



Pathways to equity for academic women in science: Research-based strategies for institutional transformation toward gender equity

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ABSTRACT

Women have been persistently underrepresented in science, engineering and mathematics disciplines in academic institutions, in both the United States and Brazil. Approaches that intend to solve this problem by “fixing women”—steering women to be more like men—have been unsuccessful in resolving underrepresentation, as well as biased in assuming that men’s careers are optimal models for women to adopt. We describe research findings from the US and European institutions of higher education that demonstrate systems-focused approaches to gender equity, especially approaches that seek to change structures and cultures that perpetuate barriers to women’s success and advancement in academic science. These approaches become strategic when they are selected based on data about the local situation and when they are strategically combined to push on multiple levers of change at multiple levels of the organization.

Keywords women in science, institutional change, bias, equity

INTRODUCTION

Universities should guide our society in providing knowledge to address challenges, preparing students to be engaged citizens, and offering opportunities to all for a better life. To do so, institutions of higher education must offer diverse, inclusive, and equitable environments. Research shows that diverse workplaces are also more successful workplaces: more productive, innovative, and open-minded. In higher education, diverse and inclusive institutions provide opportunities for women to thrive and serve as role models for others. In short, diversity is inextricably tied to excellence.

Our research team has studied US universities that undertook systemic change efforts to advance gender equity, especially in the STEM (science, technology, engineering, mathematics)

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fields. This paper summarize work done together with our colleague Ann E. Austin, with the goal to identify strategies for creating environments that welcome and support the full range of talent in society, attending in particular to women in STEM fields. From this research, we describe a set of twelve strategies that are powerful interventions for tackling inequities in academe, especially when they are combined into a comprehensive plan for organizational change.

Other papers in this special issue address different milestones on the long and winding pathway that precedes women taking up an academic position. These milestones may include girls' experiences in the family or in primary school, where girls learn and develop interest in science, and girls' pursuit of science and mathematics studies in secondary and tertiary education. It is important to understand these issues and develop evidence-based approaches to encourage girls' and young women's interest, curiosity, skill-building, and career exploration in science, mathematics and technology at all stages. It is also important to understand the formative experiences and career paths of women who pursue STEM education and then take careers outside academe, as well as those who leave STEM for other fields. This paper focuses on a later stage along the path: academic workplaces and the experiences of STEM women in academic careers.

2

Our goal here is to share what we have learned about institutional approaches to support STEM women in higher education, rather than individual outcomes. We offer examples from the US experience of transforming institutions using a systems-focused approach to gender equity, and from institutions in countries connected to the European Union. While we offer some comparisons and comments relevant to the Brazilian experience, we cannot presume to know what needs are greatest and what interventions will resonate with Brazilian academic women in STEM and their allies. We do hope that these examples may inspire others to take a systems-focused perspective—to identify the problems within organizations that impede girls and women in science, and to pursue organizational approaches to assisting them.

1. Overview of the Problem and the Systems Approach

In this section we summarize evidence about the extent of women's underrepresentation, the reasons for it, and the system-focused approach taken by institutions supported by the ADVANCE program in the United States.



1.1. The problem of women's underrepresentation

Numerically, the situations of women in academic STEM in Brazil and the US are quite similar. US government data document a myriad of ways that women are underrepresented in STEM fields (NCSES, 2023; NSB, 2023). In the US, women hold 41% of doctoral-level science and engineering jobs in universities, comparable to 44% in Brazil (IFSP, 2023). In both countries, these proportions continue to grow, even as masters and doctoral degrees earned by women lag well behind undergraduate degrees earned by women. Moreover, these proportions differ notably by discipline: women earn half of doctoral degrees in agricultural and biological sciences, but only a quarter of those in the physical and Earth sciences, mathematics and computer science. These disciplinary differences are quite similar to that in Brazil (DE NEGRI, 2019).

In US higher education, women pursue academic positions in proportions well below their representation as doctoral degree earners, and varying with race and ethnicity. STEM women leave the academy at higher rates than men, and at higher rates than their non-STEM faculty peers. Women are underrepresented as leaders, with fewer holding roles such as heads of departments, deans, provosts and presidents, but they are overrepresented in part-time and lower-prestige positions (NCSES, 2023b), and in lower-prestige institutions. Likewise, in Brazil, women make up only 24 percent of recipients of a Brazilian government grant awarded to the most productive scientists in the country and only 14% of membership in the Brazilian Academy of Sciences (REDAÇÃO GALILEU, 2018; DE NEGRI, 2019; MONNERAT, 2017)—even though Brazilian women as a group produce more papers than men (LARIVIÈRE, et al., 2013).

Women's low representation in academic STEM jobs means that some talent in the population goes untapped, and we cannot draw on the full range of human ideas, creativity and diligence that can help to address major societal problems such as hunger, climate change, and environmental degradation. Moreover, too few women are visible as role models of excellence in research and discovery, or available to students as teachers, mentors or role models. Too few are present to inspire younger women in their classrooms and labs, to educate men to value women as thinkers and collaborators, and to help shift the masculine cultures of STEM fields. Thus women's exclusion from STEM fields now also affects women's prospects for success in STEM later.



1.2. Impediments to women's advancement

Scholars have documented many impediments to STEM women's advancement in STEM fields, and in the academy more generally. Importantly, there is no single cause and thus there is no magic bullet; women's underrepresentation is a multi-factorial problem and addressing it requires multiple strategies. Three main issues characterize the literature about the causes for women's underrepresentation:

- Masculinized workplace cultures and climates
- Bias in evaluation
- Work-life conflict and inflexibility.

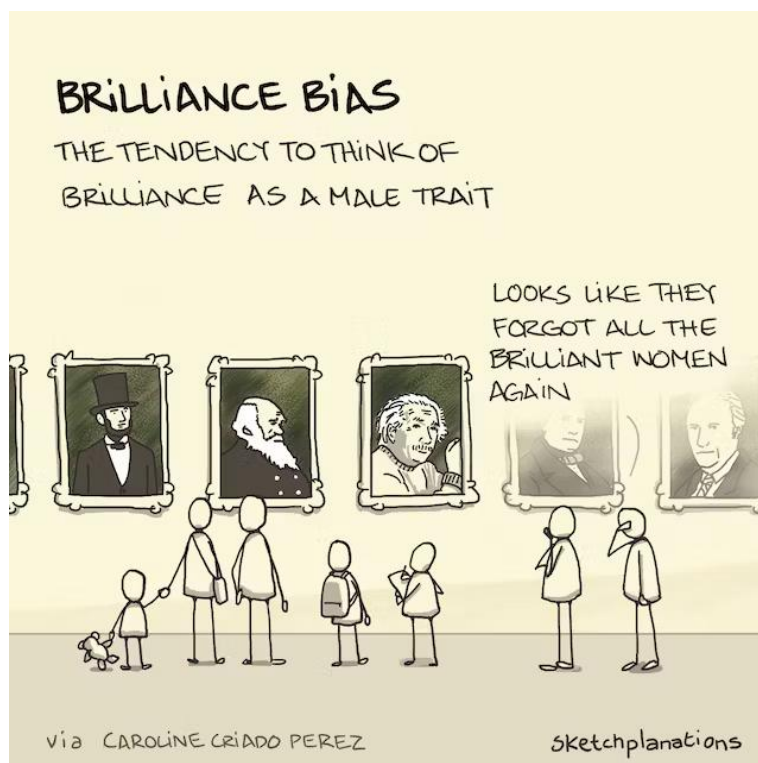
These issues in turn can lead to other challenges for women, such as experiencing inadequate resources for professional success, and feelings of self-doubt and loss of confidence.

The long history of male domination in STEM fields has resulted in masculinized cultures, including sexual harassment, patterns of deliberate exclusion and discrimination based on explicit bias, and less conscious habits of interacting that are gendered (and racialized, heterosexist, ableist, etc.). Sexual harassment includes unwanted sexual attention, coercion and assault, but also smaller, more insidious microaggressions. The U.S. National Academies of Science (NASEM, 2018) lists many kinds of harassment documented in various studies: subtle exclusion from information or collaboration networks; sabotage of equipment; hostility, name-calling and obscene gestures; and actions that sexualize the work environment, such as remarks about bodies or pressure for dates. In different studies, 20% to 50% of women report harassment at work.

Implicit biases are “implicit” because they are internal and unrecognized, caused by exposure to attitudes and ideas about gender that are common in our families, schools, and communities. Virginia Valian (1999) describes how common cultural “schemas,” or stereotypes, for how women should be—nurturing, sociable, driven by feelings and relationships—conflict with notions of what scientists and engineers are like or should be: analytical, authoritative, driven by evidence or logic. When we apply these schemas inappropriately to individuals, we unfairly interpret identical behaviors of people of different genders (Figure 1). For example, a man who speaks forcefully is “decisive” but a woman who does so is “bossy” or “shrill;” a woman who leaves work to pick up her child is “uncommitted” to her career but a man who does so is



commended for being an “involved father;” teachers who are men are described as “brilliant” while women teachers are penalized for not being “caring” or “motherly” enough. These biases are held by women as well as men, and we absorb them from our families, schooling, media, and life in broader society.



5

Figure 1: Brilliance bias, Sketchplanations. <https://sketchplanations.com/brilliance-bias> . License CC BY-NC 4.0 DEED.

In academe, unconscious biases easily creep into evaluation at all stages: review of papers, talks and grant proposals; job and fellowship applications; high-stakes evaluations for advancement and promotion; selection for leadership roles. Large-scale studies show that patterns persist across disciplines, even in those with higher numbers of women, and are best explained not by explicit discrimination by a few people but by implicit biases of many.

Work-life conflicts are particularly significant for women because of their biological and societal roles in bearing and rearing children and in caring for family members of all ages. Many studies have shown that mothers are penalized in the workplace, relative to both men who are parents and to women who are not parents (MASON, WOLFINGER & GOULDEN, 2013). Academic women often delay having children so that they can achieve certain career milestones,



such as completing a doctoral degree, securing an academic position, or receiving tenure. Having children at an older age may mean academic women are more likely to face infertility or to combine caring for young children as well as for aging relatives. While family roles and pursuits outside work are also important to many men, the fact remains that women spend more time on home and family duties, and have less time for discretionary pursuits such as hobbies, exercise and volunteer work.

The impact of any one such event or experience on a woman's career may be small or even unnoticed, but together these disadvantages compound over time and lead to significant inequalities. A modeling study showed how a small bias in performance evaluation, applied repeatedly—just 1% favoring men over women—yields an organization that has 2/3 men at the top level (MARTELL, LANE & EMRICH, 1996). Not only do they accumulate over time; some of these barriers can heighten the impact of others. For example, biased evaluation of a woman's scholarship may reduce her ability to do research and support students and staff, in turn reducing her productivity. If family roles take her away from work when informal after-hours socializing occurs, she may be excluded from decision-making or collaborations. The barrage of small inequities can harm her confidence and self-esteem, and lead to self-blame. Here we cite just a few key references to highlight both the long history of research on STEM women's exclusion, and the recent work that shows these problems are ongoing in academe. For more depth, see the overview in our book (LAURSEN & AUSTIN, 2020) and several chapters by Stewart and Valian (2018).

These challenges are compounded for women from other groups who have been historically excluded and oppressed in the US: women of color, including African Americans, Asian Americans, and Latinas/Latinos, Indigenous people, and those who identify as disabled, lesbian, bisexual, or transgender. Academics who hold more than one of these identities face additional, non-additive barriers. For example, Black women experience a “double bind” (MALCOM & MALCOM, 2011) of discrimination by both race and sex. In the US, Kimberlé Crenshaw (2009) and other Black feminist scholars developed the concept of intersectionality to articulate how race and sex interact, recognizing that women's experiences of privilege or marginalization within social systems (legal, academic, and otherwise) will depend on their intersecting multiple identities. Since then, many scholars have broadened and developed intersectionality theory (CHO, CRENSHAW & MCCALL, 2013) to understand and represent the experiences of diverse women,



yet practical implementation of intersectional approaches to equity in institutions lags well behind the theory (ARMSTRONG & JOVANOVIĆ, 2015). Nonetheless, some strategies described in this paper may apply beyond the dimension of gender and may help to advance equity among other groups in academic institutions, including women and men from historically marginalized groups.

Brazil shares with the US national histories of colonization and enslavement, as well as subjugation of women. Brazilians' experiences likewise reflect the grim consequences of that history, including persistent social inequalities in education, income, and economic mobility. Thus, we suggest, some of the strategies developed in the US may be adaptable to advancing equity in the Brazilian context.

1.3. Systemic approaches to change

Changing the representation of women and people of color to create more inclusive, diverse, and equitable academic environments, is a systems problem, deeply rooted in organizational cultures, human thinking and personal habits. It must be addressed with a systems approach—by analyzing in nuanced ways what is happening, considering what parts of the organization need to change, and identifying a set of change strategies that act on multiple levers for change and work together to respond to the specific ways the issue manifests in specific contexts.

Past efforts in the US have sought to remedy the impacts of women's exclusion by providing individual women with resources such as grant funding and professional development. While these efforts were well intended, they did not lead to large-scale change in women's participation in academic science. In 2000, the US National Science Foundation (NSF) launched a new effort, called ADVANCE, that took a new tack on this persistent issue (NSF, n.d.). The program sought to increase the representation and advancement of women in academic science and engineering careers, thus fostering a more diverse STEM workforce. ADVANCE was innovative in seeking to “fix the system” instead of “fixing the women”—that is, in addressing organizational causes of inequity instead of remediating individual outcomes.

Since 2001, the US NSF has invested over \$315M USD to support ADVANCE projects at over 170 institutions of higher learning and STEM nonprofit organizations. Of special focus here are the strategies developed by universities who were awarded one of about 70 large (\$3.5M USD),



five-year Institutional Transformation (IT) awards. Many of the strategies they developed have been adapted by other institutions. Details of the ADVANCE program and its evolution can be found in an analysis of NSF's calls for proposals by Laursen and De Welde (2019), and in historical overviews by DeAro, Bird and Ryan (2019) and by Rosser and Laursen (2022).

1.4. Sources for evidence

We offer here a summary of prior research that is reported in full in our book (LAURSEN & AUSTIN, 2020) and prior publications (LAURSEN & AUSTIN, 2014, 2018; LAURSEN, AUSTIN, SOTO & MARTINEZ, 2015). Our methods and data sources are detailed in the book (LAURSEN & AUSTIN, 2020). Briefly, we studied documents and gathered interview data from project leaders at institutions who were funded in the first two rounds of ADVANCE IT awards. We conducted extensive interviews at site visits to five of them. In subsequent efforts, we gathered documents and interviewed leaders of projects funded in rounds 3-9. All these materials were carefully analyzed to identify common change strategies and the factors that helped or hindered these strategies. Ongoing research continues to enrich our data and understandings.

Laursen derived additional insight into institutional gender equity work as an advisor to the TARGET project, Taking a Reflexive Approach to Gender Equality for Institutional Transformation (<http://www.gendertarget.eu/about/>; 2018-2022). Teams from seven research organizations, in countries associated with the European Union (EU) and located in the Mediterranean region, developed and implemented Gender Equality Plans (GEPs), which are “a set of commitments and actions that aim to promote gender equality² in an organisation [sic] through a process of structural change” (EIGE, 2023). Because GEPs are mandatory for organizations that apply for research and innovation funding from the EU's scientific funding initiative, Horizon Europe, they are a tool for ensuring that research organizations attend to gender equity. Three TARGET project members were research-funding organizations, three were research-

² The TARGET project, and other European organizations use the term ‘gender equality’ rather than gender equity, and we use this term in discussing the TARGET project. In US usage, the term ‘equity’ highlights that fairness is not just treating people the same, but taking into account the differing initial conditions of different groups, such as prior access to education and resources. Because this concept is also acknowledged in European definitions of equality, we treat this as a difference in terminology rather than in concept.



performing organizations, and one was a network of universities, and they were supported by international partners who were experienced in developing and implementing GEPs. Project leaders report their experiences in a 2022 book (WROBLEWSKI & PALMÉN, 2022).

2. Strategies for institutional change: Models from the US ADVANCE experience

Based on our research, we describe twelve strategies that institutions of higher education can use in working to make faculty experiences and outcomes more equitable. With our collaborators, we identified these strategies in our research study of institutions that received five-year Institutional Transformation (IT) awards from the US National Science Foundation's ADVANCE program. Our team examined the specific programs that ADVANCE teams developed to address gender inequity on their campuses, asking which strategies were successful for them (or not), and for what reasons. We wanted to learn how each team's strategic choices reflected the particular situation of their institution. Indeed, institutional context affects both the problem and the solution, influencing what particular inequities are evident from the numbers, demographics, and experiences of scholars, but also which interventions may work best in that setting. Readers will find much more detail about the rationale, design, implementation and evaluation of these strategies, along with numerous examples, in our book and online toolkit (LAURSEN & AUSTIN, 2014, 2020).



<i>Strategies that shift institutions' practices toward equity</i>	<i>Strategies that provide institutional support for individuals</i>
<i>Interrupt Biased Processes</i> Inclusive recruitment & hiring Equitable processes of tenure & promotion Stronger accountability structures	<i>Support the Whole Person</i> Support for dual-career couples Flexible work arrangements Practical family-friendly accommodations
<i>Reboot Workplaces</i> Development of institutional leaders Improving departmental climate Enhanced visibility for women & gender issues	<i>Foster Individual Success</i> Faculty professional development Grants to individual faculty Mentoring & networking activities

Figure 2: Institutional change strategies that support gender equity.

10

2.1. Strategies that provide institutional support for individuals

Figure 2 lists the twelve types of strategies that our study identified. We begin by describing the six types of strategies listed on the right—strategies that provide institutional support for individuals—because these are often easier places to start. These strategies address issues that shape academics' lives and have disproportionate effects on women's success and advancement, and thus can improve individuals' quality of life. Moreover, as program leaders interact with women, they will learn more about what issues are important and can develop ideas and allies for further action. However, these strategies mainly support individual women to meet challenges—they do not alter the system itself. Thus they are insufficient alone in changing deep-seated ways of working within university systems, and they should be used in combination with other approaches that address institutional structures and cultures.

2.1.1. Supporting the whole person

Strategies to support the whole person seek to help people harmonize their personal and professional lives, especially when these come into conflict. Because women are more likely to



hold care-giving roles, work-life conflicts are more common and impactful for women as a group. The timing of high-stakes academic career decisions—securing an academic position and gaining promotion, after many years of doctoral and postdoctoral education—may conflict with women's decisions about whether and when to have children. The three strategies in this group recognize that academics are not just workers, but people who have meaningful lives outside work, with changing needs and circumstances over the lifespan. Over the long term, academic employees are more productive and fulfilled when work-life conflict is reduced. Academic institutions that respond to these needs succeed in retaining staff and benefiting from their contributions to education, scholarship, and intellectual life.

Support for dual-career couples includes strategies that recognize that academic women are more likely than men to be partnered with an academic spouse. Women are also more likely consider their partner's career prospects in family decisions about where to live. Thus, institutions can attract and retain women professors by addressing the needs of dual-career couples. Some institutions have formalized pathways toward academic jobs for the partners of women whom they wish to hire, when those partners are also academics. For example, if the chemistry department wants to hire a woman whose spouse happens to be a Ph.D. physicist, dual-career policies spell out how the woman can indicate her interest in an academic job for her qualified spouse, how the chemistry department can approach the physics department to ask if an appropriate position can be created for the partner, and how the position can be funded if the partner is also hired. Other institutions developed resources to help non-academic partners build their networks and find appropriate work.

Flexible work arrangements are strategies based on the recognition that work-life challenges can arise at different points in faculty careers, following both happy and sad events such as childbirth or adoption, family members' illness or death, or the changing needs of children or elders. Here academics benefit from flexibility, and institutions benefit too when they can retain valued workers and enable academic units to plan how they will meet their teaching and service commitments. For example, "modified duties" policies allow academics to negotiate a change in their job description to provide flexibility while they respond to a personal or family crisis. Because the U.S. is one of very few countries worldwide that does not offer a national, paid family leave



(MILLER, 2021), flexible work arrangements are important but irregular in U.S. workplaces, including universities.

Practical family-friendly accommodations often pair with flexible work arrangements by offering practical support to ease work-life challenges in the short term. Examples of this strategy, seen in our research study, include childcare centers on the campus; arrangements with local childcare providers to reduce cost and increase access to childcare; lactation spaces where someone can pump or feed a nursing baby; and reserved parking spaces for pregnant people. Many institutions also organized resources and information about existing work-life supports such as family leave, disability leave, and financial support during life transitions.

2.1.2. Fostering individual success

Strategies to foster individual success offer chances to develop new skills, build collaborations, and connect with mentors and peers. These strategies must not be viewed as remediating women's deficits but rather as replacing opportunities from which women have been barred by biased selection procedures or closed social circles. These three types of strategies are practical because they support women in the present, even as slower, systemic change strategies are underway, such as changing policies, altering evaluation processes, or shifting mindsets.

Faculty professional development strategies offer knowledge and skills in areas of academic work needed for career success, or provide time and frameworks to reflect about personal career goals and plan how to achieve them. Events that gather groups of women also offer opportunities to connect with others and build supportive networks, through workshops, learning communities, reading groups, fellowships, or lunches. Faculty development may target people at specific career stages, such as early-career scholars, or those pursuing a mid-career change of direction. Individual women benefit as they develop new skills and capacities, and institutions benefit when women become strong and confident leaders.

Grants to individuals offer resources to enhance women's scholarly credentials, accomplishments, and networks. Some programs target early-career scholars as they begin their research programs; others support mid-career faculty to take on a new, perhaps risky line of research or to resume scholarship after taking time for institutional service or work-life challenges.



Some grant programs encourage collaboration with an outside senior scholar or foster new on-campus collaborations, in turn building mentoring relationships and attracting external funding.

Mentoring and networking strategies seek to bolster women's professional networks and sense of community within the university. These strategies may especially assist women who are one of very few in their department or who have experienced exclusion from informal networks where they could gain inside information and socialization into the profession. Our research identified a variety of purposes and designs: targeting faculty in different career stages, gathering people around a visiting speaker or topic of common interest, or recruiting subgroups with specific interests and needs, such as mothers, women department heads, women of color, or people seeking peer support for their academic writing. Some programs offered formal one-to-one mentoring through mentoring groups and others used informal peer-to-peer approaches.

As a group, the six strategies shown on the right side of Figure 2 emphasize approaches that require institutional action to address women's diverse needs and circumstances. They seek to mitigate challenges that fall disproportionately on women and to enable women academics to thrive. To be effective they must be coupled with deeper-diving change strategies that address bias in evaluating faculty and alter workplace cultures, such as those listed at left in Figure 2.

13

2.2. Strategies that shift institutions' practices toward equity

Here we focus on the left side of Figure 2, which shows two sets of strategies to address institutional structures and cultures that are differentially harmful to women. By 'structures,' we mean organizing features of the institution; the policies, procedures, roles, and workflows that determine how decisions are made. By 'cultures,' we mean sets of formal and informal norms, values, and conventions that together shape how people behave and interact, and communicate what is valued, expected or disapproved. Workplace cultures may vary across units, and it should not be assumed that any institution has a single, universal culture.

2.2.1. Interrupting biased processes

This subgroup of strategies seeks to alter institutional structures where embedded implicit bias affects decision-making, especially evaluation of scholars' performance. Academics are



evaluated throughout a career, when they are hired, promoted, selected for leadership training and roles; and recognized for awards, pay raises, and prestigious appointments. Our research identified three main types of strategies that institutions used to disrupt bias processes of evaluation.

Strategies for inclusive recruitment and hiring focus on the processes by which people enter the academy. Some institutions developed ways to broaden the pool of those who apply for academic positions, through tactics such as deliberate, intensive outreach to develop an applicant pool that reflects (at least) the diversity of people who have earned suitable advanced degrees. Writing a less narrow job description is another way to broaden applicant pools, helping potential applicants to see different ways they may fit the description rather than ruling themselves out a priori.

Many institutions also worked to combat bias in evaluating applicants, especially by educating search committee members and other decision-makers about implicit bias and its research basis, and by giving them strategies to catch and counter it in themselves and others. When it is carefully designed and based on scholarly research, such training can have notable impact on search committee attitudes, behaviors, and search outcomes. Rubrics or criteria for evaluating scholarly and teaching qualifications, prepared before advertising the position, can help committees fairly evaluate candidates against a common set of standards. Some institutions paired these tactics with procedures that held search committees accountable, such as giving the department administrator oversight of interview lists. Others motivated success by providing funds for an "extra" candidate to interview if that candidate would enhance the department's diversity. Overall, these interventions aim to diversify the faculty by recruiting and hiring excellent people who will thrive professionally and help to fulfill the institution's mission.

Strategies to assure equitable processes of tenure and promotion included approaches to educate review committees and institutional leaders about implicit bias, so that they could recognize it and reduce its impact on their decision-making. Other institutions worked to increase the transparency and consistency of how advancement processes worked across colleges and departments, through mechanisms such as standardizing guidelines and formalizing review processes. Some provided training to department leaders so they could better support and evaluate their faculty for advancement. Some held information sessions to demystify advancement processes or offered career coaching to mid-career scholars about advancing to full professor. Still



others initiated ombuds roles to ensure that these reviews were conducted following the new procedures. In general, these strategies aim to enhance retention and success of diverse faculty members.

Strategies to strengthen accountability structures reinforce the previous strategies by ensuring that these evaluation processes are faithfully followed and do not lapse over time. Some institutions allowed an administrator to stop a search if there was insufficient evidence that the committee had worked to diversify the pool and evaluate applicants equitably. Others designated someone to both oversee and support departmental diversity and inclusion efforts. For example, a designated "equity advisor" or "faculty excellence advocate" might provide professional development, mentoring, and advice to individual faculty; carry out implicit bias training and advise searches; and compile data to monitor progress on diversity and inclusion goals. Indeed, gathering, sharing, and using data is itself a powerful accountability strategy, making everyone more aware of how their unit was measuring up and focusing work where more progress was needed.

15

2.2.2. Rebooting workplaces

These strategies aim to improve workplace cultures, especially in the departments or colleges where academics spend most of their time and interact with colleagues. Everyday work experiences influence job satisfaction, productivity, and performance, and ultimately scholars' decisions to stay at the institution or leave for greener pastures. While women often report more negative experiences of the workplace climate, more supportive workplace climates have a positive effect on people of all genders. Our research team noticed a variety of strategies that institutions used to enhance work environments, again categorized in three groups.

Strategies for developing institutional leaders acknowledge that leaders have great influence on the workplaces they lead. They control resources, set priorities and tone, and model collegial interactions; some are role models for others. When leaders are alert to the ways institutions can marginalize women, and when they know ways to proactively combat these, they can improve working conditions and enhance their colleagues' satisfaction and success. Thus, many institutions sought to better prepare people in formal leadership positions for their roles. Some



offered new department heads orientations or workshops, to augment these leaders' capacities and to increase their sense of agency and commitment about improving working conditions and equity in their own units. Other programs tried to interest and prepare women for leadership roles. Using workshops, seminars, leadership institutes, or networking events, these programs aimed to increase women's skills, foster connections among current and emerging leaders, and guide women to assess their own potential and interest in formal leadership positions.

Strategies to improve departmental climate were intended to improve the interactions and culture of departments. Some programs invited departments to propose a plan of action and compete for small grants to implement their ideas. Other programs used social science methods, such as surveys and focus groups, to identify members' strengths and concerns about their department's climate, then provided guidance and support to help the department members address particular challenges that were identified in the assessment. And in other examples, departments gained access to extra resources and opportunities when they pursued training and a plan for self-improvement.

Strategies to enhance women's visibility had the goal to highlight women's accomplishments and to educate the university community about ways in which women have historically been excluded. By raising women's visibility as scholars and leaders, new stories take hold about whose work is valued and respected. And these stories may inspire others, debunk stereotypes, and encourage others to challenge injustice. These strategies included symposia, films, guest speakers, celebrations, awards, and publicity campaigns. Some campuses invited distinguished scholars who could highlight women's achievements, discuss scholarship about gender, and interact with students and young scholars, all with the goal to celebrate women's scientific achievements and normalize participation in the academy by people of all genders.

We emphasize again that these strategies are not alone sufficient to change systems. Each type of strategy addresses a different part of the problem within institutions, or operates at a different level of the institution—so they must be combined into a comprehensive change portfolio in order to be effective (LAURSEN & AUSTIN, 2020). It is important to gather institutional data and study the issues, before choosing a set of interventions and adapting it to the local context, institutional culture, and specific needs. In addition, ADVANCE initiatives have been rightfully criticized for centering the experiences of white women and not attending to the identities, needs



and impacts of institutional systems on women of color and others with multiply marginalized identities (ARMSTRONG & JOVANOVIĆ, 2015; JACKSON & MACK, 2022). It is important to learn about these issues and to include the voices of diverse women in the leadership, planning and design of organizational initiatives to advance equity.

3. Multi-national Models from TARGET

We offer examples from the TARGET project to highlight how the general approach of systems change and the types of strategies documented in the US have been successful in other national contexts, including diverse countries on all sides of the Mediterranean Sea. TARGET project teams began their work on Gender Equality Plans by conducting a gender audit. Each collected data about the numbers and experiences of women and men employees at each level of the organization, the presence of women in leadership roles, and the policies that governed workplace processes such as evaluation for hiring, promotion, and salary increases, family leave, workplace climate, professional ethics, and more. Sometimes the absence of data was itself revealing about how gender was perceived or invisible within the organization. These data were used to interrogate the current situation, identify problems and assets, and develop goals for moving gender equality within the organization along three dimensions:

1. achieving gender balance in all fields and decision-making
2. abolishing structural barriers to women's careers,
3. integrating gender into research content and teaching.

These three dimensions are sometimes referred to as “fixing the numbers,” “fixing the institutions,” and “fixing the knowledge (SCHIEBINGER, et al., 2011-20)—all importantly contrasted with older strategies of “fixing the women” to make them more like men.

Examples of actions taken by individual organizations to implement their GEP reflect different ways to make progress on these goals. After data revealed a shortage of women at senior levels, one university team recognized that they lacked formal mechanisms to address such inequalities and established a permanent commission to oversee policy development in this arena. As they began work on Dimension 1, seeking to “fix the numbers” of women in decision-making positions, the team discussed how gender inequality is shaped by cultural prejudices and



stereotypes, building their awareness and understanding of gender issues. They ultimately settled on an affirmative action approach that would give preference to women when candidates held equal qualifications (CAPRILE et al., 2022). In another example, a research-funding organization built new data systems to gather and disaggregate gender-related data about its grantees, so that they could analyze gender balance on research teams (DE MICHELI & VINGELLI, 2022).

To address Dimension 2, or “fix the institutions” where structural barriers impede women’s careers, one institution adopted a university-wide rulebook with policies and practices to prevent sexual harassment and protect people who are harassed (Miražić & Duhaček, 2022). Importantly, the team designated a new position within each faculty, the equality commissioner, to carry out the work of training personnel and handling harassment complaints. Teams from other organizations examined their internal policy documents, replacing gendered language with gender-neutral language and introducing gender equality as a principle to guide staff recruitment and appointment to top management positions. Language choice matters, because emphasizing non-discrimination can convey a legal and bureaucratic approach to inequality, and emphasizing meritocratic language embeds the assumption that all people have had equal opportunities. Discussing these policies provided opportunities to educate leaders and colleagues, combat gender-blind perspectives, and incorporate values-based, human rights perspectives on equality (DE MICHELI & VINGELLI, 2022).

18

When we compare the TARGET organizations’ GEPs with the US ADVANCE program, we see that the first two of the three dimensions align well with the goals of the US ADVANCE program, “to increase the representation and advancement of women in academic science and engineering careers” and “to address various aspects of STEM academic culture and institutional structure that may differentially affect women faculty and academic administrators” (NSF, n.d.). That is, Dimension 1 emphasizes women’s representation and visibility, and Dimension 2 emphasizes institutional approaches to mitigating barriers such as implicit bias in evaluation, sexual harassment, and policies that valorize career paths derived from historically male career patterns.

The strategies observed in practice are aligned with one or both of these. For example, strategies to interrupt biased processes (Figure 2) seek to mitigate structural barriers built into evaluation processes for hiring or advancement within universities, like GEP Dimension 2. If these

strategies succeed, such that women experience more equitable evaluation, more will be hired and promoted, and their numbers will grow over time, reflecting progress on GEP Dimension 1 as well as increasing intrinsic fairness. A few strategies seen in the US addressed Dimension 1 with a focus on participatory balance rather than just numerical equivalence. For example, strategies to improve equity in disciplinary units' decision-making processes addressed how decision-making is conducted and who is invited to take part.



19

Figure 3: One size fits men, Sketchplanations. <https://sketchplanations.com/one-size-fits-men> . License CC BY-NC 4.0 DEED.



In contrast, GEP, Dimension 3, or “fixing the knowledge,” addresses the need for explicit attention to gender in research studies. Designing for men—whether technologies, facilities, or medical treatments (just to name a few; Figure 3)—has often resulted in products and processes that fail to accommodate women or even harm them (SCHIEBINGER et al., 2011-20; CRIADO PEREZ, 2019). Thus, the process of knowledge-building, research itself, must be altered to attend to include gender in posing research questions, gathering and analyzing research data, interpreting data, and using research to design products or set policy. The knowledge dimension is not addressed in the US ADVANCE program (ROSSER & LAURSEN, 2023), but it was an important area of work for several TARGET organizations. For example, one organizational team linked gender equity to sustainability and resilience, acknowledging gendered differences in who is vulnerable to climate disaster. They worked with a network for young engineering scholars to build their alertness to these issues as developing scholars and leaders who could bring gender awareness to their future work (ZABANIOTOU et al., 2022). One university team built gender competency training into its curriculum on management and professionalism for engineering students, with content on topics such as stereotypes of women and of engineers, the glass ceiling, and legislative frameworks for addressing gender in the workplace (BOIRON et al., 2022), changing students’ training in order to change research and product design for the future.

20

In the best scenarios, all three dimensions of the GEP were mutually supportive. For example, one research-funding organization developed new requirements to address gender balance on the research team (Dimension 1) and in the design and implementation of the research (Dimension 3), and developed new guidelines for grant evaluators to increase their sensitivity to these issues in their reviews (Dimension 2) (DE MICHELI & VINGELLI, 2022). As research funders worked with their stakeholders, they modeled how to develop and use a GEP and raised critical consciousness of gender in their larger research community. These synergies illustrate how strategic choices of actions can have larger impact, and how the work of one small organization can have broader impacts on future knowledge that will be developed in their field.

4. General lessons and conclusions

We have offered many examples of specific strategies and actions to advance equity for women scholars in academic science, engineering, mathematics and technology fields. They were



developed based on evidence about the nature and sources of women's exclusion, and to address root causes, not symptoms. The examples shared here are drawn from studies that have spanned more than twenty years examining practical work to undertake systems change efforts to advance gender equity, in the United States and across the Atlantic. We highlight four key ideas:

- These issues, while difficult, can be addressed from a systems-focused point of view.
- The approaches shared here are strategic when they are selected to respond to specific local challenges, opportunities, and contexts, not applied as generic solutions.
- These actions do not stand alone, but work best when they are combined so that multiple levers of change are deployed at multiple levels of the organization and can work in synergy.
- Changing systems for equity tends to improve things for everyone, not just the targeted group.

The work of designing and carrying out these initiatives has been done by many people at many institutions—people of all genders, in the United States and across the Atlantic, as described here, and also through institution-focused initiatives in other countries such as Athena SWAN in the United Kingdom and SAGE in Australia. Together, their efforts have built a body of useful knowledge and strategies that others can use, building momentum for gender equity even at times and places where we cannot assume that this right is secure.

Gathering and publicizing data is an essential first step to identify specific bottlenecks for women in US and Brazilian organizations alike. Such analyses must be done with a systems lens and with a focus on understanding how institutional structures and cultures pose barriers and perpetuate unequal experiences and outcomes for women. Some of these structures and cultures will be found within individual universities or research organizations, and others may reside in governmental processes such as those that categorize researchers and allocate funding. Equipped with such data, leaders can consider what strategies can be fruitfully adapted to the context of Brazilian higher education, or what new strategies invented. We share this work to spark ideas, to inspire and encourage Brazilian women and academic leaders, and to express solidarity with the women STEM scholars of today and tomorrow.

5. Acknowledgments



S.L. acknowledges research support from the US National Science Foundation under awards HRD-0930097 and HRD-1830185, and from NSF EES-2100242 for D.R. and S.L. We acknowledge a longtime collaboration with Ann E. Austin and highlight her intellectual contributions and leadership on the research described here about change strategies used by US ADVANCE institutions. We also thank Kristine De Welde for collaboration and insights over the past two decades, and Angela Wroblewski and other TARGET colleagues who were generous with their insights. All findings and conclusions are those of the researchers and do not represent the official opinions or policy of the US National Science Foundation.

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Recebido em 01 de dezembro de 2023/ Aceito em 02 de abril de 2024.