, but my credibility and my likeability will be questioned over and over.

As a takeaway and as something I would encourage all of us to do, even us as practitioners of this space, is to question ourselves, “Am I not liking this person because of deeply rooted cultural stereotypes? Or am I not liking them because they're unlikable?” Be thoughtful about how you're making decisions and how you choose to engage with people because all of us have those deeply wired beliefs and are susceptible to those as well.

Patrice Storey (Ph.D. Student and Assistant Director of DEI)
I've thought about this from an elementary standpoint, from the barriers that women face that affect their ability to succeed. When you compare men and women, little girls are often compared to men and told not to major in STEM fields. In elementary through high school, girls lack the confidence to pursue a STEM field. Now, there are more women in college than men, but more men are graduating. There are about 28% of women that are in STEM, and there are even fewer when it comes to leaders in STEM.

For women of color, they face the stereotype that they do not have sufficient math, science, and technical skills. We lack the confidence to pursue those fields. We are told, “Do not major in STEM. Major in social sciences or things like that.” Not that anything is wrong with those fields, but we shouldn't deter young girls from majoring in STEM. The early promotion of camps and things like that could help. But for right now, when you talk to young girls, some say, “I can't do math, chemistry, or physics.” So, they switch off to something else. That's an early barrier, is their ability to succeed.

Stephanie Adams (Dean)
I thought about this from an ability standpoint. On a lot of our majority campuses, there's this notion of ability and belonging. There's still a subset that thinks that women and people of color can't or aren't able to do math, and therefore they don't belong. Or when you see them in the classroom, “Well what are you doing here? How'd you get here?” Now there becomes this conversation about whether you should be there from a perspective based on those things. That also holds people back. So, “I can have all the ability in the world, but you don't think I belong.” For example, an African American male graduate student entered one of our research buildings through the back door, like everybody else does, but the security guard stops him and questions who he is and why he is there. Mind you, everyone entering the building is required to have an ID badge. The student reported the incident citing that this made him feel that he didn’t belong. If society still thinks that we're not supposed to be there, then a lot of their actions and things continue to perpetuate that.

The “pet to threat” theory that Minerick describes was first coined by Thomas in 2013, where she described underrepresented individuals in academia, particularly women, as being “pioneers” in their respective workplaces, in the sense that they are usually the only minority individual in their respective environments and are often victims of tokenism. These individuals face potential scrutiny from their peers for only being hired as part of affirmative action efforts and not because of their abilities [24]. Along with these misconceptions is the notion that women of color need to serve on diversity committees and participate in service projects simply because they are people of color. These endeavors can be both time-consuming and mentally draining and are not in the merits that are considered for tenure and promotion. Young women of color faculty are tasked with these activities while their white, men colleagues have more time for research and career

development [25]. It is a trend for young women faculty to have more teaching and service roles than their men counterparts [7]–[9], [12], [14]. Storey talks about the barriers that young women face from an early age. The lack of support from childhood leads girls to believe that they are not equipped to have a successful career in STEM. This trickles down the pipeline, so there are fewer women enrolled in undergraduate engineering and graduate programs. Adams answers this question from an ability and belonging standpoint. She describes the stereotypes that women and people of color face, one being that they do not have sufficient math and science skills. She extends this by providing an anecdote about an African American graduate student who was denied access to a research building while his white colleagues were let in without question. People of color have barriers to their education because of stereotypes and biases that their white colleagues do not [6].

Question 2: How can we impact the K-12 education system so that women and people of color are being situated for success in a STEM field?
Patrice Storey (Ph.D. Student and Assistant Director of DEI) At the University of Arkansas, this summer, we're immersing young girls and boys of all identities in camps. We have camps spread throughout the state of Arkansas, from first grade up to senior year. I know that's not the complete answer, but it is a start. All those camps this summer are filled. We have one that's just for young girls, and a staff member said, "We need more people of color in this camp". We went out and sought students from church and other local secondary schools. We had grants and aid to cover the fees. We told students, "We don't want to deter you from applying because we have scholarships and need-based opportunities." From there, going out to the Delta and other schools and even partnering with HBCUs could create a type of revolving door. We have to start, and those summer camps are great exposure. I can say from a parental perspective, my son attended four engineering camps and as a result, he is a freshman coming into the U of A, majoring in mechanical engineering and has a full ride. He chose U of A because of that exposure, not because I'm employed there. I think we have a great foundation at the U of A because of the summer camps. Every time we can go to a school and present, we take it. We drill in STEM. We say, "Girls, we need you. Take calculus, AP physics, and AP chemistry. We're not so concerned about the scores on the AP exams but get that requisite knowledge." We try to do it as much as we can.
Jena Asgarpoor (Professor) Yes, and those camps that the universities drive are very effective. I also think that the education system K-12 needs to be revolutionized systemically so that those disparities are removed and opportunities are made available to everyone equitably.
Adrienne Minerick (Professor and Past Dean) I see this as a culture problem that fundamentally, if we keep giving the message you can't because of... Then we will perpetually be in this issue of trying to counter that messaging. If we go to the root of the culture and try to shift that to, we need everyone to do this and everyone can, then it just shifts that conversation. I think digging at this belief that, "You can't because of…", and reframing that, to talk about the growth mindset. We need an equivalent term for our culture to shift that entire narrative.

Meagan Pollock (DEI Consultant)
One of the things I've had the opportunity to do is work with many pre-college and post-secondary institutions to do root-cause analyses. We train teachers and work with schools to help them understand what's happening on their campus using a six Sigma process.

First, they understand their data. Then we teach them the root causes because there are decades of research to help us understand why people aren't choosing and persisting in STEM pathways. Most importantly, interest is not a root cause. That is an outcome. Next, we help educators create surveys and conduct interviews, aiming to ask, "What's happening on our campus with our students?" Finally, they create targeted strategic interventions that directly address the identified root causes. Because what happens otherwise is they start burning time and resources on interventions that may not address root causes. Unless we understand the unique root causes on our campus and strategically address those, we can't begin to understand how to change the outcomes we wish to see.

In addition, through this process, we help educators begin to think about their positionality. Prompting themselves with the questions: "How do I show up in the classroom? How do I understand my power and privilege, and the ways in which students who have faced other barriers that I may not have because of their own identities?" There's a personal expansion, but digging into understanding systems, too. This process works in industry and higher ed as well. (Learn more about root cause analysis here: https://engineerinclusion.com/root)

Storey describes how the University of Arkansas is promoting engineering summer camps for young girls and boys to promote their interest in STEM. She explains how these camps have positively affected her children and increased their chances for success in undergraduate engineering programs. She also mentions the importance of promoting STEM to girls in K-12 education, which was also mentioned in the literature [3], [19]. Asgarpoor approaches the problem from a broader perspective and proposes that the whole K-12 educational system “needs to be revolutionized” so that equal opportunities are given to all people, regardless of gender, race, ethnicity, etc. Minerick’s point is that we must get to the root of a culture problem and change the narrative so that every child, regardless of gender, race, ethnicity, etc. has the resources and opportunities to become an engineer. Pollock picks up on that point and describes her work as a DEI consultant performing root causes analysis. Their findings show that interest is not a root cause of the lack of women and people of color in engineering in higher education. Pollock suggests looking at the root causes of each institution and addressing those issues individually because each institution has its own set of problems that need to be analyzed and handled accordingly.

Question 3: How can men in engineering be better advocates for gender and racial equity in the profession?

Stephanie Adams (Dean)
The first thing is that men must understand and own that they have a certain amount of privilege. Just flat out you've been there forever, but society is changing. We need everybody at the table. Your being an advocate for a group that has been historically underrepresented or disenfranchised does not mean you're selling out or giving up your power. It just means that

you're welcoming or advocating for others to be at the table. Sometimes if there are 11 seats at the table and none are held by a woman or person of color, there is no harm in adding a 12th seat to the table. This does not mean that a man has to lose his seat. If our male counterparts change their thinking about this and don't look at it as if they are losing somehow, then we can begin to really see some impact. People can't get to the table by themselves.

I've been a Black woman in engineering now for over 30 years. A lot of times it's me and one other woman, or it's just me or it's another woman. At times this means men may have to make a little bit of extra effort to make women feel welcome. When I started my first faculty position, there were a group of men in my department who played bridge every day at lunch. My colleague frequently lamented that she had not been invited to join them. As one of the two women in the department and a junior colleague, I didn't wait on them to invite me. I asked to join the group. I approached this from a place of I could wait on them to invite me or join, or I could invite myself. Shirley Chisholm once said, "If they don't give you a seat at the table, bring a folding chair." As a woman of color, I think I had just grown accustomed to inviting myself so that is what I did and I was more than welcomed. They ended up being a very nice group of guys. Since I don't fully know what transpired before I joined, I will simply say I don't think they were intentionally not including her; I just think they were accustomed to being a department of men for so long that they were just the "boys" who played bridge at lunch.

Another place where men can demonstrate equity when in leadership positions is regarding salaries. It is well documented that women earn less than their male counterparts in almost every sector. Thus, it is imperative that male leaders pay close attention to this. As Dean, I pay close attention to salary equity. The first year we awarded merit raises I paid close attention to salaries, examining things beyond how long so and so has been here or a department head's desire to give this person a big raise. I compared people by rank, gender, time at the institution, time since degree or last promotion, etc. Time and time I found men and women faculty who were equal in terms of their productivity and the time they have been at the university and still found cases of women making $30,000 less than their male counterparts. Finding no sound reason for that, I raised the woman's salary.

Lastly, I think leaders must continue to engage in dialogue even when it may not be comfortable. We are at a place in society where we don't talk to each other anymore because it's too uncomfortable when we have differing opinions. We have to become comfortable with the uncomfortable. A colleague, who I have a lot of respect for, and who happens to be a white woman, reached out to me saying, "I read this article written by a Black woman who was advocating for a change in nomenclature from underrepresented minorities (URM) to a person from a minoritized group." She asked me to read the article and then invited me to discuss it. I read it, and we had a good conversation. One where I felt comfortable saying that I don't like the term minoritized and still preferred URM. We reached the conclusion that there really is not one right answer. As leaders, we must have those conversations with people and be willing to be vulnerable and learn something. I'm worried about today's leaders because we stopped talking about hard topics. The academy is supposed to be the place where you can have difficult conversations from a scholarly perspective to advance the knowledge base. If we can't talk to each other about things, then the rest of the people are in bad shape, so we have to keep talking about some of these things.

Meagan Pollock (DEI Consultant)
Something I'm doing as I'm trying to build my own racial consciousness, is that I must recognize that there are times when I do need to give up my chair. To truly be an ally, it means I need to not only make space, but I need to look at my position and recognize when I need to get out of the way and elevate someone else. To me, that's true inclusive leadership, of recognizing, "I don't need to be here. How do I elevate someone else? How do I make sure that I am pushing someone else who hasn't had space?" That's a real challenge that we have to face. I'm trying to bring forth this notion of stewarding. How are you stewarding and creating stewardship behaviors? Check out the "How to practice stewardship instead of gatekeeping," resources on my website, including a set of nine prompts. (https://engineerinclusion.com/stewarding/) These are things that we must intentionally practice. Sometimes we must give up a seat.

Adrienne Minerick (Professor and Past Dean)
It's important to recognize that becoming an ally isn't a one-and-done thing. It's a forever journey. That journey requires attending sessions like this where you get a set of perspectives that's somewhat in a public format, it's private reading, and then it's also really cultivating your friendships. That's also one of the most important ones because when reading something or processing information, being able to sit down with Patrice and say, "All right, I'm having a hard time pulling this together because my set of lived experiences has taught me A, B, C, and I'm reading this, that maybe you've had D, E, F lived experiences and what's a pathway to resolve this?" Working through that pathway as a co-partner, with a trusted individual, is extremely valuable. Even if we try one thing, and Patrice here said, "Yeah, that sounds like a good strategy," this is a social experiment, and it may not work and it may get perceived in a manner that is harmful or hurtful to somebody else. Being able to say, "Oh, my best intention was this. I'm sorry that it resulted in you being harmed and hurt. Let's talk about a better strategy going forward." There's not one solution for every single one of those situations.

Patrice Storey (Ph.D. Student and Assistant Director of DEI)
We mentioned belonging, and then we mentioned having a seat at the table, but it's also important for men to show empathy and compassion. We must remember the work/life balance component. Most women suffer from physical and mental issues in silence, and we're afraid to say anything, so it's important for, once again, empathy and compassion. Sometimes we're afraid to speak up, or when we're too vocal, we're seen as being bossy. Take the time to see why we have that energy and passion versus comparing us as being bossy. If a woman is speaking, we're often interrupted. We need men to be our allies and to say, "Give her the opportunity to speak. Let's hear her out." That's to prevent women from being burnt out.

If you're a parent and your child gets sick, there will be parents listed on the emergency contact form. Who are they going to call? They're going to call the mother. Or, if they call the dad, the dad's going to say, "Okay, thank you," but they're going to in return call the mother. At work, it's seen as, "You can't do your job because you have to leave and go take care of a child." No, it's work/life balance. Be fair. Understand that we must be the parent, we are an employee and all these other things. Be understanding and show empathy and compassion. Give us a seat at the table and show us that we belong.

Adams shares an anecdote about a woman colleague being excluded from the lunchtime bridge game with men colleagues, which is a perfect example of women being unintentionally excluded from informal social networks that were mentioned in the literature [7], [9], [14]. The men in that

story may not have excluded her on purpose, perhaps unconscious bias clouded their thinking. Adams also addresses the pay gap that affects many women in engineering [8], [12] and how she counteracted that in her role as Dean. She concludes this question by bringing up an excellent point that as a society, we have become averse to having conversations that may be difficult or uncomfortable. In a safe environment, these conversations can bring people together and provide an avenue to discuss topics that people may be uncomfortable bringing up in normal circumstances. Adams promotes adding an extra seat at the table for women and makes a point that men do not need to give up their seats for women to contribute to the conversation. Pollock addresses this from a different perspective by adding that sometimes white individuals need to give up their seats at the table to elevate their underrepresented peers and make their voices heard. Minerick reinforces Adams' point that we need to continue having conversations with those who come from different backgrounds than us to make headway with our peers and understand each other's lived experiences. Storey concludes by reinforcing that men need to be empathetic and compassionate towards their women coworkers. This can take the form of uplifting women's voices in discussions, being understanding of the responsibilities that some women have as mothers and caregivers, and once again, adding a seat to the table [9].

Question 4: How should all individuals in leadership roles advocate for and help with gender and racial equity in the workplace?
Patrice Storey (Ph.D. Student and Assistant Director of DEI) We all bear the responsibility to make sure that we're being fair and equal. Before I arrived at the University of Arkansas, others already revamped our hiring structure to make sure that we had representation from all areas. If it did not have that representation, we'd send it back and say, "Unfortunately, you need to start this search over." The Dean of the College of Engineering and her leadership have advocated and made sure that we need women and minorities, and we need to see this dynamic change. That's what we're currently practicing and doing. I'm not saying that is the complete answer, but that is one step. We've taken a hard look at salaries. We've taken a hard look at classified versus non-classified positions and saw the need to raise some from classified to non-classified or give that 5% to 10% bump. Even from a belonging and inclusion standpoint, we are doing things specifically for faculty and staff, like launching a book club for staff and graduate students. We're looking at these separate pieces and trying to say, "Let's create an inclusive environment and give everyone the opportunity to belong. Let's talk about this and have these conversations." I may be having one problem, but Jena may be having another problem, so if we have that opportunity to be in the same room to talk about it, then we can holistically assess what those problems are and start to make a change. Change doesn't happen overnight, but we may be able to handle some of the smallest steps first. Then, set realistic goals that this could happen in year one, two, etc., but you must have those conversations. Everybody bears responsibility from the top, down to the bottom. We all bear it to make sure that we all have equal opportunity.
Adrienne Minerick (Professor and Past Dean) What comes to mind are some Indigenous practices. For example, there are people that worked hard to make a decision, and they likely were operating from a frame of good intentions...then, it gets pointed out that we have this inequity. The tendency is to try and defend the thought process that led to that instant. A department chair makes a lot of hard decisions, and one of those is

when you've got a finite pool of money, you're allocating that to different individuals and trying to decide merit. They can be consciously very good-intentioned about that, but there are subconscious things that fall into the decision. There's an institution that went through and manually set the medium for salaries exactly the same between genders, and then let their processes continue the exact same way that they always had before. It went from being the same to once again having a wide gap. You can manually try to do that repeatedly, but what that tells you is that there is a subconscious difference in value and the messaging that we give to faculty of different genders. A perfect example of that is if you have an individual whose identity places them not in the majority when you hire them into a department, they are well practiced at watching that ecosystem around them and trying to adapt to what's there. It's a constant feedback loop, they're trying to do what they perceive they need to do. What can happen is when there's an assumption of this person would or wouldn't be good at this, then the societal messaging says, "You should really be organizing that social event for all the faculty." We don't assume that your majority individual is good at that, so they don't tend to get asked. When it comes to that merit review, in terms of who's contributed to the climate in that department and the overall productivity, you have one person who has facilitated an activity with collaborations and networking. That's not listed in what we count for our tenure and promotion, so it gets discounted, and we say, "This person published half less paper than this other person," so…

Going back to that defensiveness that happens when this is pointed out to somebody, "No, I had good intentions, I was doing all this", to that point, Indigenous cultures have a healing circle. It varies depending on each of the different communities, but it's a process to really listen to each of those and say, "I see your perspective. I see your hurt. What do we do going forward?" It's to consciously bring into focus those behaviors that cause the diversion so that doesn't repeat.

Meagan Pollock (DEI Consultant)

To reach a place where you're advocating for gender and racial equity or equity for any marginalized group, you must begin to be intentional about those efforts. For a roadmap, consider the Inclusive Leadership Development (https://engineerinclusion.com/ild) model, a continuous loop of recognizing how you situate in the world. You have to look in to understand your positionality. You must look at how you're looking out and understand your lens. Then you need to build the practices of what that looks like so that you're driving the outcomes that give us the equitable and equal outcomes that we want. It's a skill that you can develop. You can't completely advocate for racial and gender equity until you begin to understand the barriers and the sort of systemic oppression that people have faced. That's a skill we can all develop. Ultimately, you're not woke after just reading a book. It's a journey of awakening.

Stephanie Adams (Dean)

The first step to achieving gender and racial equity is to acknowledge that equity does not mean equal. A lot of times people think that equity means equality, and that's not the same. Just because you give someone a resource or tool that they need doesn't mean you have to give everybody else the same thing because everything doesn't need to be equal, it needs to be equitable.

Leaders must set expectations and model the behavior they want to see. And they must bring their team along with them. As a leader, I strive to have my "unit" mirror the context of where it sits. So, when I arrived at UT Dallas I set a goal for our demographics to mirror the state and nation, which meant that we needed to really focus on diversifying our faculty. At the first

school-wide faculty/staff meeting when it came time to recognize new faculty, I shared pictures of our new faculty, (seven foreign nationals including one woman when our student body is approximately 19% women and 22% URM) asking, “What’s wrong with this picture?” It’s not that I objected to the hiring of seven foreign nationals. It’s that this demographic is not reflective of our student body. I essentially let it be known that as the Dean, I did not expect us to ever have another picture that looks like this, saying “I won't tolerate that, so let's set that as an expectation." Then, the next year we hired, and the picture pretty much looked the same. But this past year, we hired 13, and 6 were women, and a few were domestic. In one of our more senior departments, we actually hired three women, a first. I attribute this to the expectation that I set and the leadership team that I have built before their eyes.

When I arrived, all of the associate deans were male with no representation from underrepresented populations. All the assistant deans were male with one woman, and all the department heads were comprised of four men and two women, who were both interim. Now the leadership team looks like the rainbow coalition. When it comes to faculty hiring, I push the department heads to ensure that there is equitable representation from diverse populations in the pool, before they are able to move forward. In some cases, I challenge them when they bring their slate forward to extend offers. In one instance, a department indicated the faculty were leaning toward a certain male candidate, yet it seemed the woman candidate was better. It seemed the faculty preferred the male based on his perceived success as a post-doc, given his citations and grant funding. The more we discussed the two, it became clear that perhaps the male candidate had been leveraging his post-doc advisor’s accomplishment, while the female candidate had experienced success on her own merits. The faculty revisited their thinking, and the offer went to the woman candidate.

To me, this is the epitome of leadership. I'm not the only one that does that, but that's what you must do. You must set expectations, model the behavior you want, hold people accountable, and bring your team along. We're in a year of discussion around diversity and equity as the leadership of the school. I'm not facilitating it, because I'm not an expert. Just because I'm a Black woman doesn't mean I know everything about DEI, so I'm bringing in some experts who can talk to our team and meet them where they are. I think those are the things that leaders have to do.

Jena Asgarpoor (Professor)
I've always said, not only in academia but in the industry also, "A lot of the times people who are productive and they're good at what they do, they move up into leadership positions." The difference is that in industry, those individuals are sent to in-house and external workshops to get training and to become good and inclusive leaders and good managers. But, in academia, I don't see that happening as often. To Stephanie's point, and she's a dean, it's all these department chairs, assistant deans, and associate deans that also should understand DEI, subscribe to it, and internalize it. If there is not a plan of action by leadership to make changes to themselves, then we cannot expect the system to change. That's a key takeaway here from the discussion today.

Storey claims that it is the individual’s responsibility to promote fairness and equality in the workplace, from the top of the ladder to the bottom. She speaks to the initiatives being conducted at the University of Arkansas to address the pay gap between men and women and make sure that their hiring process includes recruiting a diverse pool of applicants. Storey reinforces the

earlier point that conversations are essential to understanding what an institution's problems are and how to address those. Minerick tells how unconscious bias can affect a workplace, using salary as a specific example. Other examples of unconscious bias were mentioned in the literature [5], [7], [12]. Leadership figures can be well-intentioned about salary but continue to give or accept women having lower salaries for no discernable reason. It is in these situations that men's advocacy is crucial for directly addressing the inequities that women face [9]. Minerick calls on some Indigenous practices that could be employed in these situations to allow for individuals to be heard and understood so that unconscious behaviors do not repeat. Pollock provides resources that can be used for leaders to practice inclusivity and brings up a great point that allyship is a constant educational journey that does not stop at any point. As a Dean, Adams knows the importance of modeling the behavior that you want to see in your college. Setting an example for the level of conduct that is expected is the first step, and then holding people accountable for their behavior is the second. Adams has implemented these practices to consciously hire women and those from marginalized groups while making sure that they are hired based on their merits, not just their gender, race, ethnicity, etc. Asgarpoor closes off the question by emphasizing that the promotion of good DEI practices by leadership is essential for the rest of the organization to operate under those guidelines.

Question 5: What organizational characteristics show that an organization is making progress toward gender and racial equity?

Meagan Pollock (DEI Consultant)

Belonging is an outcome of good DEI practices. What often happens with belonging is we say, "Of course, you belong here." There are two different kinds of belonging. There's forced belonging of, "I'm going to be here. I'm going to show up, and I'm going to belong." Then, there's structural belonging. For that, we ask, "How are we changing the environment? How are we changing the way that we operate to facilitate that?"

I was with a client who had surveyed their engineering and technology group, and they were proud that they had a 76% belonging rate and were boasting about it. I get up to give my speech, and I'm like, "I'm worried about the 24%. How do they feel? What's happening to them?" We began to have a conversation about that and helping everyone, whether you're in management or not, to recognize that we all have an opportunity and a responsibility to make sure that we're facilitating belonging for those around us. We can look at the metrics around pay, retention, promotion, and tenure, and as engineers, you could look at data all day, but sometimes that data doesn't really tell the story. We have to listen.

Imagine if we talk to people, hear their stories, and understand what they're experiencing! The key thing is we have to respond to it because so many groups I work with say, "We're doing listening sessions." I'm like, "How are you responding to that?" If we're just doing listening sessions, but there's no evidence of how you'll act on that, it sends a way worse message than you intend because just hearing people or having people talk at you isn't going to lead to change.

When discussing organizational characteristics, it's understanding, "How do people feel in a space? How are we changing the way that we operate? How are we looking at the pools of numbers?" You can quantify much of that, but I always fear that we get too lost in those numbers

and we miss the stories of people. It always has to be "Yes, and." We have to have both kinds of scenarios. Sometimes when we're trying to build consensus is that in the process of that, we center dominance. You must be really careful. At some point, there must be a decision to move forward because if we're trying to make the people from the more privileged group comfortable, then progress isn't going to be made toward equity.
Adrienne Minerick (Professor and Past Dean) An entire organization has an attitude and a mindset. The analogy that I like to use is that each of us, and each organization, has what they put out in front of the stage curtain, and then they have what's behind that curtain. An organization can have the attitude of everything about us is filtered through university marketing and communications to either be on the front of the stage or behind the curtain. If an organization is unwilling to ever address what's behind that curtain, that's a major barrier to whether that organization is on a path toward equity or not. That filter really determines what's going on. That's challenging to assess if say you're a graduate student looking at joining an organization or not. It's dependent on the people that are there. Key individuals in leadership within an institution can change that pattern of whether we're acknowledging what's behind the curtain and we're directly listening to it and willing to address it, or whether we focus only on what we've put out in the front of that stage.
Patrice Storey (Ph.D. Student and Assistant Director of DEI) We need consensus at the beginning to say, "We have a problem." Otherwise, from there, anything that you do with DEI is going to be met with hesitation. Once we develop that consensus, then we can start to seek change. That change comes from reaching out to the external industry leaders or building an internal committee that has a focus on where they want to see change. From an organizational standpoint, change needs to occur from the top down. When faculty, staff, and students can see that your leader is on board, then others are more willing to hopefully be accepting of change as well. Sometimes the bottom-up doesn't always work as fast, but when you can see that your chancellor, provost, deans, and department heads want to see this change take place, it makes for a better situation. Of course, not everyone is going to be on board, and you will be met with resistance, but you have to move forward. We have to be allies and advocates for one another to make that change happen.

Pollock outlines the two different types of belonging: forced and structural. Institutions should be working towards changing structural belonging so that individuals from all backgrounds are incorporated into the work environment. This can be done by evaluating their current practices [5]–[8] to work towards promoting belonging. Pollock reinforces the need for management to have productive listening sessions to understand the concerns of their employees, which is a common opinion among all the panelists. Pollock's most important point is that management must act and make changes. Minerick uses the analogy that every organization operates behind a curtain, and its willingness to make changes in front of the curtain depends on whether the organization is willing to address problems that are present behind the curtain. Storey backs up this point by reinforcing that identifying the problem is the first step toward making change happen. She backs up her previous statement that change needs to happen from the top down, and people are usually more accepting of it that way. Change can still happen from the bottom up, but it takes longer for everyone else to get on board.

Question 6: At what organizational level(s) do you believe change has to occur for gender and racial equity to be realized?

Adrienne Minerick (Professor and Past Dean)

It has to happen at all levels. Many institutions and organizations are in this cycle that is using up time but is counterproductive to moving forward. We have those who are higher up in the organization that tend to be mono-demographic and good-intentioned. They say, "We need to be more inclusive to women of color." So how do we do that? We tap on the shoulder of the women of color in our organization, who are say assistant professors and in this very tenuous spot where their time is so very precious, they really need their time on task. We put them on a committee and say, "Deliberate on this. Give us a report." The report comes back and it outlines, "Here are the different ways this can be accomplished…" And the mono-demographic goes, "That was just this group, but we've got all these faculty constituents that we need to pay attention to, so we better do a survey of the entire institution." Another year goes by, we do this survey and the data comes back and it says, "We've got this 24% of people who don't feel like they belong. How do we deal with that? We better go back and ask our assistant professors to sit down and tell us how to do it."

We're in this constant loop of collecting data and not doing enough. We need to break that cycle and say, "We've got data." Social dynamics do not morph into something entirely different over five years. Even if that data is five years old at your institution, I guarantee the echoes of what was in that five years ago still exist. Use the data, focus on that, and quit taxing your people to try and fix it expecting them to have the perspectives of your lived experience and 30-year career and leadership where you've seen all corners of the institution. When you walk in the door and you've been there two years, you can't tell how to get each of those corners of the institution to work together. Quit expecting them to be subject matter experts on how to do it. We've got to break this data cycle. We have got to move to the how and do it.

Patrice Storey (Ph.D. Student and Assistant Director of DEI)

In the industry, change must start with the CEOs and other high-ranking officials. In universities, it must begin with the president, chancellor, board of trustees, etc. It needs to happen at all levels.

Jena Asgarpoor (Professor)

In almost all cases, if that support for DEI is not backed by higher-ups who drive the culture, then it's going to fail. We need their support so others can see the value in it. The mindset must be developed that unless I commit to it, this will not become an organization that I can belong to. So the change hopefully and gradually will begin.

Meagan Pollock (DEI Consultant)

The answer is accountability. If you're an educator, we know that there's a "hidden curriculum." What you choose not to teach, you're sending a message of, "I'm making a choice not to teach this; therefore it is less important." Those things that we don't talk about, there's an implicit message that says it's not important.

One of the things that are in our ABET standards is inclusive collaboration… it's part of what we're supposed to be doing. We're supposed to be raising engineers who are inclusive collaborators. To what extent are we holding educators accountable for training students to be inclusive collaborators, and how are we helping students to build those skill sets? If we're going to reach it at all levels, it starts with how we're training our students and the accountability connected to it.

Stephanie Adams (Dean)
If gender and racial equity are to be reached, we can't wait for others to lead and make changes. Each of us has to lead and act from where we currently are. Early in my career, a group of Black faculty were meeting with the president of the institution, and the question was raised, would said university ever have a VP for diversity? It came as a total shock to me and others when his response was, "No because diversity is everybody's job and we don't need to have a VP for that." As I was an assistant professor at the time, and I knew better than to say what truly came to my mind, "So is research, finance, academic affairs, and student affairs, but we have VPs for those things. So why couldn't we have one for that?" Instead, I said nothing and thought to myself, "Clearly he's not going to do anything, but I can do things from where I sit."

While this approach may not lead to university-wide change, it did lead to the hiring of our second tenure-track Black faculty. So, if your leader is not enlightened don't fret, instead, lead from where you are and you might just make a ripple. Your sandbox may not be as wide as some others, but you can seek to expand the bounds of your sandbox, and who knows it might just spill over into somebody else's sandbox. You can't sit and wait for somebody to take action, just lead from where you are.

Minerick adds to the ongoing conversation about the need for change to occur at all levels of an organization. She backs up a finding in the literature, which is that women (especially women of color) are often asked to serve on committees about diversity and inclusion, taking up their time when alternatively, they could be working on projects that are considered in the merits for tenure and promotion [7]–[9], [12], [14]. She says that institutions are in a cycle of collecting data and not using it to make changes, which sets a bad precedent for trying to make future changes. Storey says that change must be made at all levels of an organization, whether it be industry or higher education. Asgarpoor mentions that if DEI is not supported at the top levels of an organization, it will fail. This goes back to Adams' previous answer about how leaders must model the behavior they want to see and hold people accountable. Pollock approaches this question from the perspective of an educator, saying that educators are responsible for teaching students how to be inclusive collaborators. Choosing not to teach those valuable skills can send the wrong message that those skills are not important. Adams closes off the question by saying that if the senior management is not making changes fast enough, as individuals we cannot wait around for them to catch up. She says we must use the voice and resources that we have where we are now to promote equity and change.

The main takeaways from the panel are the following:

- Faculty need to address their unconscious and conscious biases.
- The K-12 education system needs to be changed to support and encourage girls that they have the capabilities to pursue an engineering career, whether that be in industry or academia.
    - Interest is not a root cause. It is a symptom of layers upon layers of messaging around who is assumed good and who innately belong in STEM.
- For men to be better allies and advocates for women, they must recognize their privilege, have open and honest conversations, and show empathy and compassion towards women.

- For organizations to make progress toward racial and gender equity, they must recognize that there is a problem, listen to their employees, and most importantly, make changes that move away from a system designed by White men, for the benefit and success of White men.
    - Surveying the population and only listening to the majority is a systematic way to continue to be responsive only to the majority population. Deliberate amplification of minoritized perspective is essential to achieve equity.
- All individuals bear the responsibility to be advocates for gender and racial equity in the workplace. Expectations need to be set forth by leadership, but the individual can act regardless of rank.
    - Recognize that minoritized individuals experience more repercussions and more negative outcomes when they speak up and act.

Discussion

As anticipated, there were many similar themes between the literature review and panel, and this is visually represented in a Venn diagram in Figure 1. We acknowledge that Figure 1 is not an exhaustive list of all the ideas presented in the literature review and panel discussion. We also recognize that some ideas mentioned in the panel are represented in existing literature, but those ideas were not found specifically in the engineering literature. The most significant issue identified is the underrepresentation of women and women of color in engineering [3]–[11], [21]. Pollock emphasizes that interest is not a root cause of this; it is an outcome. From the beginning of their education, young girls do not receive the same support that boys do to pursue engineering and receive discouraging messaging, and this lowers girls' confidence in their abilities. Girls and those from marginalized groups should be given the same messaging, support, encouragement, and opportunities to pursue engineering careers as boys and those who are from majority identities [3], [19], and we must also remove barriers that are preventing them from succeeding. Storey discusses how the promotion of STEM and engineering camps encourages girls to earnestly consider engineering as a career path.

For those women who do pursue engineering and stay in academia, as young faculty they are often assigned more teaching and service roles, often while they are on a tenure-track path and their time is very valuable [7]–[9], [12], [14]. Minerick gives the example of women of color assistant professors being asked to serve on a diversity committee, which is also evidenced in the literature [6], [8], [10], [11]. Even though these women are dedicating extra time to help their students, these activities are not considered for tenure and promotion. Leaders should re-evaluate the merits that are considered for tenure and promotion to include the efforts put in by women to excel in teaching and be an advocate and mentors for student and their demographic. While doing this they should also look at the tenure system structure and critically evaluate how it affects women who are or aspire to be mothers or caregivers. There is a need for more family-conscious policies for parents, such as “stopping the tenure clock” and allotting sufficient time for maternity/paternity leave [3], [5], [6], [9], [13], [14], [19]. With this, expectations should not be higher with a longer timeline than anticipated. Women should be allowed to utilize those resources without facing scrutiny, judgment, and/or harsher merit reviews due to higher

expectations because of an expanded timeline. Men, especially men supervisors, should be understanding and empathetic to women's issues [9]. One of the ways they can do this is by understanding the extra responsibilities women have if they are mothers and/or caregivers for their loved ones. As Adams points out, men must recognize that they have a certain amount of privilege, and then have conversations (which can be difficult) to determine how they can best support their women coworkers.

Unconscious bias can permeate a workplace and unknowingly negatively affect the culture [5], [7], [12]. Women are often excluded from informal networks centered around men. This leads them to feel further ostracized in environments where they are already outnumbered [7], [9], [14]. Women of color are subject to specific discrimination and bias and often isolated as they may be the only person of their identity in their department [6], [8], [10], [11], [16]. Hiring committees should look to increase diversity while avoiding tokenism [11], [18]. Pollock said that for organizations to make progress towards gender and racial equity, they must recognize that there is a problem, then they can identify the source of the problem through root cause analysis. The most important step is for organizations to make changes once problems have been identified.

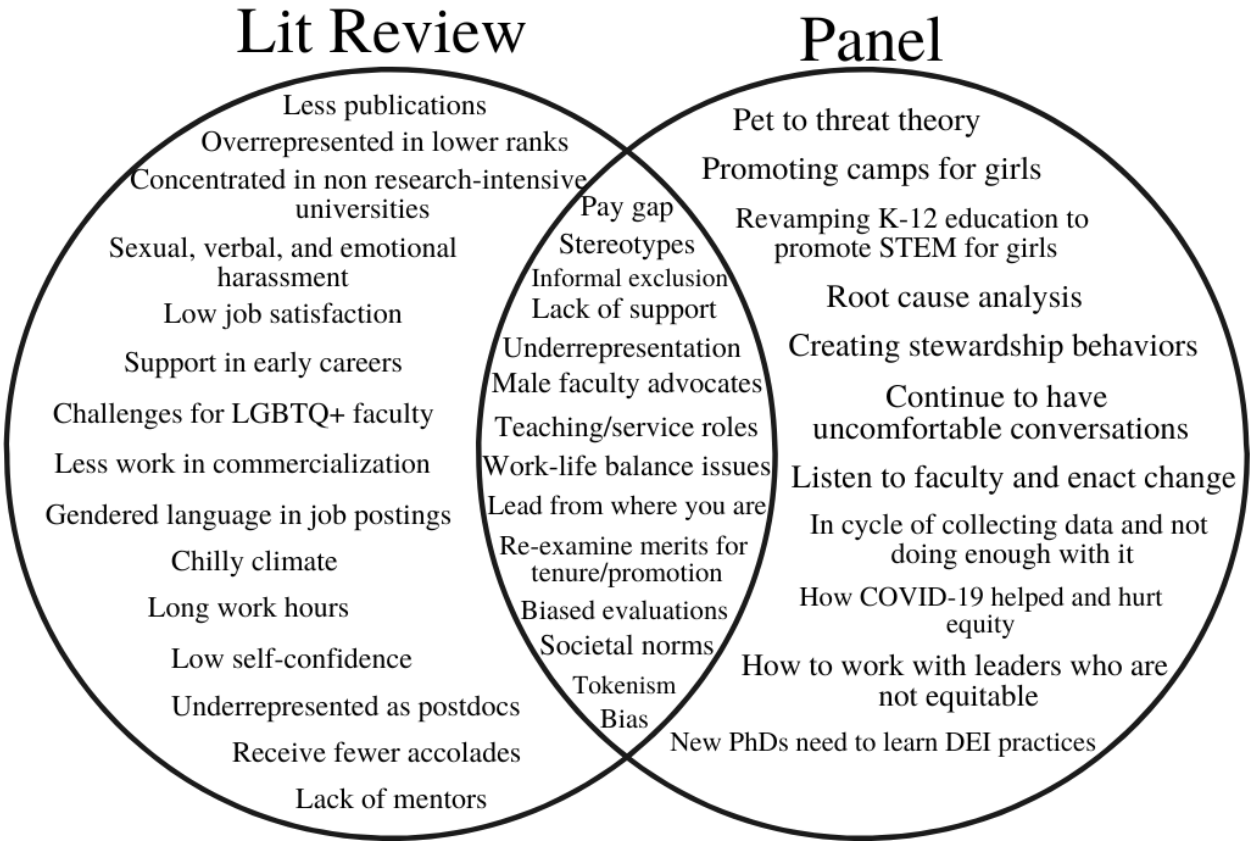

Figure 1. Venn diagram detailing the ideas presented in the literature review and panel.

When looking at the themes that occurred in only the literature review or the panel discussion, context is key. The panelists were asked specific questions and were only allotted a certain amount of time to answer. An hour of conversation cannot fully grasp the extent of one's academic career. The panel brought forth the unique perspective of a DEI consultant, which would not have been considered for the literature review that only focused on the perspectives of women in engineering in academia. The literature review is unique in that it elicited a specific subset of literature based on select keywords. If broader language had been used and more papers were reviewed, we would find more literature that aligns with the themes that were only mentioned in the panel.

Conclusion

This study was conducted to provide a platform for promoting gender equity for women in engineering in academia, who have historically been underrepresented in this field. A structured literature review was conducted to focus on the disparities that exist for women and how institutions can overcome those. Specific keywords were used to elicit relevant literature from databases. For the literature review, this study exclusively used 18 papers that were focused on engineering and computer science. Future work will use the literature that was not utilized to examine the disparities for women in STEM and other areas of academia. The results from the literature review were compared to a panel on gender and racial equity that included subject matter experts and stakeholders which consisted of faculty, administrators, a graduate student, and a DEI expert. The findings revealed many similarities between the literature review and the panel, which signifies the importance of the issues presented. Suggestions are given as to how institutions can implement good DEI practices to promote gender equity. Additional research could focus on the disparities that affect LGBTQ+ engineering faculty and their experiences.

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