VOL. 16, NO. 2 | SPRING 2014

peerReview

EMERGING TRENDS AND KEY DEBATES IN UNDERGRADUATE EDUCATION

Gender Equity in STEM

A PUBLICATION OF THE ASSOCIATION OF AMERICAN COLLEGES AND UNIVERSITIES

CONTENTS

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Published by the Association of American Colleges and Universities ©2014
1818 R Street, NW • Washington, DC 20009
202.387.3760 • www.aacu.org

ISSN: 1541-1389

SPRING 2014

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Peer Review (ISSN-1541-1389) is published quarterly by the Association of American Colleges and Universities, 1818 R Street, NW, Washington, DC 20009-1604. Annual rates are $35 for individual subscriber and $45 for libraries. Periodicals postage paid at Washington, DC, and at additional mailing offices.

POSTMASTER: Send address changes to: *Peer Review*, 1818 R Street, NW, Washington, DC 20009-1604.

For decades, the Association of American Colleges and Universities (AAC&U) has taken the lead in advancing women's standing and equity in higher education, which AAC&U President Carol Geary Schneider underscored in a recent issue of AAC&U's journal *On Campus with Women* (*OCWW*) (published from 1971 to 2013): "Our long-term commitment to equity throughout higher education and in society at large, and to women's roles and voices as strands in the larger tapestry of what we now call inclusive excellence, remains central to AAC&U's sense of mission, purpose, and priorities. In the context of our renewed commitment to equity and inclusive excellence, AAC&U has been taking a close look at how we can best advance these priorities in a twenty-first-century context. Equity—meaning access to educational excellence and opportunity for those who have been marginalized both in higher education and in society—will be a key part of AAC&U's portfolio going forward."

In that same *OCWW* issue, Kelly Mack, AAC&U vice president for undergraduate STEM education and executive director for Project Kaleidoscope (PKAL), focused her lens on gender equity for science, technology, engineering, and mathematics (STEM) faculty. "Never before has the United States' global preeminence in STEM disciplines been more uncertain. As economic development leads to improved educational and professional opportunities around the world, the country can no longer rely on foreign-born talent to drive American advances in these fields. Indeed, it is now crucial for the United States to focus on the rich but untapped talents that exist in groups historically underrepresented in STEM fields, including women of all races and ethnicities. Increasing women's participation is not only a matter of ensuring equity, but also of enhancing the country's ability to innovate in these essential fields."

AAC&U's work on equity is shaped by its recently released strategic plan. One of four goals in that plan is Equity: Innovation, Inclusive Excellence, and Student Success. And we are committed to working on equity in all areas, including in our work on STEM. With the 2010 AAC&U/PKAL alliance, we launched the first of a family of coordinated projects that includes Preparing Critical Faculty for the Future, which is designed to nurture a new generation of STEM women faculty of color as both leaders and educators at minority-serving campuses. A more recent initiative, TIDES (Teaching to Increase Diversity and Equity in STEM), will support curriculum and faculty development activities to generate models for broader institutional change and to advance evidence-based and culturally competent teaching in STEM fields, particularly in the computer and information science domains. In all our equity and undergraduate educational improvement projects, we are committed to the ongoing essential role of an effective, supported, and diverse pool of faculty to ensure we reach key learning goals for *all* students.

This issue of *Peer Review* provides a close examination of the status of recruiting, retaining, and advancing STEM women and women of color at four-year colleges and universities. It was conceptualized and realized by guest editors Kelly Mack and Patrice McDermott, vice provost for faculty affairs of the University of Maryland Baltimore County and AAC&U senior scholar. Through their leadership, we provide below a story on how a tragic death provided inspiration to a host of Latina STEM women faculty ("The Jessica Effect"); one school's work to establish a culture of success for African American STEM women ("Realigning the Crooked Room"); and the results of a series of campus workshops that challenged STEM women to think entrepreneurially ("Academic Women: Overlooked Entrepreneurs"). This *Peer Review* is bookended by articles that build strong cases for stimulating new determination—by joining research and practice—to advance STEM gender equity.

Kelly Mack's *OCWW* article captures the urgency and importance of this issue: "When we consider the overall underrepresentation of STEM women faculty and the differences they experience across varying social positions and identities, the truth of the old adage becomes clear: indeed, not all women are alike. That is why it is critical to take a holistic approach to addressing both the collective needs of STEM women, and the individual needs of every woman in STEM. To do less would be not only to dishonor the disciplines that have guided the technological and medical advances that we enjoy today, but also to rob our students of the fully inclusive and optimally effective educational experiences they deserve."

—SHELLEY JOHNSON CAREY

The Twenty-First-Century Case for Inclusive Excellence in STEM

▸ **Patrice McDermott,** vice provost for faculty affairs, University of Maryland Baltimore County; and AAC&U senior scholar
Kelly M. Mack, vice president for undergraduate STEM education, AAC&U; and executive director, Project Kaleidoscope

The urgent need for science, math, engineering, and technology (STEM) higher education reform in the United States is fueled by projections that our labor market will require greater expansion for those trained in science and engineering than in any other sector in the twenty-first century. This challenge is compounded by the fact that improved global economies and opportunities abroad will no longer allow this country to rely on foreign-born talent to meet its STEM workforce demands. To remain competitive within this shifting context, America must aggressively pursue the full participation of all of its college-age population—and most especially the women and women of color who embody an untapped source of talent for meeting the nation's needs. This mandate will require institutions of higher education, and the professional societies that support them, to depart from their continued reliance on incremental change strategies and, instead, to fearlessly embrace more radical shifts in organizational paradigms, along with the uncertainties accompanied by them.

[I]f we are to consider the most effective means of maintaining a diverse workforce, then the matter of gender equity in STEM at all faculty ranks as well as among student majors emerges as a national imperative for higher education reform, and requires our careful understanding of both historical and contemporary influences on trends in gender equity

INCLUSIVE EXCELLENCE AS A CATALYST FOR TRANSFORMATIVE CHANGE

This issue of *Peer Review* captures that spirit, propeling us forward into a series of real and provocative discourses designed to disrupt our present understanding of the academy, and to underscore the need for inclusive excellence as a catalyst for transformative change. Given the urgency imposed by our global challenges, the evolving nature of our disciplines, and the confounding complexities of our current social context, our collective actions toward fortifying the nation's STEM enterprise must be bold, swift, precise, and inclusive.

We must begin by retaining students who are already pursuing science, engineering, and mathematics degrees in college. According to recent data from the National Science Foundation (NSF), over 30 percent of women, including women of color, who were first-year college students in 2010 expressed intentions to major in science and engineering fields, just 11 percent fewer than their male counterparts (NSF 2013). Despite this encouragingly high level of interest at the baccalaureate level, the representation of undergraduate women significantly declines by the time they graduate. Of particular note is the disturbing fact that between 2001 and 2010, the percentage of women earning

baccalaureate degrees in the field of computer science—an area of critical need—decreased by 39 percent! The same pattern holds true for minority students who plan to major in STEM at the same rate as white students, but who are far less likely than their counterparts to persist in the field to degree completion.

While considerable federal and private foundation investment has targeted the recruitment and retention of women and other underrepresented students in STEM, one potent source for leveraging change in higher education— women faculty— continues to remain overlooked and underutilized. Ongoing research regarding women student participation and performance in STEM underscores the ways in which institutional transformation relies on creating conditions in which women faculty can thrive. Bettinger and Long (2005) have concluded that the presence of women faculty in community colleges, minority-serving institutions, and predominantly white universities results in enriched mentoring relationships that lead to academic success for women students. Additionally, Trower and Chait (2002) have confirmed that the positive effects of the presence of same race/same gender faculty on retention rates are even more pronounced among women students of color. Overall, women faculty of color often serve as sources of vital social support and community connection for underrepresented students in general. Therefore, if we are to consider the most effective means of fostering a diverse STEM workforce, then the matter of gender equity in STEM at all faculty ranks as well as among student majors emerges as a national imperative for higher education reform. This in turn requires our careful understanding of both historical and contemporary influences on trends in gender equity.

The articles in this *Peer Review* collectively explore this issue. The historical view presented below not only highlights the formal structures that limited the participation of women of color in STEM over the years, but also showcases how they mirror modern day institutional barriers that continue to marginalize all women in academic STEM fields. On the surface, this persistent and systemic exclusion of women would indicate that there has been no progress. Quite the opposite is true. Recent data from the National Science Foundation (NSF 2013) indicate that the number of women in academic STEM disciplines has steadily increased in recent years to 46 percent in four-year institutions, well above the 30 percent level reported in 2006 (Burrelli 2008). However, we are cautioned that aggregated data can be extremely misleading. It is true that the number of women in the academic STEM disciplines has increased, but it is important to note that in several STEM disciplines, women remain disproportionately underrepresented, especially in such fields as engineering and physics. Moreover, women are precipitously "lost" at points of transitions to upper professorial ranks in all STEM disciplines. Collectively, women at the assistant, associate, and full professor levels make up 40.6 percent, 33.9 percent, and 19.4 percent of full-time faculty members, respectively. For underrepresented minority women—who comprise only 4.5 percent, 3.7 percent and 1.2 percent of the assistant, associate, and full professors—there is even greater underrepresentation at all levels of the professoriate (NSF 2013).

Many institutions of higher education, several of which are featured in this issue of *Peer Review*, have creatively endeavored to ameliorate STEM gender disparities at the baccalaureate, doctoral, and faculty levels. With investments from both internal and external funding sources, such as the NSF ADVANCE program, these institutional exemplars have systematically incorporated gender and gender–race intersectional sensitivity into the fabric of their institutional, departmental, and programmatic efforts. These culturally sensitive approaches come at a critical turning point in the history of the academy when faculty are simultaneously expected to make herculean advancements in more innovative and effective teaching practices, scholarly productivity, and grantsmanship while pursuing deeply engaged lives in a technologically advanced society. This cacophony of increasing and conflicting responsibilities is particularly challenging for women faculty in STEM fields who continue to be marginalized in the academy, are disproportionately burdened with domestic responsibilities, and are differentially affected by hostile departmental climates.

Clearly, there is much to be learned from our authors, and still even more to consider as STEM higher education reform evolves. This issue offers a necessary first step only—admitting that there is a larger problem which can only be remedied through radical departures from our efforts to date. We need a fundamental reconsideration of women faculty as a powerful and untapped resource for meeting our goal of achieving a well-prepared and highly diversified STEM workforce, now and in the future. ▪

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Who is Minding the Gap?

▸ **Claudia Rankins,** program officer, National Science Foundation
Falcon Rankins, president, PRISSEM Academic Services, LLC
Tasha Inniss, associate professor of mathematics, Spelman College

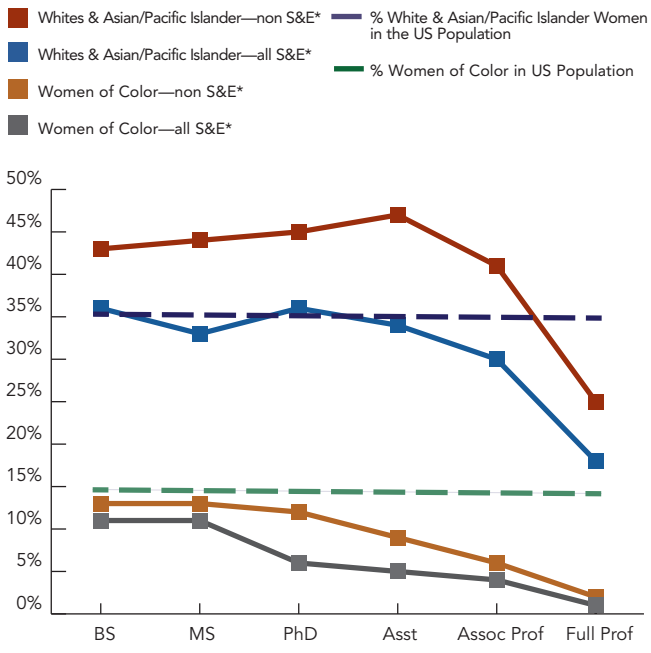
The question of *"Who is Minding the Gap?"* is particularly timely and relevant to our national science, technology, engineering, and mathematics (STEM) higher education reform efforts because the retention and persistence of an ever increasing number of women in STEM at the baccalaureate level is heavily dependent upon the number of women faculty represented at all professorial levels in STEM fields. Recent literature supports this notion and suggests that a critical mass of women faculty in postsecondary STEM education is necessary to adequately support the needs of women undergraduate students. In fact, Bettinger and Long (2005) have shown that one of the greatest influences on and determinants of success in STEM disciplines for women students is access to same-gender role models. Additionally, O'Neill (2002) reports that same-gender and same-race mentoring often involves stronger psychosocial support that may yield better career outcomes.

Admittedly, the representation of women in the academic STEM disciplines has increased over time. In the past ten years, the percentage of bachelor's degrees awarded to women in any given year has been approximately the same as the percentage of women in the United States. Moreover, the percentages of master's and doctoral degrees awarded to women have been steadily increasing and are nearing parity with the number of degrees awarded to men. It is tempting to assume from this aggregate data that extra efforts to increase the representation of women in the STEM fields are no longer necessary.

However, such cursory examinations of aggregate data overlook the fact that women faculty, and especially women faculty of color, are still far below the level of critical mass and that there are too few of these faculty to provide women students with sufficient access to preferred role models. These aggregate data also tend to mask other critical gaps related to the intersections of gender with race/ethnicity, levels of underrepresented minority women in upper professorial ranks, and underrepresentation in critical STEM fields linked to US economic growth and preeminence (fig. 1).

To more fully understand the complexities of the representation of women and women of color—specifically African American, American Indian, and Hispanic women—at all STEM academic levels, the Representation Index (RI) serves as a vital tool. We

FIGURE 1. PERCENTAGE OF DEGREES AWARDED AND FACULTY POSITIONS ACCOUNTED FOR BY WOMEN IN 2010[1]



**Science and Engineering*
[1]Data from the National Science Foundation National Center for Science and Engineering Statistics, 2013

define the RI generally as a group's percent of representation in a category divided by the percent of representation of that group in the US population. Specifically for this article, an RI equal to one implies equal representation compared to representation in the US population, an RI larger than one indicates that women are overrepresented, and an RI of less than one indicates women are underrepresented.

$$RI = \frac{\%\ \text{Representation in a category}}{\%\ \text{Representation in US Population}}$$

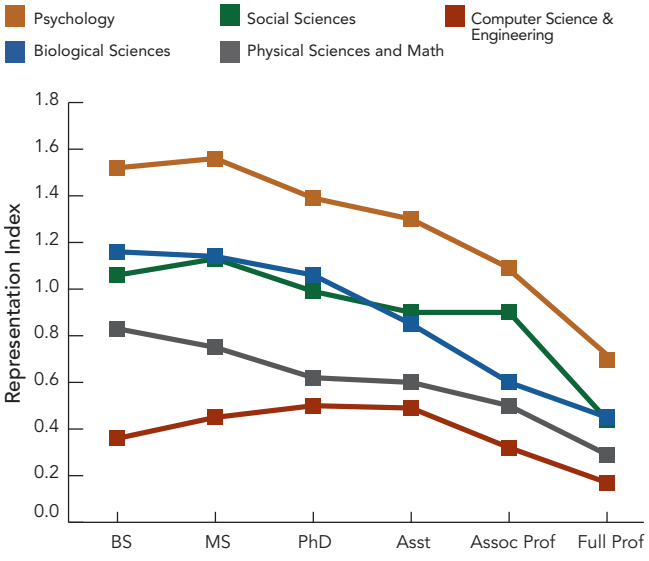
In this way, the RI demonstrates not only representation, but also the magnitude of over- or underrepresentation. While some groups of women are well-represented in terms of degrees awarded in science and engineering (S&E) fields, all women tend to be underrepresented among the faculty ranks in these disciplines, and their representation decreases as educational attainment level and professorial rank increase. Figure 2 outlines the RI for women in various disciplines. The RI for women at the rank of full professor is less than 0.8 in every discipline, and is even below 0.2 in computer science and engineering. Even in psychology, where women were awarded 77 percent of all undergraduate degrees in 2010 and held 55 percent of all faculty positions, they are underrepresented at the full professor level.

The underrepresentation of women in the academic STEM disciplines is further compounded by the intersection of gender with race and ethnicity (fig. 3). White women and women of Asian/Pacific Island descent are, as a group, well-represented among degrees awarded in S&E as well as entry-level faculty positions, while women of color are very much underrepresented in these fields at every level of degrees awarded and faculty rank. Further, the rate of underrepresentation steadily becomes more severe at higher professorial levels, resulting in the near invisibility of women of color at the full professor level.

The RI for women of color at the full professor rank is 0.08 for all S&E fields. In other words, more than twelve times as many women professors of color are needed in the academic S&E fields to achieve parity with their representation in the US population. Additionally, an RI of 0.40 for women of color in the physical sciences and mathematics at the bachelor's degree level indicates that, as a group, two and a half times as many bachelor's degrees are needed in these fields for women of color to be represented in a proportion equal to that of the US population. In engineering, five times as many degrees at all levels would have to be awarded for parity to be achieved. While these women, as a group, are well represented in psychology and the social sciences at the level of bachelor's and master's degrees, the remaining S&E disciplines would have had to award this group twice as many bachelor's degrees and three times as many doctoral degrees in 2010 to be represented in proportions equal to the general population.

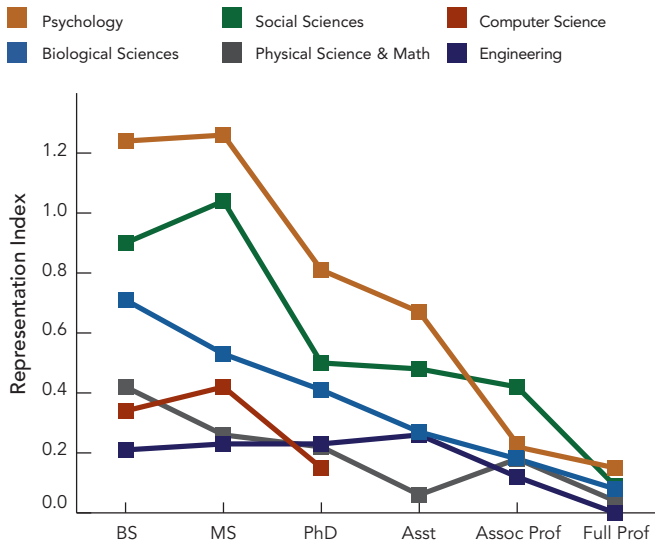
Overall, the discipline-specific gaps in the underrepresentation of women in the

FIGURE 2. REPRESENTATION INDEX FOR ALL WOMEN BY DEGREES AWARDED AND FACULTY RANK, 2010[1]



[1] Data from the National Science Foundation National Center for Science and Engineering Statistics, 2013

FIGURE 3. REPRESENTATION INDEX FOR WOMEN OF COLOR BY DEGREES AWARDED AND FACULTY RANK, 2010 [1,2]



[1] Data for women faculty in computer sciences suppressed

[2] Data from the National Science Foundation National Center for Science and Engineering Statistics, 2013

academic STEM disciplines not only negatively affect the academy's capacity to ultimately contribute to the STEM workforce, but also threaten to reduce quality of life for a significant portion of the current workforce. If the United States is to remain a competitive leader in science and engineering, it needs to rely on the talents of all of its citizens. Page (2007) points out that diversity among a group of problem solvers is more important than individual excellence, and that groups which display a diverse range of perspectives outperform groups of like-minded experts. If women are not participating equally in the S&E fields that pay the highest wages, the income disparity between men and women (Chang 2010) is not likely to improve. Forbes (2013) recently listed its "Top Ten STEM Occupations," as rated by income and employment outlook. All top ten occupations—with the exception of intelligence analyst, which ranked ninth in the list—are in engineering and computer science fields. These are exactly the disciplines, along with mathematics and the physical sciences, where women are most underrepresented.

The need for collective action by federal agencies, professional and philanthropic organizations, and higher education is immediate and urgent if we are to not only mind the gap, but also fill it. Several collaborations that are designed to begin to fill the gap exist at the National Science Foundation. The Historically Black College and Universities Undergraduate Program (HBCU-UP) and the ADVANCE Program have jointly funded projects to specifically address the unique issues of women faculty at historically black colleges and universities. The Opportunities for UnderRepresented Scholars (OURS) program at the Chicago School of Professional Psychology has developed and is delivering a graduate certificate program in academic leadership. OURS is designed to address the compelling need for women faculty in STEM disciplines at HBCUs to acquire leadership skills for academic roles either within their discipline or within institutional administrations. The first cohort of almost twenty women faculty is scheduled to receive the graduate certificate this spring and a second cohort has been selected. Already, in the programs first year of existence, over 25 percent of these participants have been promoted into leadership positions. Secondly, the Preparing Critical Faculty for the Future project at the Association of American Colleges and Universities supports women faculty at HBCUs in leading institutional change projects that target pedagogical change in the STEM disciplines. Additionally, the annual STEM Women of Color Conclave, grounded in the Entropic Career Identity Model (Mack et al. 2013), has served, since 2009, as a catalyst for helping women of color achieve STEM career identity and full integration in the STEM fields at all faculty levels. The conclave is attended by women and men from all STEM disciplines across all academic ranks and administrative positions and, to date, represents the largest convening of STEM women faculty of color in the nation.

The question "Who is minding the gap?" is meant to provoke thought, discussion, and scholarly pursuit in order to advance research, identify best practices, and implement solutions. Only research studies that fully take into account race/ethnicity, gender within race/ethnicity, STEM disciplines, and academic rank will be useful, particularly as the demographic landscape of higher education changes. No longer can failure to disaggregate data be an option if true reform is to occur in the United States. ▪

DISCLAIMER

Any opinions, findings, recommendations, and conclusions expressed in this article are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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Realigning the Crooked Room:
Spelman Claims a Space for African American Women in STEM

▸ **Kimberly M. Jackson,** associate professor, department of chemistry and biochemistry; and principal investigator, Women of Color Legacy Project, Spelman College
Leyte L. Winfield, associate professor and chair, department of chemistry and biochemistry; principal investigator, Women of Color Legacy Project, Spelman College

"African American women are standing in a room skewed by stereotypes that deny their humanity and distort them into ugly caricatures of their true selves. As they struggle to find the upright in this crooked room, they are beset by the emotional, physiological, and political consequences of race and gender shaming. This shaming has tangible, even disastrous consequence…"

—Melissa V. Harris-Perry

In Melissa Harris-Perry's 2011 book, *Sister Citizen*, she references various psychological studies of altered judgment and decision making that can arise in irregularly shaped environments, and uses them to explicate the struggles women of color face at the intersection of race and gender stereotypes. These environments, or "crooked rooms," represent an unlevel plane where misrecognition or lack of acknowledgment diminishes the contributions of women of color to the success of the nation.

Recognizing the prevalence and conundrum of the crooked room, there are institutions making strides toward changing the way the world looks at African American women leaders, scholars, artists, writers, scientists, and global change agents. One institution in particular has welcomed women of African descent in support of their becoming technically proficient and civically astute. At Spelman College, an institution committed to excellence inside and outside of the classroom, students are provided with the tools needed to cultivate the character, confidence, and intellectual curiosity that will not only shape and define them, but also enable them to think both broadly and deeply as they address some of the world's most complex problems.

As is typical of the legacy of most historically black colleges and universities (HBCUs), Spelman has a rich tradition of assisting students in finding the wherewithal to assume an upward trajectory as they navigate a proverbial room that is made crooked by negative stereotypes. Founded in 1881 and grounded in its mission to empower and inspire commitment to positive social change in African American women, Spelman enrolls approximately 2,100 students from forty-four states, one territory, and eleven countries and offers a robust, challenging liberal arts curriculum with twenty-seven academic programs. Notably, Spelman College is classified by the Carnegie Foundation as a highly selective and highly competitive Baccalaureate I institution and serves as host to a chapter of the Phi Beta Kappa Honor Society. It is also one of six Model Institutions of Excellence, as designated by the National Science Foundation, for its achievements in undergraduate science and mathematics education; Spelman ranks second among all institutions from which black science and engineering doctorate recipients earn bachelor's degrees (National Science Foundation 2013).

A LEGACY UNVEILED DESPITE THE CROOKEDNESS IN THE ROOM

"If we're going to out-innovate and out-educate the rest of the world, we've got to open doors for everyone. We need all hands on deck, and that means clearing hurdles for women and girls as they navigate careers in science, technology, engineering, and math."

—Michelle Obama

Spelman has continued to expand its national visibility and increase the scope and vitality of its educational curriculum, par-

ticularly in the sciences (Thompson and Scriven 2008). As a result, 16 percent of its graduates have entered STEM graduate programs, and forty alumnae are currently in the pipeline. However, while Spelman College is exceptional in empowering women of color to achieve doctoral degrees in STEM fields, the national racial disparity among individuals earning doctorates in the United States is startling. Women represent 24 percent of the STEM workforce, with African American women constituting 1.6 percent of those with bachelor's degrees, and only 1.4 percent of those with doctoral degrees (Lehming 2013). When considered against this backdrop, Spelman's record of accomplishments illustrates the critical role this institution serves in redressing the underrepresentation of women of color in STEM fields and in contributing to national efforts to create a more diverse scientific workforce.

Thus, Spelman has engaged in a sustained effort to build an exemplary undergraduate science program. Infrastructural developments in the past decade reflect the institution's strong commitment to building a research-intense environment necessary to sustain innovative science curricular and training resources. In 2000, Spelman College completed the building of a $37 million science center that enhances institutional capacity for teaching in modern laboratories. Currently, efforts are underway to create spaces that support hands-on instruction, exploration, and the infusion of technology in every aspect of the curriculum. The college has also aligned its strategic plans to institute effective research structures. These activities anchor the Spelman MILE, "My Integrated Learning Experience," an institutional imperative that combines a rigorous liberal arts curriculum with applied and service learning, teamwork and leadership development, and global learning. By coupling such academic initiatives with cultural relevance, Spelman is creating a novel framework of high-impact practices that provide students, particularly those of underrepresented groups, with essential experiences to nurture and build the key competencies (e.g., critical thinking, effective communication, and quantitative reasoning) researchers agree are necessary to the success of today's students (Kuh 2008).

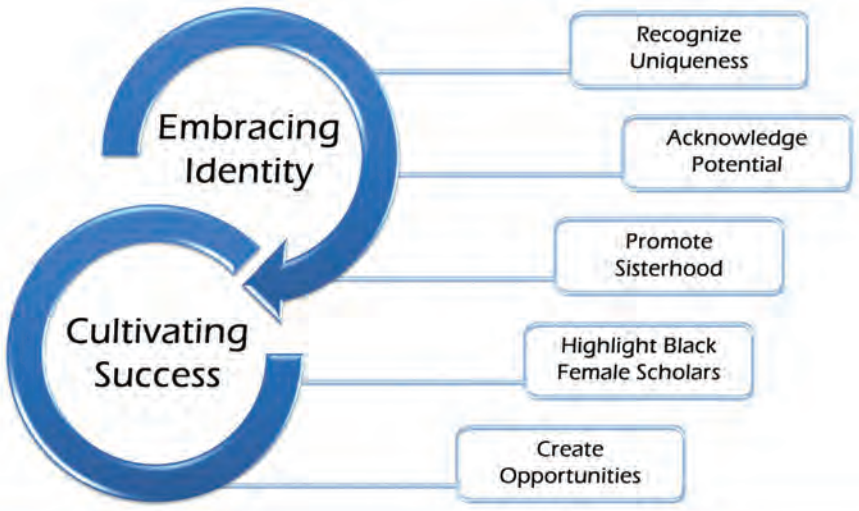
HALLMARKS OF SPELMAN'S SUCCESS

The Spelman model for empowerment nurtures the collective strengths of women, pushes students to challenge the notion that there is one correct path or one demographic especially suited to attain success, and intertwines experiences that resonate with women of color within a progressive and rigorous academic curriculum.

An essential component of Spelman's success is the sense of community shared by students. By capitalizing on this concept of social integration (connecting with the institution and fellow students), The Spelman model for empowerment also combines recognition of the relevance of being a woman of color with the belief that such an identity does not limit one's academic or professional potential. Both faculty and alumnae agree that this is the foundation of Spelman's sustained success, which is grounded in:

- faculty who recognize the uniqueness of our student population and are committed to ensuring their intellectual growth and future success;
- engaged alumnae who mirror for students their potential to become change agents;
- a community focused on nurturing the whole woman, providing academic experiences that support both professional and personal development;
- a commitment to supporting women of color in seeing themselves as members of a global community;
- a curriculum that recognizes and is responsive to generational differences, while reflecting rigor and high expectations;
- a core curriculum and cocurriculum that center the experience of women of African descent as major contributors to all disciplines and to society as a whole; and
- highly visible faculty who provide students access to same-race and same-gender role models and oppor-

FIGURE 1. A MODEL FOR EMPOWERMENT



tunities to identify with their chosen professions as scientists, scholars and practitioners.

TRAINING THE INVISIBLE SCIENTIST

To get a better view of the attributes of the Spelman experience from alumnae in STEM, we conducted a survey of forty-six Spelman alumnae who have doctorate degrees or who are currently enrolled in graduate studies in STEM fields. Among those respondents who reported having a mentor, 43 percent indicated they had mentors in their own department and that they admired the individual. When asked to identify the experiences and opportunities provided at Spelman College that were instrumental to their success as a graduate student, the primary response from alumnae was confidence instilled through Spelman's unique culture; a feeling of academic preparation; and participation in independent research.

"Spelman gave me the confidence to work amongst students in Ivy League institutions and not feel inferior because I'm a minority or female."

—Spelman STEM graduate

Among a mixed group of both Spelman alumnae and current students, many suggested that key factors that encourage women of color to pursue a STEM career are closely related to their ability to identify with being a scientist. In addition, 58 percent indicated that the perceptions about what scientists "look like" must be changed, and 39 percent indicated that there is a need to increase the presence of more relatable role models.

As STEM faculty, we build on a foundation that is established when the student enters Spelman. Our mission is to train women of color to position themselves for success in an environment where they are likely to be invisible. This often includes providing students opportunities for professional development, peer and faculty mentoring, innovative content delivery strategies, and learning resources. These activities are scaffolded over both the individual student's Spelman journey and a community that acknowledges the intersection of gender and race and fosters the success of women of color in the STEM disciplines.

THE CURRICULUM

The STEM departments at Spelman have broadened their strategies to meet the ideals of a liberal arts education while simultaneously providing students with the tools and resources needed to become effective problem solvers and critical thinkers. This is reflected by a progressive curriculum that encompasses modern pedagogical approaches (e.g., blended classes, project-based learning, and inquiry-based learning) and the infusion of technology (via computational modules, molecular modeling projects, and iPads). In fact, more than 50 percent of the STEM faculty are using web-enhanced technology, blended-learning, and/or active learning applications. In the department of chemistry and biochemistry, there has been an infusion of open-ended research-based courses and modules, many of which focus on computational modeling.

Likewise, the departments of biology and physics have developed transdisciplinary modules that integrate biology into physics courses and vice versa, enabling biology majors to see their curriculum in relation to other sciences. These initiatives are supported by a multipronged approach that strategically engages faculty and peer mentors to promote success and retention among first- and second-year majors. Peer tutors provide an additional learning resource that is interactive in nature and promotes "learning by doing." They work in collaboration with the course instructors to facilitate one-on-one tutoring and mediated group study for focused reinforcement of concepts, typically those identified by the instructor as necessary for success in the course. In addition, they support active learning exercises conducted during the lecture and moderate online blogs, allowing peer tutors to provide faculty with feedback regarding teaching strategies and how students approach learning and problem solving.

THE RESEARCH

More than thirty years ago, Spelman recognized the need for its STEM students to participate in independent research and established the first funded research internships at the institution. It was then noted that conducting independent research develops students' confidence by giving them the ability to integrate information to solve complex, real-world problems. Since this time, student research activities have been supported through a wide range of mechanisms (federal programs, industry partners, and private donors). Faculty are actively involved in research projects that create opportunities for more than 20 percent of STEM students each academic year. Research at Spelman has become more interdisciplinary, extending beyond the STEM disciplines, creating natural alliances with scholars in sociology and anthropology (e.g., in the exploration of

food science/studies) and women's studies and economics (e.g., in the exploration of women's health and health disparities). With the college's new quality enhancement plan, our students are also engaging in international research experiences that can span the summer months or a full semester. This ensures that they understand the value of contributing to the STEM enterprise on a global level, while allowing them to become more competitive and confident in their technical skills. As such, Spelman now requires every student, regardless of major, to engage in independent research projects and to have an international experience prior to graduation.

MENTORING

In addition to promoting academic excellence, Spelman is dedicated to the personal growth and professional development of its students. By employing a diverse body of teacher–scholars, students have access to faculty who are committed to providing mentorship and instruction that nurture their success. An added benefit is the capacity for Spelman students to identify with faculty of similar culture, ethnicity, or gender. This is achieved in a very fluid environment where student–faculty interactions are an innate part of the undergraduate STEM experience; it is not packaged in a formal mentoring program. Further, it provides a community of support that allows students to challenge the architecture of the "crooked room" and the boundaries of the nation's STEM enterprise. This mentoring model reverses the invisibility of women of color, particularly those of African descent, in the sciences and empowers them to persist.

THE NEW ROOM

Currently, efforts are underway to establish a national culture that encourages women of color to reach their full potential in the biomedical and behavioral sciences. Spelman is at the forefront of this effort with its Women of Color Legacy project. The core of the project will exploit impactful practices that have been developed at Spelman while addressing the holistic development of students as they navigate this "room" toward attaining STEM doctoral degrees. By considering development at various career points from middle school through college, it is envisioned that this initiative will ultimately give a voice to women of color in STEM. During the course of this project, we hope to capture the narratives of those who have persisted. We hope that this will bring recognition to the accomplishments of women of color, create a shift in the perceptions of women of color in STEM, and increase their visibility in STEM fields. ▪

ACKNOWLEDGMENTS

We would like to thank Renata Fortenberry Hilson for creating the survey instrument and analyzing the Spelman student and alumnae STEM data.

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The Jessica Effect:
Valuing Cultural and Familial Connections to Broaden Success in Academe

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Jessica Soto-Pérez, daughter of Antonio Israel Soto and Luz N. Pérez, received her undergraduate degree from the University of Puerto Rico Mayaguez. She was a promising chemical engineering graduate student at the University of Maryland Baltimore County (UMBC) and peer mentor for its National Science Foundation (NSF)-funded Alliance for Graduate Education and the Professoriate (AGEP) program—PROMISE: Maryland's AGEP.

Jessica's future plans included returning to her native Puerto Rico to pursue a career as an engineering professor. Unfortunately, she didn't reach that goal because in 2004, she was tragically killed by her husband. The reasons behind the murder–suicide still remain a mystery to law enforcement, friends, and family. However, university administrators and peers have wondered about the differential impact of STEM (science, technology, engineering, and mathematics) graduate study on the familial ties of underrepresented students, particularly Latinas, as a major factor in the tragedy.

"I can relate to Jessica, having a husband who is Latino and not in academia… It was very important for my husband… to learn not to feel threatened or intimidated by my PhD-seeking peers."
—Latina STEM PhD

Initially, the offerings of PROMISE only focused on the needs graduate students. However, Jessica's death propelled a foundational shift within the structure of the PROMISE program. This shift characterizes what we call the "Jessica Effect"—a strategic institutional planning decision to definitively invite and actively include the family members and friends of graduate students in informative and celebratory events and programs.

This practice of "family and friend" inclusion is the legacy of Jessica. It ultimately achieves several purposes including, but not limited to (1) serving as an advising model that faculty and administrators can utilize to both recognize and value the cultural and familial connections of their graduate students, postdoctoral fellows, and colleagues in the STEM disciplines, (2) promoting an understanding of the university experience among those who may not be familiar with academic processes and timelines, (3) reducing feelings of isolation on the part of students and family members, and (4) expanding the opportunities for family members to offer their students the support necessary for degree completion.

UNDERREPRESENTATION IN STEM

The underrepresentation of ethnic minorities and women in doctoral programs and in faculty positions is well documented

and often referred to as a "loss of talent to society" and a "loss of potential research." In 1999, for instance, although African Americans represented 12 percent of the population, they only earned 4 percent of the PhDs in science, engineering, and math fields (Hill 2001). In the biological sciences, there are relatively higher numbers of minorities and women, in part as a result of undergraduate initiatives and interest in biomedical careers (Maton et al. 2009), but the underrepresentation of these special populations still persists at advanced academic career levels (Patton 2011). For Latinas, this phenomenon is believed to arise, in part, from strong domestic roles that often compete with the demands of a STEM career (Malcom et al. 1975).

"Key areas of difficulty include balancing work and family, and the lack of formal support from academic institutions to alleviate this situation, which primarily affects women… women need to be armed to battle this strong and unfair dilemma of choosing between science and family."

—Latina STEM PhD

The projected demographic changes in higher education and their implications for our expanding STEM workforce have led to growing alarm (Solorzano 1995; George et al. 2001), and concern about this country losing its global competitiveness in innovation (US Department of Commerce 2012). To minimize the threat to US global preeminence, the institutional framework of UMBC's PROMISE AGEP, now grounded in the "Jessica Effect," relies upon professional development, community building, and the development of an "extended family" as factors necessary for mentoring and facilitating increases in retention, graduation, and transition to advanced STEM careers for underrepresented minorities in STEM disciplines.

PROMISE: IMPROVING RETENTION OF UNDERREPRESENTED GROUPS IN STEM

Students bring their values to graduate school, and these values shape their performance and socialization into their departments and their graduate communities. However, values for minority students are thought to be shaped differently from those of majority students. Recent literature suggests that graduate students from more "collectivist cultures" (e.g., Latino, African American) place strong emphasis on personal relationships in school, which may interfere with internally focused and task-driven characteristics that are needed for graduate school success. This is different from students from a more individualist culture who may instead place more focus on traditional activities associated with advanced graduate work, and less focus on relationships to others in the program (Taylor and Antony 2000; Davidson and Foster-Johnson, 2001).

"In Latin culture, family is more important than anything, even education… Ties in the family, especially among the women, are tight."

—Latina biology PhD

The PROMISE AGEP of the University System of Maryland (with primary partners UMBC, the University of Maryland College Park, and the University of Maryland Baltimore, and involving all of the institutions within the University System of Maryland) is one of several NSF AGEP transformation programs in the United States that supports minority graduate students in STEM. The PROMISE AGEP Transformation (AGEP-T) initiative is now grounded in community psychology theory, and promotes a "psychological sense of community" (PSOC) to meet the needs of the UMBC graduate students (Sarason 1974; McMillan and Chavis 1986). The PSOC model examines membership, influence, integration, and fulfillment of needs, as well as shared emotional connections. It also measures feelings of belonging, and students' perceptions of effectiveness as related to perceptions of benefits received (Sarason 1974; McMillan and Chavis 1986). PROMISE is designed to meet participants' needs by addressing the "needs fulfillment and influence" factor; strengthening social bonds that connect to the "shared emotional connection" factor in the classic PSOC construct; and capitalizing on both geographical accessibility and "place attachment," which assigns influence to the familiarity of a physical environment.

Our conceptual framework is based upon the hypothesis that professional development and community building are strong factors that stimulate increases in retention, graduation, and transition to an advanced STEM career. The PROMISE AGEP further hypothesizes that students of color benefit from the influence of community and an "extended family" approach to mentoring. Therefore, PROMISE mentoring and support extends to students' personal lives (e.g., weddings, funerals, domestic situations, and relationship issues). An examination of case studies from PROMISE alumni indicates that graduate students rely on a number of institutional support systems that bring people together and build connections (Rutledge, Carter-Veale, and Tull 2011).

"When people move to another environment [e.g., graduate school in the US], they miss the warmth of their Latin environment...People in the U.S. are nice, but their demeanor can be perceived as being cold… Many people from a variety of Latin American backgrounds miss the warm contact...and that is something that tends to be harder to get used to. This

is why it is a good idea to be involved in programs that share the same ideals … it makes the transition easier."

–Latina biology PhD

This unique model of family inclusion is believed to have contributed to positive outcomes in graduate student retention and graduation across the entire University System of Maryland (fig. 1). Additionally, data for Latinas in STEM at the University of Puerto Rico Río Piedras (UPR-RP), a UMBC collaborative partner, revealed that, between 2010 and 2012, more Latinas completed STEM PhDs than Master of Science degrees at UPR-RP. This trend is different from current outcomes at UMBC. It is believed that pursuit of the PhD in Puerto Rico allows Latinas access to pursue STEM doctoral degrees while still maintaining strong familial connections.

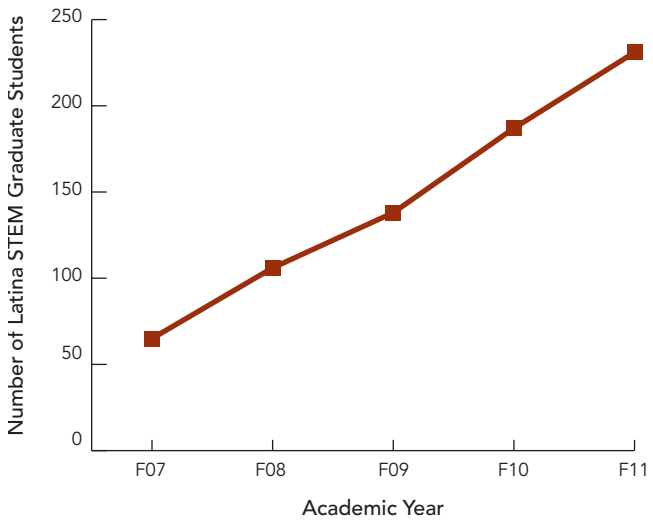
EXPANDING THE PROMISE

Attention to family has also become a focal point at the Universidad Metropolitana (UMET) in Puerto Rico, and the PROMISE model of incorporating family into academic events was adapted to and adopted by the NSF-funded ADVANCE Hispanic Women in STEM project. Specifically, in 2012, UMET convened a conference of Hispanic STEM faculty women from institutions throughout Puerto Rico to address relevant issues of family–work balance. The event was unique in that it included faculty, administrators, and family members of participants. One session, uniquely designed for family members, focused on the "Superwoman Syndrome" and exposed family members to the nuances of the family versus work conflict. As a result, both spouses and children of STEM women faculty learned specific strategies for providing intellectual and emotional support and motivation for STEM women faculty.

"It was very important for my husband to be a part of PROMISE … he stopped judging folks as looking down on him … he became their friend … That made a big difference in our relationship … and had a strong effect on me."

—Latina STEM PhD

FIGURE 1. MASTER OF SCIENCE AND PHD LATINA STEM ENROLLMENTS FOR THE UNIVERSITY SYSTEM OF MARYLAND



The conference in Puerto Rico also included a session titled "The Jessica Alert," which focused on the story of Jessica Soto-Pérez and encouraged women faculty to share their own stories about family, relationships, issues of male dominance, fears, successes, and connections. The session also encouraged STEM women faculty to be empowered to include partners and spouses of their own undergraduate and graduate students in academic events, celebrations, and career planning.

CONCLUSION

How do we move forward? In a recent editorial published in *Science,* McNutt (2013) highlighted the need for continued advocacy for increasing the numbers of women in faculty and academic leadership positions in STEM disciplines. She emphasized the weighty impact of structural issues like organizational culture dominated by male-centric and Eurocentric cultural values (Ong 2001; Gutiérrez y Muhs et al. 2012) and work–family matters (Singh et al. 2013) that greatly impact professional advancement for women in STEM. Given that women of color—including Latinas, African American, and Native American women—are grossly underrepresented in STEM academic careers (American Association of University Women 2010), the time is right to address organizational practices that can inform effective policy to enhance the success of women in STEM.

"Daughters are expected to commit time to helping the family… moving away from the family was difficult … This influenced my decisions in graduate school and now… I would only take a position at a university that would allow me to spend [time] in the town where my family lives … I do not know if I could do that in an academic leadership position. "

—Latina computer science PhD

Nearly ten years after her passing, we're certain that Jessica would have finished her chemical engineering PhD, and would have reached her dream of being a professor in her native Puerto Rico. There

are many ways to achieve the mission of increasing the numbers of women faculty in STEM. We have chosen to focus on family in the life–work balance equation, and pave plausible pathways that will help women to include, not ignore, their family life in their STEM careers.

Several recommendations emerge from the work presented here, which are intended to address the role and status of Latinas in STEM:

- Transformational leadership is needed to spearhead implementation of workplace changes (Carnes et al. 2012).
- Opportunities for formal and informal mentoring networks must be cultivated that can support career navigation in culturally relevant ways (AAUW 2010). Existing structures like MentorNet (www.mentornet.net), as well as the National Institute of Health's new initiative to establish a national research mentoring network(http://commonfund.nih.gov/diversity/Initiatives), are examples of infrastructure resources that can support such mentoring network opportunities.
- Metrics and reporting systems should be created that can track accountability and impact of system-wide changes (National Research Council 2013).

In closing, Jessica's life and death has given us pause to examine advancement of Hispanic women in STEM at the graduate and faculty levels. We must now recognize that the loss of Latina STEM talent is not just a women's issue, but the loss points to missed opportunities for advancement that affect all individuals in higher education (AAUW, 2010; Singh et al., 2013). ▪

ACKNOWLEDGMENTS

This work receives support from the National Science Foundation's ADVANCE Collaborative Research: Framing the Issue: A NETWORKing Workshop to Address Academic Advancement of Hispanic Women in STEM (# 1216490), and Collaborative Research: AGEP-T: PROMISE AGEP Maryland Transformation (#1309290). We also acknowledge Douglas Frey (Jessica's chemical engineering graduate school advisor at UMBC), and the UMBC Graduate Student Association for developing the Jessica Soto-Pérez award for graduate students. We give special thanks to Molly A. Hardigree Cancel (UMET) and Andrea Barrientos (Barrientos Consulting) for helping us to design the "Jessica Alert" workshop in Puerto Rico, and for their support with this project.

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Academic Women:
Overlooked Entrepreneurs

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The majority of US small businesses are started by women, which suggests that women are indeed entrepreneurial. Yet when it comes to the academic science, technology, engineering, and mathematics (STEM) disciplines, women lag behind their male peers. Women file proportionately fewer invention disclosures and patents, launch fewer startup companies, and are less successful attracting venture capital and angel funds (Rosser 2012).

As women increasingly join university faculties, this commercialization gender gap becomes progressively more problematic for institutions of higher education. Transferring ideas from the laboratory to the world of business is not only essential for our nation's economy, but also capitalizes on innovation, supports expanded experiential learning curricula for undergraduate students, and provides funding streams and revenue to researchers and institutions.

At Ohio State University (OSU), we have studied the institutional environment for academic entrepreneurship, especially in STEM fields, and offer insights about why higher education fails to attract and involve women scientists and engineers in the enterprise. The programs we have developed, with funding from the National Science Foundation's (NSF) ADVANCE program, show the path forward.

METHODS

As part of our ADVANCE Institutional Transformation grant, we proposed a two-year workshop series on entrepreneurship for women faculty. The two-year frame was inspired by a similar workshop series, the President and Provost's Leadership Institute, which has had phenomenal success transitioning women to leadership positions at Ohio State (Ohio State University 2011). Yet, there were significant challenges in our adapting that model to entrepreneurship.

Initially, we established a steering committee, including colleagues from Ohio State's Fisher College of Business, the technology commercialization office, and several women faculty at various ranks. The committee was charged with designing a curriculum for the entrepreneurship workshop series. However, cultural differences quickly emerged regarding what women faculty would need to know to become engaged in commercialization. Some insisted that a full grounding in the theory of entrepreneurship was essential, while others maintained that a purely practical approach was needed. After several months of little progress, we decided to conduct focus groups with women STEM faculty.

Accordingly, we met with six mid- to senior-level women faculty in STEM to discuss their careers and potential for engaging in commercialization of their basic research. We especially sought to understand the attitudes of women faculty who had vigorous and highly successful research careers, a group that has historically not engaged with technology transfer. Therefore, faculty were chosen to participate based upon two criteria: a prominent research profile and relative inexperience with commercialization. Included in this group were physical scientists, life scientists, and engineers.

RESULTS

Overall, our women faculty were found to have a preference for pursuing what they know they can do well, and we suspect that faculty elsewhere feel much the same. OSU women in STEM are highly successful researchers (their rates of funding and publication impact factors are similar to their male colleagues), tend to be risk-averse, and report being very busy. We also concluded that OSU women STEM faculty are highly attuned to the reward structure of the institution, and, as a result, tend to adopt behaviors that align with that reward structure. Not

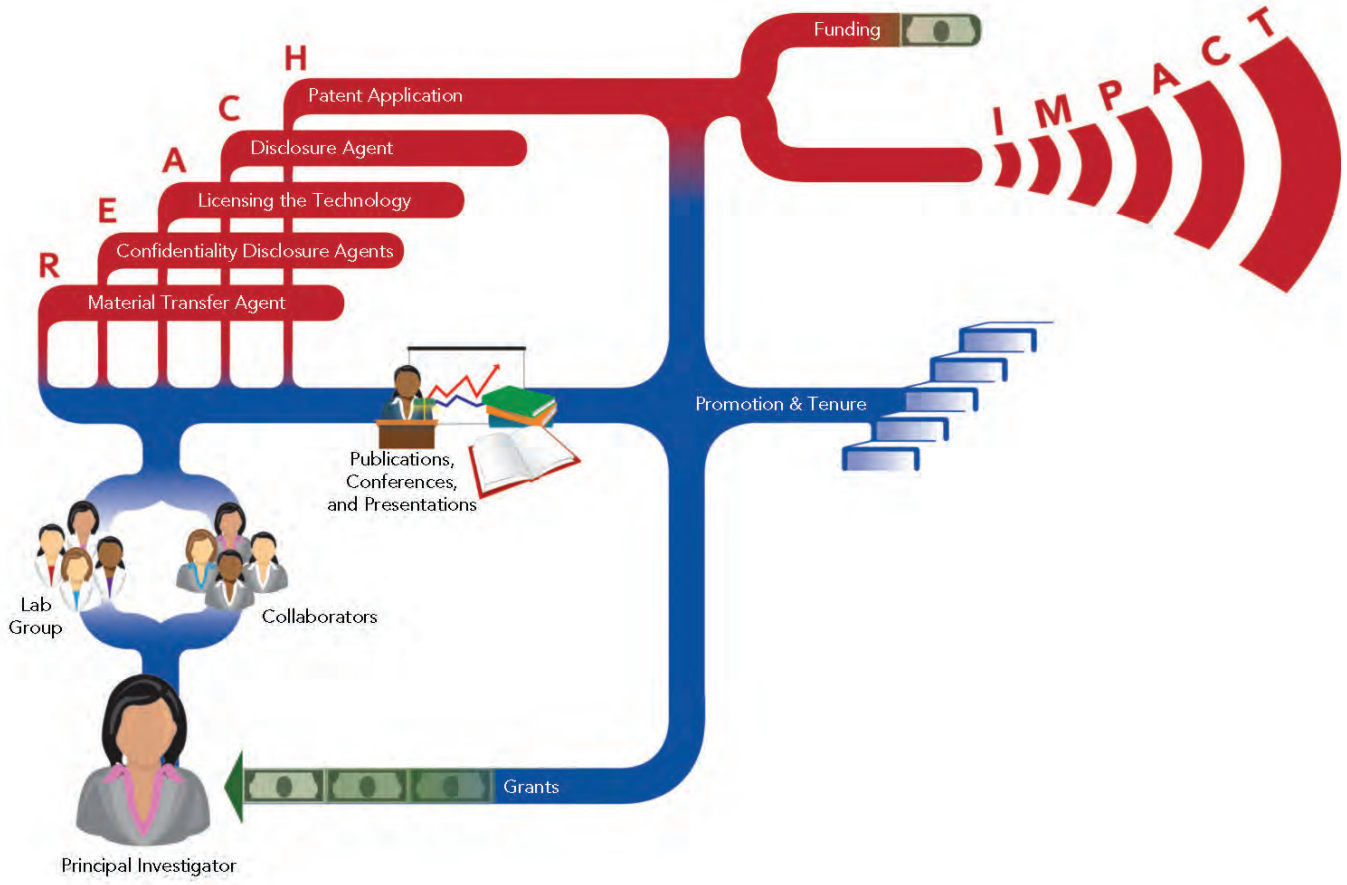
surprisingly, these women focus on traditional routes of securing support for research, namely extramural grants and contracts.

We also used our focus groups to determine what women STEM faculty consider to be relevant about the impact of their work. Several expressed frustration that breakthroughs from their labs, which have commercial potential, have been ignored by all but a small handful of specialists working in the same area. When asked to envision commercialization as an avenue for expanding the impact of their work, many of our colleagues in these focus groups became excited about the possibility of seeing their research make a real difference.

In sum, our focus groups revealed several themes related to the lack of involvement of OSU women STEM faculty in entrepreneurship:

- ***Time.*** While all faculty can claim to be busy, women expressed great reluctance to add work onto already overfull schedules.
- ***Source of Motivation.*** OSU women STEM faculty are, by and large, highly successful in garnering extramural grants and contracts to support their work. As a result, they are not motivated by the need for money.
- ***Tolerance for Risk.*** OSU women STEM faculty tend to be risk-averse, and maintain established, "safe" patterns of work, which have led to success. Commercialization lies outside of that domain.
- ***Perception.*** Faculty, particularly those in the basic sciences, have chosen academia over other career paths (especially industry). A strong prejudice against business thinking prevails, which produces a parallel distaste for commercialization—the "ick" factor. One faculty member even described venture capital funding as "dirty money."
- ***Knowledge.*** Pervasive ignorance about entrepreneurship is itself a deterrent. One faculty member described the first

FIGURE 1. SCHEMATIC SHOWING HOW THE COMMERCIALIZATION PROCESS (RED) CAN DRAMATICALLY INCREASE THE IMPACT OF RESEARCH BEYOND THE TRADITIONAL ACADEMIC ROUTES (BLUE).



step of moving into this sphere as "akin to crossing the Grand Canyon."

THE INTERVENTION—REACH WORKSHOPS

Our focus groups taught us that OSU women STEM faculty can become motivated to engage in commercialization when the activity is framed in terms of societal impact. All faculty want their research to matter, but most do not take steps to disseminate their work outside of traditional academic routes such as refereed journal articles and presentations at scientific conferences. We, therefore, designed our workshops to emphasize that impact (fig. 1). Specifically, we invited them to extend the REACH of their research via commercialization.

As we designed the REACH workshops, we kept in mind that our women faculty are highly successful, therefore extremely time constrained. As such, the most critical decision we made was to scale back the programming significantly from a two-year series to that of four two-hour workshops spread over a five-month period.

Designing these workshops required that we focus on what women faculty wanted to learn and how they would be inspired to follow through on their learning to engage in commercializing their research. We also learned from other efforts on campus that a "talking heads" approach would not succeed; our faculty need to envision themselves as entrepreneurs, with activities and learning tailored to their own work. Personalizing the training was our tactic to keep women faculty engaged in the workshop series.

The NSF ADVANCE program has led to numerous findings that underscore community building among Women STEM faculty as essential for organizational change. As such, a second important decision was to assemble cohorts of faculty, chosen by their deans and chairs, for our workshops. The cohort approach to our workshops not only provided content knowledge, but also assembled a coterie of like-minded individuals. The end result of two years of planning was a series of four REACH workshops that synthesized basic introductions to concepts of technology transfer with one-on-one analysis of research potential for the marketplace. Personalized attention allowed faculty to learn about emerging markets and potential investments for their technologies; having direct feedback on the potential of one's work often sparks successful commercialization.

We offered our REACH workshops on campus for two successive cohorts of faculty from Ohio State, and then adapted the content and format to develop a two-day workshop for a national cohort. The REACH workshops themselves were organized around three themes:

- ***Learning the Landscape.*** Because initiating a commercial enterprise is quite daunting, we offered an overview of the world of commercialization and also stressed some new ways of thinking. Faculty need to understand clearly that great research is not the same as marketable inventions, and they must be willing to accept the advice of those who know the market. Many mistakenly believe that commercialization must involve a startup company, an effort foreign to most academics in the STEM disciplines. When our participants learned about the myriad pathways for commercialization, their apprehensions were visibly assuaged. Furthermore, faculty were surprised to learn how long the process can take, that most inventions are not marketed, and that most patents never return their costs. By combining these reality lessons with examples of successful women scientist entrepreneurs, the workshop allowed participants to envision themselves and thereby gauge their potential in this new arena.
- ***Building the Team.*** Faculty mistakenly think they must become experts at business in order to commercialize. During our training, we offered a skills assessment session that helps individual faculty discover their strengths, as well as what kinds of skillsets they must seek in partners. When faculty learned that the business side is typically assumed by a partner, they were both relieved and apprehensive about losing control of their ideas. Finding the right team members for any given entrepreneur requires individualized analysis, and universities must be prepared to offer assistance connecting faculty with individuals in the business and regulatory world.
- ***Identifying Resources*** (especially for startups). Faculty may have heard about Small Business Innovation Research/Small Business Technology Transfer (SBIR and STTR) grants, but few knew how they are structured; even fewer had an appreciation for the timeline of commercial development, and the respective roles of small grants, angel funds, and venture capital.

To date, our REACH program has supported nearly one hundred women,

Personalized attention allowed faculty to learn about emerging markets and potential investments for their technologies; having direct feedback on the potential of one's work often sparks successful commercialization

including faculty and postdocs at fifteen institutions. We conducted pre- and post-assessment for our participants of their interest, knowledge, and potential for commercialization activities. We also conducted follow-up assessments and asked participants to submit reflective essays, the full results of which will be published elsewhere. In sum, they demonstrate that understanding of and interest in commercialization was elevated through our training, and those effects persisted for at least one year after the training itself. Furthermore, the number of industrial contacts for our participants and their involvement with our office of technology commercialization and knowledge transfer rose dramatically within two years; indeed, one of our alumnae received the Ohio State Innovator of the Year Award. We continue to track patent applications, industrial funding, and other metrics of commercialization activity, and will report on those in the coming years.

We were struck by two demographic characteristics of our participants. First, postdocs are eager for this kind of training, especially international postdocs. Many are interested in nonacademic careers, and expect to be involved in the world of patenting and commercialization. Indeed, interest by postdocs can often drive an entire laboratory to become entrepreneurial.

A second surprise was that individuals who were well-versed in commercialization sought our training. Even faculty with patents and successful startup companies wished to be involved in the workshops. They expressed several reasons for participating. Most wanted to stay current in their respective enterprises and were pleased that such training was available. Apparently, there is no such thing as too much support from an institution for successful tech transfer. Second, we learned that cultivating a community of women entrepreneurs is essential: women have different experiences than do men, and being able to share concerns and engage in peer problem solving is a powerful way for universities to foster faculty entrepreneurship. Further, because women often have shallower collegial networks, our REACH workshops proved significant in expanding their circle of colleagues. Indeed, our REACH alumnae continue to meet regularly to exchange experiences and seek peer support.

RECOMMENDATIONS

Change in the Reward System

Overall, our participants expressed concern that entrepreneurial ventures were not recognized as legitimate or valued faculty activities. While universities may offer considerable support for entrepreneurial activity, including a special office and a profit-sharing scheme, the academic reward system is not designed to include such pursuits. Clearly, if universities wish to attract their women researchers to commercialization, they must recognize such activity in the same way that research, teaching, and service/outreach are recognized. Explicit value must be placed on entrepreneurism for promotion and tenure reviews, annual salary deliberations, and other assignments. These activities must also be perceived as contributors to career development and advancement of stature within the institution. If we do not change the reward system, women who already perceive such activities as add-ons to overloaded schedules will simply ignore them.

Inclusive Excellence

Women often think about problems differently, and can develop new approaches to long-standing problems that also open up new areas of learning (Schiebinger 2008). OSU women responded very positively to the message that commercialization is a powerful mechanism to make a better world—whether through saving lives, developing new materials, combatting environmental degradation, or improving social programs.

CONCLUSION

Our work on entrepreneurship among STEM academic women has taught us a common lesson: systems established by men tend to appeal to and serve men's interests. In order to make those systems attractive and helpful to women, we must think more broadly about what motivates women and what they require to be successful. Institutions that tailor their programs to include women's needs will always outinnovate those that do not. ■

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Mission Possible:
Empowering Institutions with Strategies for Change

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The National Science Foundation's (NSF) ADVANCE Program began in 2001 with the primary goal of supporting the development of systemic, sustainable approaches to advancing women in academic STEM (science, technology, engineering, and mathematics) fields. Over the last thirteen years, over sixty universities have received significant institutional transformation (IT) ADVANCE grants, and many more have obtained funding to implement institutional partnerships or smaller initiatives, all focused on ameliorating the persistent underrepresentation of women in academic STEM careers. ADVANCE's mission is predicated on the understanding that promoting diversity in STEM facilitates both innovation and excellence. As the program's original descriptive synopsis notes, "The pursuit of new scientific and engineering knowledge and its use in service to society requires the talent, perspectives and insight that can only be assured by increasing diversity in the science, engineering and technological workforce." More than a decade of articulating the value of diversity and supporting efforts to reduce underrepresentation has made ADVANCE a national leader in fostering diversity in academic STEM fields.

So where are we now in terms of that underrepresentation? Since 2001 there has been a slow but steady increase in the number of female faculty in STEM education fields in the United States (NSF 2013). The overall percentage of US faculty women in the physical sciences increased from 16 percent in 2001 to 22 percent in 2010; in engineering the percentage increased from 8 to 16 percent (NSF 2013). Yet hidden within these encouraging trends are some troubling patterns, particularly regarding underrepresented minority (URM) women. Despite the growing number of doctoral degrees in STEM fields awarded to underrepresented racial/ethnic minorities, the percentage of women of color in academic STEM fields has in fact decreased (Asian American women are the exception) (National Science Board 2012). Moreover, American women of color continue to be underrepresented in STEM fields relative to their proportion in the overall US population; in 2010, African American, Hispanic, and Native American women collectively earned only 4.5 percent of doctorates awarded in science and engineering despite constituting 14 percent of the population of 25–64 year-olds (NSF 2013). These data clearly show that, despite advances for women overall, women of color continue to be an "untapped resource" of domestic talent for academic STEM fields (Ong et al. 2011, 200). As majority women now move forward in STEM fields at a pace exceeding that of women of color, the need to understand this disparity and find successful ways to support URM women in STEM is more urgent than ever.

We posit that one possible explanation for the overall positive increase for women faculty in STEM generally but bleaker outlook for women of color specifically is that approaches to institutionally supporting URM women have not typically been *intersectional* in perspective or approach. Originally emerging from critical race studies and gender studies, intersectionality holds that any identity category (such as gender) cannot be fully addressed (at the individual, social, or institutional levels) until understood in the full context of any individual's or group's *social location*—that is, relative to other intersecting and pertinent aspects of identity (Bowleg 2008; Crenshaw 1989; 1991).

The literature suggests that the active intersection of gender and racial/ethnic identity may indeed significantly impact the experience of URM women in STEM (Malcom and Malcom 2011). Leggon (2010) has argued that failure to systematically take the interaction

of identity categories into account results in policy, programs, and practices that are both inefficient and ineffective in developing and enhancing the STEM labor force. And available data consistently indicate that when institutions do consider the active intersection of gender and URM status through practices such as targeted hiring efforts, cultural- and identity-specific mentoring programs, or through access to ethnically/racially specific professional networking opportunities, URM women feel they "matter" and are more likely to thrive professionally (Blake 1999; Bova 2000; Kayes 2006; Thomas and Hollenshead 2001; Turner 2002).

Yet despite the promising evidence of what intersectional perspectives offer, institutional strategies for addressing underrepresentation in STEM in the United States have been routinely framed in "single target" ways that construe aspects of identity as distinct, e.g., women *and/or* underrepresented racial/ethnic groups. This means an institution often assumes an *additive* mode to fostering diversity, in which it is assumed that the disadvantaging effects of different aspects of identity can be summed together for any given individual. Under the additive approach, organizations take different kinds of URM status into account by adding categories of concern as new populations emerge or new groups are identified as underrepresented. The hope is that the cumulative effects of separate institutional initiatives will combine to adequately serve the needs of all URM faculty.

But attempts to institutionally address issues faced by persons with multiple subordinate identities by offering multiple single-identity programs may lead not to inclusion but rather to "intersectional invisibility" (Purdie-Vaughns and Eibach 2008). Because identities are not experienced vertically and independently but rather horizontally and simultaneously, "inclusive" policies may instead inadvertently promote intersectional invisibility for URM women in STEM. For example:

- Failure to see variations in the experience of "women of color" may unintentionally create new forms of marginalization. For example, in the United States, biases associated with Asian American women may be overlooked due to assumptions that Asian women do not experience racism because there is a proportional population in the STEM labor workforce.
- Programs designed to create supportive communities for women in STEM may be locations of intense stress for lesbian, bisexual, and transgender (LBT) women because they produce a dilemma where such women must expand efforts to mask their LBT status or "come out" to colleagues. Efforts meant to helpfully address work-life balance may result in additional marginalization for some LBT women.

As these examples show, interventions aimed at supporting URM women and increasing diversity in STEM may fail to create institutional spaces where complex, intertwined subordinations can be sufficiently articulated. Instead, the distinct needs and voices of the very people whose experiences lie at the juncture of multiple identities are effectively erased.

We suggest that the lack of progress of URM faculty women in US academic STEM fields (understood relative to majority US women in STEM fields) results from the kinds of issues and challenges that emerge when such well-intended initiatives (policies, support and resources, evaluation procedures, data collection structures, etc.) cannot address actual forms of disadvantage.

UNDERSTANDING THE CHALLENGES TO SUPPORTING URM WOMEN STEM FACULTY

In an effort to better understand the challenges that institutions face in supporting URM women STEM faculty, we conducted a study of eighteen universities that received large NSF ADVANCE IT grants. We focused on the efforts of IT programs funded since 2006, reasoning that an examination of later IT cohorts was warranted given NSF's progressive, evolving emphasis on diversity, now defined as "women of diverse characteristics and backgrounds including, but not limited to: race, ethnicity, disability status and sexual orientation." Our project goal was to examine these IT programs' overall attentiveness to issues faced by URM women (broadly defined) in STEM fields and identify strategies for addressing these issues, particularly if and when intersectional approaches were considered. Included in our assessment was an effort to highlight the common obstacles and enablers of these institutions' ability to successfully support URM women.

We gathered relevant publically available documentation for each IT program, including any specific program documents that the IT staff wished to share with us. Documents included the ITs' original NSF ADVANCE proposals, along with annual reports, related self-studies, and external evaluations. We then used standard content analysis procedures (Boyatzis 1998) to qualitatively measure evidence of interest in and development of diversity-related initiatives across ADVANCE programs, paying particular attention to those that considered the intersections of gender and other URM identities. We drew from the work by Diana Bilimoria and her colleagues (who developed a comprehensive assessment of the transformational initiatives of the nineteen first- and second-round ADVANCE IT grants) in order to meaningfully and consistently identify types of IT strategies (Bilimoria, Joy, and Liang 2008). Bilimoria's work resulted in the identification of a number of "pipeline" and "climate" initiatives and we used this approach to identifying initiatives to develop our own set of codes, which we then applied to our document analysis.

Findings from our document analyses then formed the basis of conversations with ADVANCE IT personnel and staff, which incorporated basic questions that we posed to all ITs and questions specific to the program goals and activities identified in our document analyses. A central question was, "What do you identify as the single most important institutional enabler and the most significant barrier to successfully supporting URM women at your institution?"

Our conversations with IT staff made it clear that programs are consistently interested in and deeply committed to supporting URM women but recognized that "we have a long way to go." There was consensus across programs that addressing the lack of women of color in STEM was a necessity and a priority and, in several instances, such efforts were a central focus of program efforts. However, while the results of our document analyses highlighted numerous differently structured programmatic efforts to support women STEM faculty, overall we found relatively few instances of programming specifically structured to address and support women of color or other URM women groups. The obstacles to doing so were often described as too great and the institutional challenges were typically characterized as overwhelming.

However, our findings revealed a persistent pattern of barriers and challenges faced by universities actively trying to promote institutional change for women at the intersections of multiple identities. Informed by our conversations with IT staff, we have identified five key "intersectional facilitators" that emerge from these challenges (and, in some cases, successes). We believe these five intersectional facilitators, complexly understood, offer innovative ways of thinking about change that can then drive new strategies for practical interventions.

THE FIVE INTERSECTIONAL FACILITATORS

Creating "Accountable Leadership" Specifically around Issues Concerning URM Women

The ability for programs to address the specific needs of particular groups of women begins with institutional leaders who are supportive in more than principle. While expressions of support are always useful, institutional leaders (provosts, deans, department chairs) must now *move towards a more active role as invested change agents for URM women in STEM*. Our research indicates that institutional leaders who participate actively, consistently, and cooperatively in efforts aimed at supporting URM women in STEM positively drive policy. Institutional leaders lend credibility and momentum to efforts at creating institutional change around a group that is too commonly seen as a "subset" of women. These leaders can foster change on multiple levels.

For example, an individual provost might chair a committee focused on URM women's needs, sending a clear message that those needs are an institutional priority; in other cases, a high-ranking administrator can make structural changes—such as relocating the office of equity under academic affairs to enable effective interventions in hiring. Leaders should also work with change agents (including URM women) to build structures of accountability around issues for URM women into the institution. Efforts at institutional transformation (such as the other four intersectional facilitators, described below) have "teeth" when they are linked to structures of assessment and evaluation in the larger institutional framework. "Intersectional invisibility" can be reduced if people with power require that the intersection of gender and URM status be seen. IT staff noted consistently that when leaders are passive or merely reactive, "things do not change."

Identifying Climate Zones

An institutionally specific awareness of the multiple locations of climate in which faculty find themselves is needed to understand the nuances and variations of the experience of women of color in STEM. There is no one "institutional climate." *Rather, every institution has multiple climates which may require several different strategies for intervention and change.* Institutional leaders and actors must work to both recognize and engage with multiple climates in a locally intersectional context. For example, university-wide climate can involve policies and procedures that may or may not create spaces for the voices of URM women to be heard. Climates across different disciplines and departments might be more or less welcoming to women of color. There also exist micro-climates that emerge from biases or stereotypes around certain differences (e.g., the climate for blacks v. Latinas), which can then generate specific and different experiences for particular URM women in the context of the same university or department. And all climates are located within larger local, geographical, or political climates that may be "isolating" or not supportive to URM women. For example, an intersectional perspective would ask how institutional policy can respond to the needs of women of color in a state with explicit anti-affirmative action policies.

Understanding the (N)umbers Game

It is now a truism to note that efforts at increasing the low numbers of URM women in STEM are paradoxically impeded by the low numbers of URM women in STEM. However, our research indicates that the "small N" problem can be more than shorthand for the challenges of institutional change or an expression of frustration. *This concept should also be understood as marking the boundaries of several key intersectional opportunities.*

The "small N problem" (1) signals the need for informed majority faculty to listen to URM voices and learn how to be effective allies in the specific context of that institution, (2) identifies imminent dangers

for the women of color present in the institution who are often trapped between serving as key "voices" for URM women and the exhaustion of tokenism and such representational work, and (3) alerts the institution to the dangers of hierarchizing URM groups, which may take the form of obsessively counting women of color (e.g., referencing numbers of black faculty—while not acknowledging those numbers are often a revolving door) or not tracking or addressing the need of populations of URM women with "other" subordinate identities (women with disabilities, LBT women). Institutional change agents must also leverage the "small (N)" problem as an opportunity to name and intervene in the dynamics of majority privilege and learn how to be effective allies to URM women.

Overcoming Epistemological Hurdles: The Need to Learn and Listen

There is a world of valuable research on issues facing URM women in STEM and on strategies for institutional transformation—but that does not mean that people in support of or active in transformational projects are aware of the work that has been done. There appears to be a frequent "knowledge gap" between research and the agents of change at any given institution and often among the change agent team members themselves. *Leaders and change agents must become knowledgeable about common institutional obstacles and solutions and aware of the key scholarship and research findings specifically on the issues most commonly effecting URM women in STEM.* It is critical that administrators and leaders come to the table educated so that we break the burdensome cycle of explanation and justification under which many change agents, particularly URM women, labor. For example, only when institutional leadership and change agents are knowledgeable about the research on implicit bias can they effectively hold other decision makers (e.g. search committees) accountable. Key in these educated power structures are department chairs, who were most often identified as the "points of change."

Promoting Community Structures: Engaging URM Women on Their Own Terms

When an institution re-imagines what groups are, how they are formed, and where they are located, it allows URM women to develop and access support in new spaces. In our analyses we saw instances of models of cooperation across universities (as project partners or within consortia) and also state-wide partnerships that provide women opportunities to find other women with whom they shared a particular identity, thus allowing for collaboration or mentorship. Research shows that URM women in STEM benefit directly from structures that bring them together, increase their investment in organizational change, and bolster their knowledge about campus structures and resources (Turner, Gonzalez, and Wong 2011). At the same time, because of the particular challenges that an intersectional perspective makes clear, *URM women need opportunities to organize themselves, define their own needs, and create communities that make sense to them.* As one program with noted success in supporting women of color noted, "we don't do things 'for them'—we empower them."

Institutions need to recognize the fact that an intersectional perspective requires that change agents from majority groups create venues through which URM women can be recognized on their own terms as primary change drivers—and not as objects of study, goals to be reached, or secondary or passive recipients of change. ▪

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Always the Exception:
Women and Women of Color Scientists in Historical Perspective

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In March 2014, France Córdova, astrophysicist and former chancellor of Purdue University and the University of California–Riverside, became the first Latina to serve as director of the National Science Foundation (NSF) in its more than sixty years in existence (Morello 2013). This position is one of the most influential in American science. As director of the only federal agency tasked with supporting basic research and education in science and engineering disciplines, Córdova oversees a multibillion dollar budget to ensure continued US leadership in scientific discovery and the development of new technologies.

Despite the presence of a woman of color leading this prominent funding agency, women overall still remain underrepresented in other national organizations, including the National Academy of Sciences (NAS). Incorporated by Congress in 1863, NAS is a distinguished society of scientists and scholars that advises the country on all matters related to science, engineering, and technology. However, in its 150-year history, neither has there been a woman president nor are women well represented among its elected membership. On average, women account for 10 percent of its elected members annually, and in 2013, only 213 of its 2100 members were women (IAP 2014). Since the NAS does not share disaggregated membership data, it is impossible to know the actual number of US-born underrepresented minority (URM) women who are members. Physicist Shirley Ann Jackson, president of Rensselaer Polytechnic University, may be the only one.

One wonders who will be next, and when. Even the top fifty STEM (science, technology, engineering, and mathematics) departments (as determined by NSF), where many current and future scientists and engineers advance their careers, do not inspire much confidence. In a 2010 study, Nelson and Brammer noted that "URM women faculty, especially full professors, are almost nonexistent in physical sciences and engineering departments at research universities. Surprisingly, most of the few female minority professors in those disciplines were not born in the United States." For those minority women scientists and engineers that are US born, the low number is especially stunning, particularly when considering that many of the structural barriers that impeded their full participation in higher education in the mid-1900s were removed decades ago with the passing of the Civil Rights Act (1964) and Title IX (1972).

Today, the underrepresentation of women of color in institutions of higher education approximates levels characteristic of the Jim Crow era (1876 to 1965), when society was structured to subordinate people of color. At that time, the very curiosity of women of color about the natural world and their desire to be experts challenged the institutions of American science and their unquestioned self-image as the privileged domain of white males. If anything, the current status of women of color in key STEM institutions reminds us not only how much the United States has changed, but also the glacial pace of change in academic science.

This is particularly evident in the historical data on PhD production. Although the data before 1960 is imperfect, the effects of racial and gender barriers in science are still quite obvious. The total number of white women earning PhDs grew from 25 before 1890 to 204 in 1900. While their absolute numbers continued to grow through late 1930s, the relative share of science doctorates earned by women declined from a high of 15.5 percent to a low of 11.5 percent. (Rossiter 1982).

Data for African American women PhD recipients paint an even more dismal picture. Of the 381 known PhDs awarded to African Americans through 1943, only 48 were earned by women. Among these recipients were some of the earliest women to receive degrees in the natural and behavioral sciences (table 1).

BECOMING A SCIENTIST IN THE AGE OF JIM CROW

The promise of remaking the United States into an interracial democracy ended in 1876. A combination of state laws and local practices constructed a vast system of racial caste that subordinated African Americans to whites in all facets of public life. In 1896, this system was sanctioned by the US Supreme Court in the *Plessey vs. Ferguson* decision, which upheld "separate but equal" as constitutional.

Higher education was deeply affected by this culture of white supremacy. It shaped the origins of many of today's pubic land-grant universities. Although the landmark Morrill Act (1862) transferred federal lands to states to establish industrial colleges in southern states, they would enroll exclusively white men and women. Congress legitimized racial segregation in higher education in a second Morrill Act (1890) by provided funding for existing and new universities to serve African Americans (Roebuck and Murty 1993).

However, African American women who sought higher education faced the double bind of gender prescription and racial discrimination. As daughters, they were taught how to negotiate the often perilous racial norms. Whether raised in working- or middle-class families, education for them was highly valued as a means of community uplift. At the same time, these women were subjected both to powerful social expectations to care for their families and society as wives and mothers and institutional quotas that limited their participation in colleges and universities.

The purpose of higher education for women was not to serve as a stepping-stone to a career and life of independence but, rather, to equip them to fulfill traditional domestic roles. In fact, it was family responsibilities that delayed some from starting or completing graduate school. For instance, it took Roger Young fourteen years before she received her PhD in 1940 from the University of Pennsylvania after earning her master's degree at the University of Chicago. During that time, she taught classes and conducted experiments for her mentor, Ernest Everett Just, when his frequent research trips to Europe were necessary. The income supported her ailing mother, but the sense of exploitation, the burden of family responsibility, and the struggle to advance her work took a heavy toll on her own physical and mental health.

The image of the scientist as white and male was neither an accident nor the random distribution of interest, talent or merit, but, rather reflected structures and choices that differentially burdened, oppressed and devalued women in general and women of color in particular.

TABLE 1. FIRST AFRICAN AMERICAN WOMEN PhD RECIPIENTS IN STEM FIELDS

NAME	UNDERGRADUATE INSTITUTION	GRADUATE INSTITUTION (YEAR)	DISCIPLINE
Ruth E. Moore	Ohio State University	Ohio University *(1933)*	Bacteriology
Ruth Howard Beckham	Simmons College	University of Minnesota *(1934)*	Psychology
Flemmie Kittrell	Hampton Institute	Cornell University *(1935)*	Nutrition
Jessie J. Mark	Prairie Valley College	Iowa State University *(1935)*	Botany
Roger Arliner Young	Howard University	The University of Pennsylvania *(1940)*	Zoology
Ruth Smith Lloyd	Mount Holyoke College	Case Western Reserve University *(1941)*	Anatomy
Marguerite Williams	Howard University	Catholic University *(1942)*	Geology
Marie Maynard Daly	Queens College	Columbia University *(1948)*	Chemistry
Phyllis Wallace	New York University	Yale University *(1948)*	Economics
Evelyn Boyd Granville	Smith College	Yale University *(1949)*	Mathematics
Dolores Cooper Shockley	Xavier University	Purdue University *(1955)*	Pharmacology

NEGOTIATING THE BARRIERS OF RACE AND GENDER

The academic choices of those women of color reflected the contemporary landscape of higher education then and mirrored those of all women in higher education today, particularly in the STEM disciplines. Scholarship support was crucial, but it is also likely that during their careers these pioneering women experienced the hyper visibility and social isolation that is often associated with being the only woman or one among a few in their classes or on campus. Further, the psychosocial load was made heavier by the pressure to perform not simply for a course grade or even to satisfy a degree requirement, but to refute the pervasive racist representations of the inferiority of African Americans in popular culture. On their shoulders rested an impossible burden: reconciling the myth of American meritocracy with the reality of racism and sexism in and outside of the academy.

Even with the distinction of an undergraduate degree, for these women of color the path to the doctorate was contingent on satisfying two conditions wholly unrelated to their preparation and promise: identification of universities that permitted them to enroll and access to faculty who were willing to work with them. Finding a supportive faculty advisor was essential. Then, as now, faculty advisors and mentors played a key role in the next stage of educational achievement. They formed part of a network that created pathways for women of color to enter and persist in research universities. As gatekeepers, they inspired these talented women to pursue graduate study while validating their competency and affirming their character. For established white male and female faculty, advising one African American graduate student did not threaten their reputations. On the contrary, it widened their protégée circle

without significantly disrupting the social landscape of academic science. Still, the very institutions that awarded degrees to African Americans would not hire them in any field for several decades to come.

Consequently, with their doctorates in hand, these women joined the faculties at minority-serving institutions, which primarily focused on undergraduate education in the liberal arts or vocational subjects. By the turn to the twentieth century only a handful offered master's degrees and only in a limited number of science fields. None awarded PhDs until 1958, when Howard University bestowed the first PhDs in chemistry and zoology. The life of a faculty member at these institutions involved considerable teaching, little time for research, and the challenge of sexual double standards. For example, Moore and Shockley rose to head the departments of bacteriology and microbiology at Howard University and Meharry Medical College, respectively. Even though they led important and large units, neither was ever promoted to full professor. Similarly, Ruth Lloyd joined Howard's medical school as an assistant in physiology and anatomy and was promoted to instructor. Sixteen years passed before she became an assistant professor.

For others, a research career involved a circuitous path in and out of institutions of higher education. Ruth Howard, a specialist in childhood development, began her independent research career at the Illinois Institute of Juvenile Research and later the National Youth Administration in Chicago. She and her husband, Sidney Beckham, established their own consulting practice. Marie Daly began her faculty career as an instructor at Howard in 1949 and ended as a professor at Yeshiva University's Albert Einstein College of Medicine in 1986. Between these milestones she was an instructor at Howard, a research assistant at Rockefeller Institute, a research associate at Columbia University Research Service, and a professor of biochemistry at the College of Physicians and Surgeons of Columbia University. Her research explored the biochemical effects of cholesterol, sugars, and smoking on the human body.

Regardless of their varied trajectories, these women scientists applied their training and research to improve the condition of society. At a time when the vast majority of medical schools refused or limited the admission of African Americans, Ruth Moore and Dolores Shockley played an integral role in the production of health science professionals. A specialist in nutrition, Flemmie Kittrell raised awareness about malnutrition in the United States and campaigned for improved farming practices throughout the world. She also was an architect of the Head Start program. Early in her tenure as a faculty member, Evelyn Granville noticed the inadequate preparation for college-level mathematics among students. She not only coauthored *Theory and Application of Mathematics for Teachers* (1975), but also participated in NSF-funded math-enrichment initiatives for school children and professional development programs for teachers. At MIT, Phyllis Wallace's ongoing activist research on race and gender discrimination gathered momentum and included some of the earliest studies of salary equity in corporate America.

CONCLUSION

By the time the careers of these women of color began to wind down, the landscape of academic science had changed. In response to World War II and the subsequent Cold War, the flood of federal dollars to universities enabled research universities to expand their capacity for innovation and research. However, the impact of the revenue associated with overhead and subsidized tuition for returning male veterans did more than contribute to research. It also reinforced the structures of race and gender exclusion and discrimination that had historically characterized science. Even in the wake of the civil rights movement, universities and their faculty either resisted change outright, or changed slowly as a result of the fear of losing federal support that funded post-war academic science.

Despite stunted career horizons that arose for no other reason than their gender and race, these pioneers pursued with temerity their curiosity about the earth, nature, and society and challenged an entire social system—including the institution of academic science—that was organized to marginalize them at best and subordinate them at worst. Today, many of their achievements have been widely recognized. In 1989, Smith College awarded Evelyn Boyd Granville an honorary degree. The American Home Economics Association also established a scholarship in the name of Flammie Kittrell, the American Society for Microbiology now features Ruth Moore on its history webpage, and the American Chemical Heritage Foundation celebrates the career of Marie Daly.

However, if given the choice between equity and equality or deferred recognition in the twilight of their careers, I suspect all of these trailblazing women would have preferred the unfettered opportunity to advance knowledge as full members of society and the US scientific enterprise. ▪

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AAC&U Work on Diversity, Equity, and STEM

About Project Kaleidoscope

Project Kaleidoscope (PKAL) is AAC&U's center of STEM higher education reform dedicated to empowering STEM faculty, including those from underrepresented groups, to graduate more students in STEM fields who are competitively trained and liberally educated. PKAL also works to develop a scientifically literate citizenry as part of its commitment to principles and practices central to AAC&U's Liberal Education and America's Promise (LEAP) initiative. Since its founding in 1989, PKAL has been one of the leading advocates in the United States for transforming undergraduate STEM teaching and learning. It has to date empowered an extensive network of over 7,000 STEM faculty and administrators committed to the principles, practices, and partnerships that advance cutting-edge, integrative STEM higher education for all students. To that end, all PKAL undertakings are uniquely designed to foster quality, diversity, and social responsibility.

Select AAC&U/PKAL Projects

TIDES

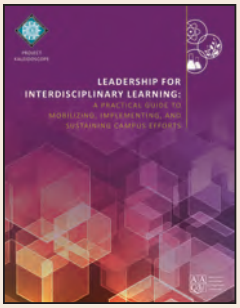
The TIDES (Teaching to Increase Diversity and Equity in STEM) initiative supports curriculum and faculty development activities to develop models for broader institutional change and to advance evidence-based and culturally competent teaching in STEM fields, particularly in the computer and information science domains. The overall goal of this three-year initiative is to increase the learning outcomes and retention of students historically underrepresented in the computer/information sciences and related STEM disciplines. The project will pursue two goals: (1) develop and implement curricula that will enhance underrepresented STEM student interest, competencies, and retention rates; and (2) empower STEM faculty to adopt culturally sensitive pedagogies and sustain the necessary changes in practice required for relevant and inclusive STEM teaching.

Preparing Critical Faculty for the Future

The goals of the Preparing Critical Faculty for the Future (PCFF) project are to provide professional and leadership development for women of color faculty in science, technology, engineering, mathematics (STEM), or in NSF natural and behavioral science disciplines; and improve undergraduate STEM education at HBCUs and beyond. This project is funded by the National Science Foundation's Historically Black Colleges and Universities-Undergraduate Program (HBCU-UP).

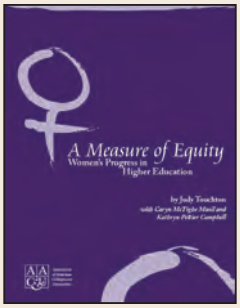
Women of color faculty in STEM disciplines at HBCUs are the critical focus of PCFF. Preparing these faculty members for the future is critical because enrollment at HBCUs typically consists of approximately 70 percent women and because HBCUs confer nearly 25 percent of all baccalaureate degrees earned by African Americans. HBCUs are among the nation's leading institutions in producing graduates who go on to obtain PhD degrees. By uncovering useful strategies for preparing women faculty of color for academic leadership in STEM fields, PCFF expects to improve STEM education broadly as well as at HBCUs.

Select AAC&U/PKAL Publications



Leadership for Interdisciplinary Learning:

A Practical Guide to Mobilizing, Implementing, and Sustaining Campus Efforts



A Measure of Equity:

Women's Progress in Higher Education

By Judy Touchton, with Caryn McTighe Musil and Kathryn Peltier Campbell

If Not Now, When?
The Promise of STEM Intersectionality in the Twenty-First Century

▸ **Nancy Cantor,** chancellor, Rutgers University–Newark; and AAC&U senior scholar
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Patrice McDermott, vice provost for faculty affairs, University of Maryland Baltimore County; and AAC&U senior scholar
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Nearly forty years ago, a small group of highly accomplished women of color working in STEM fields gathered together to share their stories about how the "double bind" of race and gender had set them "apart at every turn," required difficult personal choices, and rendered the price of a career in science—particularly in higher education—far too high. Their resulting collective sense of mission produced the first recorded blueprint for change specifically designed to alter the forces that had kept them small in number, relatively invisible, and excluded from mainstream science (Malcom et al. 1976). Yet, after decades of work and sacrifice to open the doors for women of color in STEM fields, differential participation persists, disparities in level of achievement continue, and a career in science still exacts a heavy personal and professional toll. And so we ask, what new approach can we bring to bear on this issue in order to make the most compelling case for change as we face the challenges of the twenty-first century?

STEM AND SOCIAL JUSTICE

There are many good and fair reasons to invest in increasing the number of women of color in STEM and not least among these is the social justice argument that the opportunity to pursue personal and professional success is a fundamental right for all of our citizens. But, faced with new labor market projections that indicate students of color will account for 45 percent of the nation's public high school graduates by 2020 (Prescott and Bransberger 2012), we cannot continue to merely implore institutions of higher education to "do the right thing." Moreover, the majority of students in this pool of students are female. Among African Americans, for example, approximately 64 percent of all college enrollees are female. Nor can we continue to allow a slow pace of change that focuses solely on the necessary, but insufficient, effort to add one, two, or three more women of color to a physics lab or computer engineering department.

We argue that this is not a matter of eschewing the social justice case; it is simply a matter of unpacking that case within our current economic context. Our nation is facing a STEM pipeline crisis in a world where both our workforce needs and the growth of our international competition are growing at an ever accelerating pace. Students who live at the intersection of race, gender, ethnicity, and class are disproportionately absent from the STEM enterprise, and yet they constitute the fastest growing college-aged population in the United States (National Science Board 2010). In view of the current and future racial and gender demographics of the US college population, the United States cannot continue its global leadership in STEM without an acceleration in its production of women in general and women of color in particular for the STEM workforce. Thus, the scientific questions we need to address, the scientific talent we need to develop, and the deeply entrenched conditions that continue to foreclose the possibility of inclusive excellence, are now situated in more complex ways.

USING AN INTERSECTIONAL LENS

As this issue of *Peer Review* aptly demonstrates, continued reliance on narrowly construed arguments for diversity—with singular and mutually independent categories of race and gender—can never adequately address this challenge. Clearly, if we are really going to meet the demands of the twenty-first century through the pursuit of full participation in STEM, we must remake the academy in a way that fundamentally values what intersectional groups bring to the table (Sturm 2006). Intersectionality is a well-established contextual framework for understanding how multiple categories of difference work together to determine social experience, patterns of knowledge production, and systems of subordination (Cho et al 2013). The intersectional lens pushes us to ask new questions about the conditions under which talent can thrive. It expands and deepens our scientific understanding of lived experience and our predictive models in arenas as far-ranging as health and nutrition, environmental sustainability, and the nuances of the digital and cultural divides of our world.

To truly understand what needs to be done we have to address these issues with nuanced perspectives that cannot be captured through broadly drawn dimensions of gender or race. We must recognize that our students don't want to be captured that way. In their lived experience, dimensions of race and gender might be secondary to their immigrant, first-generation experience or completely confounded by class-bound conditions in particular geographic locations. If we are to fully tap the talent in underrepresented populations, this effort will require us to think about under-examined contexts like large urban centers, where these trends are particularly acute. It also requires that we target the richest environments for change, including our urban campuses, HBCUs, and other minority-serving institutions, which have been historically marginalized and underresourced but are best positioned to teach and conduct research from culturally diverse perspectives (Taylor and Carter 2006).

Similarly, an intersectional analysis forces us to examine the specificity of institutional transformation in order to create the fertile intellectual environments that will attract underrepresented talent and enable it to thrive. It drives us to seriously and systematically mentor the next generation of scientists in ways that empower them to persist in a profession in which federal funding cuts threaten the ability of faculty to conduct scientific research with broad impact at all but the most elite institutions. It compels us to reconsider today's system of tenure and promotion that often exacts a high price from the underrepresented faculty we wish to attract and the communities they wish to engage, partner with, and impact (Alston and Cantor 2014). Surely, such institutional transformation will benefit all engaged faculty, but arguably this is most pivotal, in light of our national needs right now, for otherwise underrepresented faculty in the STEM talent pool.

If we are to make real use of the talent in underrepresented populations, it will require us to think about under-examined contexts like large urban centers, where these trends are particularly acute

GROOMING THE NEXT GENERATION OF STEM WOMEN FACULTY AND EMERGING LEADERS OF COLOR

The intersectional analysis also propels us to address both the cultural competence and the race/gender composition of our STEM faculties—and our academic leaders. Rarely have we attended to these issues in our efforts to increase the enrollment of women of color in science and engineering, especially at the leadership level. The impact of same race, same gender faculty, mentors, and leaders on the enrollment, retention, and graduation of women students of color has been reported in the literature (Bettinger and Long 2005). The NSF-funded OURS program (Opportunities for Underrepresented Scholars) at the Chicago School of Professional Psychology is an example of an intensive professional development experience designed to groom the next generation of STEM women faculty and emerging leaders of color for leadership roles in academia. Such efforts underscore the essential, and now threatened, contributions the social and behavioral sciences provide in the areas of cultural competency and inclusive excellence in STEM (Leibow 2013).

Finally, we are convinced that an intersectional approach offers a powerful means of producing new knowledge and the more fully human social and institutional practices that will be essential for improving the quality of life for both majority and minority populations in the twenty-first century. What is the probability of producing good science if you leave vast pools of talent and sources of innovation behind? Science often works by comparative analysis and contrast; an understanding, for example, of cardiovascular structure and function in women yields new insights into cardiac physiology as a biomedical subdiscipline, and improves health outcomes not only for women, but also children and men. When we look at the intersections

of race, gender, class, national origin, disability, sexual orientation, geographic location, and more, we enter into a deeper and inescapably necessary understanding of science and the human experience.

It is frequently said that truth is often the perception of truth viewed through the lens of culture. If the same can be said of scientific truths, then the advancement of inclusive excellence is our greatest potential resource not only for gender equity and global competitiveness, but for better science. Indeed it is the only thing that can single-handedly and simultaneously create space for multiple cultures to be embraced, diverse research questions to be asked, different research methodologies to be considered, and multifold interpretations of data to be explored. ▪

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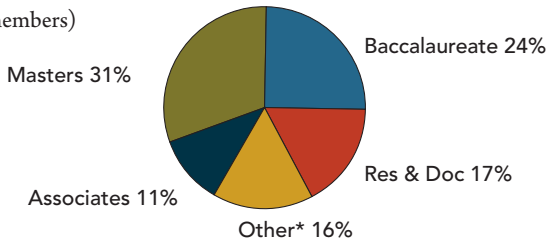

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