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Using Research to Inform Policies and Practices in Science Education: Conversations With Faculty and Administrators

Postsymposium Report

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Using Research to Inform Broadening Participation in Science, Technology, Engineering, and Mathematics (STEM) Higher Education and Academic Pathways

Providing all students with equitable access to high-quality STEM education, including equitable access to opportunity and encouragement to pursue STEM academic and career pathways, is one of the nation's greatest education priorities and challenges. The labor market of the 21st century requires graduates with STEM competencies and skills at all levels of the workforce and in many job sectors. A diverse workforce proficient in STEM is required to sustain the economy and to produce economic stability and mobility among the nation's citizens (Carnevale, Smith, & Melton, 2011; President's Council of Advisors on Science and Technology [PCAST], 2012; Rothwell, 2013). With labor projections indicating growth in STEM-related jobs that far exceeds growth in non-STEM jobs (Langdon, McKittrick, Beede, Khan, & Doms, 2011; PCAST, 2012), the United States must engage and prepare students of all races and ethnicities, socioeconomic backgrounds, and geographic regions in high-quality preparation in STEM at each education level.

Broadening participation in STEM academic pathways, particularly at the highest academic levels, is a necessary strategy for meeting the STEM needs described. Census reports forecast that by the year 2043, the United States will become a majority–minority nation, with only 43 percent of the population being composed of single-race, non-Hispanic White individuals (U.S. Census Bureau, 2012). Although the non-Hispanic White population will remain the largest single group, no group will make up a majority of the nation's population (U.S. Census Bureau, 2012). Current participation rates in STEM are not reflective of this growing diversity, particularly at the graduate-school level and among the highest faculty ranks (Nelson & Brammer, 2010). The dearth of underrepresented minorities (URM) and women of all races and ethnicities in tenured and tenure-track STEM faculty positions at research universities limits the availability and array of role models for new generations of scientists. As a result, the talent pool of individuals who can offer new approaches to research and practice in these critical fields is diminished (Holmes, 2011; Nelson & Brammer, 2010; Rosser & Taylor, 2008; Zumeta & Raveling, 2002).

Despite urgent calls (and multiple efforts) to broaden participation in STEM, increasing the number of URMs and women of all races and ethnicities in many of these fields has remained a challenge. Many students who express an interest in STEM studies and careers, including those who also demonstrate aptitude and achievement, do not earn STEM-related degrees (PCAST, 2012). Currently, fewer than 40 percent of students who enter college intending to major in a STEM field complete a STEM degree (PCAST, 2012). Studies suggest that many students, especially those who have traditionally been underrepresented in science and engineering fields, leave scientific studies or change scientific career aspirations because the STEM academic community is unwelcoming, uninspiring, or structured to "weed out" rather than nurture and encourage talent and diversity (National Research Council, 2009; PCAST, 2012; Sonnert, Fox, & Adkins, 2007).

Any efforts aimed at broadening participation in STEM need to consider not only the potential explicit biases that present obstacles to URMs and women in these disciplines but also the more implicit biases that hinder underrepresented groups' advancement through STEM pathways. Social science research offers important insights into the biases and barriers. These insights can help institutions of higher education build their capacity to support broadened participation in STEM by developing more effective strategies that are informed by the research and the local contexts in which they operate. For example, research indicates that the following factors must be considered in designing efforts to enhance underrepresented groups' recruitment, retention, and career aspirations in science:

- The academic and social integration of URM and female students pursuing degrees in STEM into their discipline of study (see for example, Chubin, 2007; Herrera, Hurtado, Garcia, & Gasiewski, 2012; Poirier, Tanenbaum, Storey, Kirshstein, & Rodriguez, 2009; Tinto, 1986, 1993)
- The support systems that are in place for URMs and women within their department, including opportunities for authentic and meaningful mentoring relationships and the presence of viable and relevant role models (see for example, Busch-Vishniac & Jarosz, 2007; Davis, 2008)
- The extent to which URMs and female students are made aware of and socialized into the rewards of a STEM career, especially in academe (see for example, Gay, 2004; Golde, 2005; Payton, 2004)
- The extent to which URMs and women who are in STEM degree programs or early in their careers as academic scientists encounter cultural marginalization, isolation, or stereotype threat (Busch-Vishniac & Jarosz, 2007; Charles, Fischer, Mooney, & Massey, 2009; Gay, 2004; Steele, 2010; Steele & Aronson, 1995)
- The extent to which the programs and strategies being developed reflect an *ecological approach* to creating an institutional culture that welcomes and supports diversity in STEM (Malcom-Piqueux, 2013; Renn, 2004)

In September 2013, American Institutes for Research (AIR), with the support of a grant from the National Science Foundation (NSF), convened a two-day symposium, *Using Research to Inform Policies and Practices in Science Education*, to engage key stakeholders in a series of discussions on how social science research can inform broadening participation efforts in STEM (see Appendix A for meeting agenda). Specifically, the symposium brought social science researchers and STEM faculty and administrators together to explore ways that STEM academic departments can use social science research to provide more supportive environments for underrepresented groups of individuals in academic science. With this objective in mind, researchers and practitioners who were using social science research to guide programmatic efforts were invited to share their work and foster conversations with faculty and administrators. In turn, practitioners were offered opportunities to share their perspective on the how the research could be applied, the associated challenges, and potential solutions at their institutions and more broadly (see Appendix B for a list of featured speakers).

The symposium was divided into four topical sessions, each of which was designed to address critical questions for the field:

1. **Developing a science identity.** What factors are contributing to the attrition of talented underrepresented minorities and women from STEM degree programs? Is it possible to support the development of a positive "science identity" to improve student retention and success?
2. **Stereotype threat.** How does stereotype threat influence the recruitment and retention of underrepresented minorities and women in science? What actions can be taken to mitigate the stereotyping of individuals from underrepresented groups in STEM?
3. **Chilly climates.** What barriers impede the recruitment, retention, and advancement of women and underrepresented minorities in science faculty positions? How can the cultures of academic departments be changed to better attract and support a diverse faculty workforce?
4. **Science education in the current fiscal environment.** What are the price and cost of producing graduates with science degrees? How does the price differ for students of different racial and ethnic backgrounds and who attend different types of institutions? What are the financial conditions that impose on students' STEM pathways?

This postsymposium report summarizes the research that was presented at the symposium and the ensuing discussions among symposium participants. Although this report organizes the discussion around each of the four topical sessions listed, it is important to note that, throughout the convening, presenters and discussants emphasized that any approach aimed at broadening participation must be comprehensive in nature. Isolated efforts will not foster the level of cultural and institutional changes critical to support diversity. As keynote speaker Lindsey Malcom-Piqueux emphasized, "an *ecological* approach is required—one that effectively creates opportunities, strengthens minority-serving institutions, provides supporting individuals, and can lead to institutional transformation."

Developing a Science Identity: A Need for Increased Understanding and Change

An individual with a well-developed science identity is one who exhibits "competent performance in relevant scientific practices and a deep and meaningful knowledge and understanding of science, and recognizes herself and gets recognized by others as a 'science person'" (Calabrese et al., 2008, p. 1*)*. The process of STEM identity development is "both a reflection of how one perceives and positions and aligns oneself with STEM, and how they are perceived and recognized by meaningful others" (Herrera et al., 2012, p. 10).

This ability to self-identify with science and to see oneself—and be seen—as a scientist can serve as a lens for understanding how the dimensions of an individual's identity, such as gender, race/ethnicity, religion, and class interact. The inability to self-identify with science and to successfully pursue a STEM graduate degree is most salient among groups of individuals whose identities do not align with the predominantly White, masculine norms found within most STEM disciplines (Cheryan & Plaut, 2010; Fries-Britt, Johnson, & Burt, 2013; Herrera et al., 2012; Stout, Dasgupta, Hunsinger, & McManus, 2011). Theories of intersectionality suggest that an individual's multiple identities intersect or intermingle within the context of a given situation or environment in ways that affect self-perception, experience, sense of belonging, and behavior (Crenshaw, 1989; Grant, Kennelly, & Ward, 2000; Ken, 2008). For underrepresented groups in STEM, reconciling personal identities of race or ethnicity, gender, and religious and cultural backgrounds with a largely White male-dominated academic environment can challenge science identity development. These individuals may struggle to connect their academic studies to their non-STEM communities or may view their own research goals and perceptions of themselves as in alignment with the norms of the predominant academic community (Fries-Britt & Holmes, 2012; Fries-Britt, Rowan-Kenyon, Perna, Milem, & Howard, 2011; Fries-Britt et al., 2013; Herrara et al., 2012; Tate & Linn, 2005).

Opportunities for Broadening Participation

Participants in the session noted that science identity was a vital lens for enhancing the fields' understanding of factors that may be contributing to the continued underrepresentation of certain groups of individuals in STEM academic programs and careers. Often, departmental efforts to broaden participation in STEM are concentrated primarily with enhancing students' STEM competencies while ignoring the other identity-related factors that could be influencing their academic and career pursuits. How does their position in the STEM community impact their faith and relationships with family, and vice versa? This information needs to be considered and could be used to strengthen efforts to support historically underrepresented groups in STEM.

The research conducted by this session's panelists served to highlight how gaining a strong sense of belonging in STEM and the ability to negotiate and reconcile personal and academic identities are critical factors in supporting students' persistence and success. Dr. Charles Lu, Director of Academic Advancement and Innovation at the University of Texas at Austin, presented his research on Latino males in STEM doctoral programs. The results of Dr. Lu's study demonstrated that the students struggled with overcoming their own perceptions of "who does science." They described their vision of scientists as "unattractive, older White men." This image made it difficult to negotiate and reconcile their personal identities related to their ethnicity, religious beliefs, and cultural backgrounds with their academic environments. Students described having to keep their religious identities separate from their scientific identities, or to keep their religious identities "hidden" from others within the community. However, when students had opportunities to participate in friendly yet competitive activities with their peers, their engagement with STEM learning increased. These opportunities not only helped students feel as if they were viable members of the scientific learning community but also enhanced their perception of themselves as scientists.

The research of Dr. Jane Stout, Director of the Center for Evaluating the Research Pipeline at the Computing Research Association, and Dr. Sharon Fries-Britt, of the University of Maryland, highlighted the challenges some individuals experience in developing a strong science identity and in gaining a sense of belonging in STEM academic environments. Dr. Stout described how a belonging framework can be used to examine and better understand the gender disparities in STEM graduate programs. Students who do not have a strong sense of belonging can experience depression, lack motivation, and underperform; all of these elements can lead to students being pushed out or opting to pull out of academic programs and pathways (Stout et al., 2011). Dr. Stout's research has revealed that STEM academic programs, which typically lack female mentors, role models, and broader representations of women in science, has led women to feel isolated from the larger academic community and to decide against pursuing STEM degrees. Similarly, Dr. Fries-Britt's research has demonstrated the importance of supporting URMs in the transition into advanced postsecondary STEM degree programs to ensure their science identity is fully developed and encouraged. Her research has found that, even among URMs who have demonstrated ability and achievement in STEM through high school and their undergraduate programs (particularly among URMs who had attended a minority-serving institution), their sense of self-efficacy in STEM and their science identity was challenged when they moved to the next education level. Students began to question their abilities and belonging when they entered into academic environments that provided limited opportunities for them to connect with relevant and viable role models, and when interactions with peers and faculty left them feeling unwelcome or marginalized (Fries-Britt et al., 2013; Fries-Britt, Villarreal, McAllister, & Blacknall, 2012).

The Fisk-Vanderbilt Master's-to-Ph.D. Bridge Program (F-V Bridge Program) offers one example of how institutions can focus programs and efforts that help build students' science identities and gain a stronger sense of belonging. The F-V Bridge Program began in 2004 and is built on two principles: (1) to identify and enroll "unrealized or unrecognized potential" and (2) to "cultivate potential" in students (Stassun et al., 2011, p. 377). Dr. Dina Stroud, the executive director of the F-V Bridge Program, described how the program supports students' identity development through ongoing and frequent mentoring, provides students with research opportunities, and encourages students' participation in academic internships and journal clubs. These activities can enhance students' scientific knowledge as well as promote students' visibility and recognition within the department and broader field. The F-V Bridge Program's success is evidenced in part by the retention rate of students: Since its inception, it has served more than 60 students and has demonstrated a 90 percent retention rate, which is double the national retention rate for URMs in the same disciplines (Stassun et al., 2011). See the text box, "The Fisk-Vanderbilt Master's-to-Ph.D. Bridge Program" for a more detailed description of the key components of the F-V Bride Program.

Considerations for Broadening Participation

Several recommendations for increased understanding and change in institutional and departmental practices emerged from the discussion after the panelists' presentations. The recommendations focused on the leverage points and potential strategies that could support the development of a positive science identity among underrepresented groups of individuals; also included were important considerations for implementing efforts that intend to help students develop stronger science identities. These include the following:

- *A one-size fits all approach will not work*. Underrepresented groups of individuals are unique. They will experience and negotiate their identities and intersections of identities differently. It would be a mistake to design programs or strategies that make assumptions about students' identity development and the way they experience their identities within social and academic communities on campus.
- *Strategies and programs must be evaluated*. Just implementing new strategies and programs aimed at bolstering students' science identity development is not sufficient. Good-intentioned programs aren't necessarily effective. It is critical to evaluate the programs that are put into place to identify the components or activities that have the greatest impact and why they work. This knowledge is critical for improving and adjusting practice, and for other institutions or departments to learn from others' experiences. At the same time, care needs to be taken in generalizing the results of program evaluations. Studies need to be replicated in different settings, with different samples, to ensure contextual understanding of the results and to determine which findings are generalizable across groups and locations.
- *Faculty understanding is key*. STEM faculty may be unaware or lack understanding of social identity and how identities and intersections of identities differ across different groups of individuals and within various contexts and locations. Faculty are not necessarily provided with opportunities or resources to attend trainings on how to mentor students or cultural competency. They also may rely on traditional performance-based measures to identify talent, or be working in departments and among colleagues who promote a "weeding out" approach in which students are required to demonstrate aptitude in often mathematically based courses before being eligible for more discipline-specific and applied practice coursework. This weeding out approach to identifying talent worthy of mentoring and support fails to recognize the multiple pathways students can take to successful scientific careers and the myriad ways that science talent can be demonstrated and recognized.
- *Efforts to build faculty understanding should be positive.* Efforts to build faculty understanding and to train them to be more effective and culturally sensitive mentors must be approached positively. Faculty trainings that are framed in the context of faculty being "in the wrong" and that need correction are not likely to result in meaningfully staff engagement. In addition, it may be helpful to change the language surrounding the issue from "broadening participation" to giving *all* students the tools and support they need to succeed, and to ensuring a strong STEM community of research and practice. Diversifying STEM is not just a moral imperative. A diverse STEM community benefits all students, all faculty, and the field at large. Reframing the discussion may also help

faculty feel like they are playing an active and positive role in supporting best practices and research in STEM rather than being blamed for the situation.

The Fisk-Vanderbilt Master's-to-Ph.D. Bridge Program

The F-V Bridge Program began in 2004. The primary goal of the program is to increase the number of Latino, African American, and other underrepresented minorities earning doctoral degrees in STEM fields through a combination of institutional structures and support services that address what have been identified as the specific needs of underrepresented groups of individuals in STEM.

Students begin in a two-year master's degree program in physics, chemistry, or biology at Fisk University with full- funding support. During their master's degree program, students have access to instruction and research opportunities at both Fisk University and Vanderbilt University. Students also receive Graduate Record Examination (GRE) preparation and Ph.D. application assistance, including fast-track admission to the Vanderbilt Ph.D. program, with full funding support, in physics, astronomy, biology, biomedical sciences, chemistry, materials science, and engineering.

The program also creates a community of practice and supports for the participating students, including regular monitoring of student performance and progress, regular mentoring by graduate student peers and faculty members, and structured professional development to develop students' science identities and STEM-related academic and skills. Interested students undergo a rigorous application process, but one that emphasizes a talent development approach to student selection into the program. In addition, the selection process identifies students based on non-cognitive traits associated with success in STEM academics and careers rather than achievement on standardized tests of performance.

Stereotype Threat: A Call to Action

Stereotype threat is a phenomenon whereby negative stereotypes place people from the stereotyped groups in a state of physiological threat and cognitive overload, both of which can interfere with performance. The "father" of stereotype threat, Claude Steele, summarized decades of research on this phenomenon in *Whistling Vivaldi* (2010). Experiments demonstrate that performance on high-stakes tasks, such as tests of intellect or ability like the Graduate Record Examinations (GRE), declines for a group of individuals when the stigma or stereotype for that group is "activated" prior to the task. A series of experiments conducted by Steele and Aronson (1995) found that African American students under threat of stereotype (i.e., who were told that performance on the test indicated intellectual ability) performed worse than White students on the verbal portion of the GRE. However, African American students in the non–stereotype threat condition (i.e., who were told that performance on the test was a nondiagnostic problem-solving task), did not perform worse than their White peers.

The implications for this phenomenon are widely applicable, given that no group is free from stereotypes. For example, women may perform worse on the mathematics section of a test when they are reminded of the stereotype that women are not good at mathematics before the test is administered. Similarly, other underrepresented groups of individuals may experience stereotype threat when they do not t fit the widely adopted perception of who does science, who is good at science, and who scientists look and act like. The STEM fields have historically been dominated by White males, and the predominant image of a scientist in media representations, in textbooks, and among top STEM faculty departments are older, White men whose primary obligation and commitments are to his career and laboratory (Acker, 2006).

Stereotype threat has relevance and important implications for broadening participation in STEM because performance-based tasks are often used by institutions, departments, and faculty for advancing students through STEM degree programs (Stassun et al., 2011). Women of all races and ethnicities as well as underrepresented minority students may be at a disadvantage if they experience stereotype threat and do not perform up to their potential on high-stakes tests. Moreover, researchers have found that students who are most concerned about doing well on academic tasks are most impacted by stereotype threat because of their anxieties about performing well. As Dr. Collette Patt of the University of California–Berkeley noted: "The ironic and unfortunate finding … is that it is the students who are most likely to succeed, who are the highest achieving and who care the most about achieving, who are the most vulnerable and at the greatest risk of falling prey to the sense that their performance will be judged based on their social identity rather than their academic performance." However, students can develop a growth mindset (i.e., that ability is based on effort and is not a fixed attribute), which can inoculate them from the threat of viewing individual academic tasks as a demonstrations of their academic ability (Dweck, 2006; Miyake et al., 2010). Students who are given an opportunity to reflect on their values can draw on their whole sense of self and identity to perform their best on a test by taking them out of the threat mindset (Miyake et al., 2010).

In addition, students who are provided with opportunities to develop meaningful cross-race or cross-ethnicity relationships with peers and faculty that affirm their belonging and identification within a community can mitigate feelings of threat without harming a student's ethnic identification. Ethnic identification and race-sensitivity are often conflated with race, but they are not the same. One can affect race-sensitivity (which would be impacted by stereotype threat) without impairing ethnic identification (Mendoza-Denton, Kahn, & Chan, 2008; Mendoza-Denton, Pietrzak, & Downey, 2008; Page-Gould, Mendoza-Denton, Alegre, & Siy, 2010). Furthermore, students can be taught to understand that performance on academic tests is not necessarily reflective of their innate abilities; rather, test performance is affected by many factors (Walton & Cohen, 2007, 2011; Wilson & Linville, 1982). For example, poor performance on a physics exam in a student's freshman year could be attributed to being a new college student rather than to a student's actual abilities in physics.

Opportunities for Broadening Participation

Symposium participants identified stereotype threat as an important but difficult and not well-understood phenomenon that might be affecting underrepresented groups of individuals' persistence in STEM graduate programs. Faculty may be triggering stereotype threat unknowingly, or the environment and culture of the classrooms, departments, and laboratories may be subconsciously activating stereotype threat if they do not reflect diversity. Informing faculty of the phenomenon and training them in strategies for minimizing the stereotype threat when they are administering tests may help mitigate the anxiety and underperformance experienced by some individuals. In addition, students may be unaware of stereotype threat and that their experience is "normal." Making students aware of the phenomenon and providing them with safe spaces among peers and faculty mentors with whom they can share what they are feeling and experiencing could provide them with an opportunity to better understand and overcome the challenges associated with stereotype threat.

At the University of California–Berkeley, Dr. Collette Patt is overseeing the launch of a new effort aimed at reducing stereotype threat for underrepresented groups of individuals in STEM. Dr. Patt described the following key strategies that Berkeley has implemented as part of this effort, suggesting that similar strategies could be used to spur conversations and actions among STEM faculty at other institutions.

- *Show data on university trends.* Faculty members respond to data demonstrating what is happening and why, and what strategies and practices can effectively make a difference and have a positive impact on improving outcomes for students. At Berkeley, the data on underrepresented individual's participation and advancement in STEM graduate programs were informative for faculty. Dr. Patt described using these data to engage faculty in discussions of the challenges and solutions for broadening participation in STEM.
- *Provide authentic and ongoing learning opportunities.* Authentic learning experiences can include workshops or other activities for faculty that are engaging and provide tangible evidence of the impact of stereotype threat. For example, Dr. Patt suggested using the "Eye of the Storm" video (Peters, 1970), a documentary demonstrating the emotional and educational impact of stereotyping to engage faculty. She explained that "unlearning entrenched knowledge" takes time and changing minds and behavior cannot be accomplished through isolated efforts or one-time workshops.

- *Talk with faculty and administrators*. Face-to-face conversations and interactions with faculty can garner better traction than a memo or a workshop that is impersonal and can be more easily ignored or dismissed. The issues challenging underrepresented individuals' success in various STEM departments are unique and stereotype threat will best be mitigated through department-specific efforts that engage faculty personally and in collaboration to effect change. Dr. Patt recommended also that change can be motivated by finding "friendly faculty" who can help champion the effort and work "behind the scenes" to develop relationships and buy-in among a larger group of faculty to address stereotype threat.
- *Consider the "ecological approach."* As programs do not occur in isolation, they need to interact with and inform each other. Consider how a myriad of programs within the institution or department that have the same diversity goals can come together to address the multiple challenges to broadening participation while recognizing and addressing their own needs.
- *Build on your local resources*. Find support from social science departments, for example, anthropology, education, or psychology, to research and evaluate effective efforts and who can also provide research and resources that can inform departmental efforts.

Berkeley's stereotype threat efforts are described in more detail in the textbox, "Efforts to Reduce Stereotype Threat at Berkeley."

Efforts to Reduce Stereotype Threat at Berkeley

Dr. Patt provided a preview of the early work started at Berkeley that address the stereotype threat in STEM academic programs at the university. Dr. Patt has partnered with Dr. Mendoza-Denton, a psychology professor at Berkeley, to develop strategies for better supporting STEM students that focus on issues of ethnic identification and race-sensitivity. This effort builds on Berkeley's rich history and institutional infrastructure for equity and inclusion, especially in STEM. In the early phases, faculty were provided with research on stereotype threat to develop their understanding of the phenomenon and the effect student experiences of stereotype threat may be having on their academic performance. STEM faculty received a copy of the book, *Whistling for Vivaldi* (Steele, 2010), with a letter from the dean asking them to read and think about the book. Then, the author, Dr. Claude Steele, spoke on campus about the research. According to Dr. Patt, faculty understanding and buy-in is critical if the effort is to gain ground and credibility. Dr. Patt explained that Berkeley's initial plan for moving forward with this effort was to engage STEM faculty in collaboration with psychology faculty to develop effective approaches and strategies. STEM faculty could incorporate these practices in introductory STEM courses and through mentoring activities. Consideration had also been taken about whether and how to engage students directly, for example, when and how to inform them of the efforts being put into place, for what purpose, and how they themselves can recognize and monitor their own potential experiences of stereotype threat. Dr. Patt indicated that Berkeley plans to research their efforts and use the results of this research to refine their efforts and ultimately, "ramp up and go to scale," to engage more and more faculty and departments in similar efforts across Berkeley.

Considerations for Broadening Participation

Participants agreed that stereotype threat is an important phenomenon to consider in their diversity efforts. Participants also expressed concern, however, about how to implement effective programming that appropriately engages faculty and students. Much of the formal research on stereotype threat and mitigating stereotype threat has been conducted in controlled and experimental situations. The body of qualitative research exploring experiences of stereotype threat and programmatic efforts to mitigate stereotype threat in "real-world" situations is limited. As a result, there are many unknowns and challenges to consider as STEM academic departments strategize efforts and opportunities to use the research on stereotype threat to promote diversity and improved outcomes in STEM graduate programs. The following considerations and potential cautions were discussed by the symposium participants:

- *Stereotype threat-focused interventions will not be sufficient on their own.* Student performance on high-stakes tests may be affected by stereotype threat, but other factors are also at play. Efforts to support underrepresented individuals in STEM graduate programs need to be based on a deep understanding of all the factors that may be affecting performance, including their financial situation, their out-of-school responsibilities, academic skills and aptitude, among others.
- *Careful consideration for how to engage students and faculty is important.* Students may benefit from knowing about stereotype threat and putting a name and understanding to what they may be experiencing. However, because not all students may experience stereotype threat, participants raised concern about potentially activating stereotype threat among students by drawing their attention to it, thereby causing more harm than good. In addition, faculty will likely need intensive training in how to appropriately implement strategies in the classroom that can mitigate stereotype threat and not trigger it.
- *Efforts to scale will pose challenges.* Scaling departmental efforts is one of the largest challenges in implementation research. If a program succeeds in diminishing the threat that interferes with success in one context, then when and how can that program be taken to scale? Institutional and departmental efforts to address stereotype threat should be evaluated and studied so that other institutions and departments can learn from what others are doing, including their successes and challenges. The exact programming may not be generalizable, but key components of successful programming or strategies could be applicable across settings.

Chilly Climates

The concept of chilly climates for underrepresented groups of individuals in academic environments has been discussed and researched for more than 30 years (see for example, Hall & Sandler, 1982; Stanley, 2006). Chilly climates refers to academic environments that can interfere with the educational process for individuals who are treated differently, through the overt or subtle actions of faculty, colleagues, and peers, on the basis of their gender, race/ethnicity, or other dimensions of their identities (Hall & Sandler, 1982). Indeed, after many years of concern about the continued disparities in the participation and advancement of underrepresented groups in STEM, the notion of the chilly climate remains an important barrier that must be overcome to encourage greater opportunity for all individuals in STEM.

The climate for diversity on individual campuses is shaped by the interaction of a series of external and internal (or institutional) forces, both of which can affect the academic career pursuits and opportunities for underrepresented individuals in STEM (Hurtado, Milem, & Clayton-Pederson, 1998). These internal forces include compositional diversity, or the availability and array of role models. In STEM, the composition of the faculty is likely a contributing factor to chilly climate experiences among historically underrepresented groups of individuals. Female faculty overall, female faculty of color, and URMs are not well represented in STEM at any faculty rank, and a disturbing paucity of these individuals exist in the highest ranks of academic leadership. Data reveal that URMs and women are more likely to be found in junior faculty and non–tenure track positions than males overall and especially White males (Mason, Wolfinger, & Goulden, 2013; National Academy of Sciences et al., 2007; Trower & Chait, 2002).

Other, likely interrelated, factors that can lead to chilly climates are historical legacies of inclusion and exclusion, implicit and explicit biases against underrepresented minorities and women, and cultures that perpetuate academic environments that are unwelcoming of diversity (Hurtado et al., 1998). External forces could include government or institutional policies (e.g., race-blind admissions and standardized test cutoffs for program eligibility), practices, or initiatives that privilege some while limiting opportunities for others (Hurtado et al., 1998). For example, research suggests that a bias against caregiving exists in the academy and particularly in STEM departments that are male dominated (Drago et al., 2005). Universities often place a low priority on providing faculty with high-quality child care, which leaves many women with the difficult choices between their careers and their family. Further, these women are often stigmatized among colleagues and peers as being less serious about their careers when they do take time off to meet child care or family needs (Etkowitz, Kemelgor, Neuschatz, Uzzi, & Alonzo, 1994; National Academy of Sciences et al., 2007). Although the chilly climate research has focused largely on the climate for faculty, the students themselves can also experience chilly climates in STEM that can affect their graduate school pursuits and their aspirations and successful pursuits of academic careers in the sciences (Gay, 2004; Golde, 2005).

Opportunities for Broadening Participation

Two of the symposium presentations identified potential leverage points for addressing and reversing the chilly climate that underrepresented individuals in STEM often encounter.

Dr. Keivan Stassun presented the underlying theory of action of The Fisk-Vanderbilt Master's-to-Ph.D. Bridge Program, which aims to address the chilly climate issue by providing supports for students and encouraging more diversity within the faculty ranks. As discussed in the summary of the science identity session, the F-V Bridge Program underscores the opportunities for broadening participation that become available when the status quo is challenged and levers for institutional change are put into place. For example, the F-V Bridge Program challenges the status quo graduate school application process by not using GRE cut scores to "weed out" applications. Instead, students are selected into the program based on alternative rubrics that measure the noncognitive skills and academic characteristics associated with success in STEM that cannot be measured by a standardized test. These rubrics are used to determine whether students have the following: a positive self-concept, realistic self-appraisal, preference for long-term goals, leadership and community involvement, knowledge in a field or nontraditional learning, relevant research experience, communication skills and presence, and perseverance.

According to Dr. Stassun, implementing this new approach to identifying talent was an important cultural shift in how the institution and the STEM departments understood and perceived STEM talent. This approach has broadened their understanding of who has the potential to be scientists and encouraged a more welcoming and supportive environment for URMs in STEM. The F-V Bridge program has not only helped create a critical mass of graduate students but also focused institutional and departmental efforts on identifying and hiring faculty—both URM and non-URM—who care deeply about increasing the diversity of the field. According to Dr. Stassun, these shifts have facilitated culture change and a more welcoming climate for all students.

Dr. Mia Ong presented findings from two studies of the New England Alliances for Graduate Education and the Professoriate (NEAGEP) project. A primary objective of the NEAGEP project was to build the capacity of the participating institutions to better serve and support URM students' success in STEM graduate programs and their STEM academic career pursuits. The research presented by Dr. Ong showed that the program supports, including staff dedicated to reaching out to and supporting URMs in the program, were potentially helpful in providing a more supportive and less chilly environment for students. Department or program administrators often serve as gatekeepers to insider knowledge about the culture of the academic department. This information includes who is important to talk to and get to know, where to find resources and supports on campus, the best way to reach and communicate with faculty, and other information that is critical to students' success. Underrepresented groups of individuals in STEM can have difficulty gaining this insider knowledge if they are being treated differently and offered less encouragement, advice, and access to opportunities than their peers are. Thus, having staff who can provide students with this knowledge can help students gain a sense of belonging, increase their own visibility in the community and help them perceive themselves as valid members in the community. Furthermore, it helps them build the types of networks and relationships that are necessary for academic and career success. Indeed, although Dr. Ong's research offers examples of some successes, it also exposed how perceptions, stereotypes, and indifference toward diversity in STEM remained in place, despite the NEAGEP project in many departments. Dr. Ong shared several examples from her research of troubling experiences among graduate students and junior faculty. Some of the graduate students in the study cited institutional factors such as a lack of diverse faculty, a lack of cultural competency among faculty, a perception that diversity was not valued at the institution, and a lack of structured support for underrepresented minorities as factors that influenced their decision not to pursue careers in academic science. Students and junior faculty also shared encounters with faculty and colleagues who made references to their gender or racial or ethnic background while questioning their abilities, their performance, the opportunities available to them, or their work ethic.

Dr. Stassun and Dr. Ong emphasized the importance of recognizing and valuing students' and colleagues' lives outside of the classroom and laboratory. Dr. Ong said that in her interviews, students explained that being out of the laboratory—volunteering, traveling, exercising, going to church, and visiting friends or family—kept their passion for science alive. Dr. Stassun said, "We've invited the students to reconnect with their cultural, familial, historical, faith identities because we want them to see that they have within them this incredible source of strength, of power, of vision… when we first started this program, it surprised me the extent to which these students have had to shed that… that being a scientist is about being this thing and all of these other things don't matter. And part of our job is to say, actually it does matter. If you're going to be all that you can be, you need to bring it. And those that will hire you, in fact want people who will bring it. They don't particularly care where it comes from…We send all these messages that these things don't matter… but it matters."

Considerations for Broadening Participation

Dr. Stassun's and Dr. Ong's presentations highlighted the cultural and institutional changes that can occur when there is meaningful commitment to putting structures into place that can better support underrepresented individuals in STEM. Their presentations also demonstrated the challenges in making this happen. Fully reversing a chilly climate requires a true disruption of the system. The discussion among symposium participants after these two presentations identified the following factors as critical to any effort to reverse a chilly climate:

- *Strong leadership and commitment is critical.* Dr. Stassun noted the symbolic power of support from the university president and dean's level administrators for the F-V Bridge Program. Dr. Ong explained that lower-level administrators also play a critical role in creating a more welcoming STEM environment for traditionally underrepresented groups of individuals. Symposium participants agreed that strong leadership and leadership's commitment to engaging faculty at all levels in the effort are critical to effect change. In addition, leaders must be communicated not just verbally or in writing, but in action, behavior, and accountability measures.
- *"Ideal worker" norms must be challenged.* The ideal academic scientist worker norm is someone who prioritizes work first and foremost, above and beyond family, friends, community, and personal health and well-being. A 14- to 16-hour work day is expected and academic scientists who cannot or do not devote that much time to the lab or their research are too often considered as not serious about their work or undeserving of their position. This ideal worker norm can negatively impact all students and faculty who aim to achieve a better integration of their work with their personal and family lives. The ideal worker norm in science may be particularly difficult to transform. It is reflective of a larger societal issue in the United States that is present in many other fields, professional occupations and type of positions. This ideal worker norm can adversely affect URMs and women of all races and ethnicities who are subject to racial, ethnic, and/or gender stereotypes about their work ethic or commitments to work versus family.

Leaders, faculty, staff, and the students must reframe their notions of what it means to be a successful scientist. To broaden participation and combat chilly climates, students must be provided with role models whose lives reflect the type of balance that better aligns with the type of work and careers students hope to pursue.

- *Daily interactions serve as critical incidents.* Dr. Ong described examples from her research that highlighted the significant a series of individual "incidents" can have on students and faculty. These incidents may include, for example, off-hand comments or subtle signals from colleagues and peers that devalue or ignore an individual's work, research, or presence. These incidents alone and in combination can build up and discourage students' sense of belonging, self-efficacy, and can ultimately lead them to abandon their academic pursuits.
- *Students' individual identities matter.* Students' identities and their abilities to reconcile or meld their personal identities with their identities as a scientist, as discussed in the science identity session summary, are important factors in determining students' success in STEM degree programs and academic careers. Reversing and transforming chilly climates in STEM requires an understanding and appreciation for the wider array of values, perspectives, and approaches that diversity brings to the field. This understanding and appreciation must be promoted and shared among leaders, faculty, advisors, and students.

Science Education in the Current Fiscal Environment

The price of higher education and the debt students accrue to attend college is high. At the same time, the need for a college degree is more important than ever. Individuals with college degrees earn more than those with less education and are less likely to be unemployed. Even more jobs in the future will require some level of education beyond high school.

As policymakers and higher education administrators grapple with ways to reduce the price and cost of college and provide access to a more diverse group of students, numerous reports have called for the need to increase the number of STEM degrees and workers (Carnevale et al., 2011; PCAST, 2012). If the nation is to meet these projected needs, groups typically underrepresented in STEM, women of all races and ethnicities, as well as Hispanic, Black, and Native American men, need to become engaged in STEM fields and earn STEM-related degrees.

Despite the almost daily attention these issues receive surrounding the escalating costs of college and the need for more students with STEM skills and degrees, these issues are rarely discussed together. Might not the price of a STEM degree and debt incurred obtaining one or both the undergraduate and graduate levels have an effect on who decides to major in STEM and pursue advanced degrees? This symposium session examined these issues through two lenses: Dr. Rita Kirshstein focused on the price of STEM undergraduate and graduate degrees and the debt students incur, as well as the institutional cost of producing a STEM degree. Dr. Lindsey Malcom-Piqueux examined how financial aid policies at the institutional, state, and federal levels structure underrepresented minority students' pathways to and outcomes in STEM.

What Is the Price and Cost of a STEM Degree?

Conversations about the cost of higher education typically focus on the price of a college degree—either the "sticker price" that students are charged (tuition) or the "net price" they end up paying (tuition minus financial aid). The desire to reduce, or at least rein in, what students are paying for college receives constant attention. Often absent from the conversations about college affordability, however, is the cost colleges and universities incur to educate students.[1] Courses and degrees in STEM disciplines are often the most expensive for colleges and universities to produce.

Dr. Kirshstein presented data that estimated the cost to institutions of producing undergraduate degrees in STEM; social, behavioral, and economic (SBE) sciences; and non-STEM disiciplines, such as the humanities. Most STEM degrees—including undergraduate degrees in engineering, agriculture, computer, and science-related fields—have higher than average production costs. In general, undergraduate degree costs in STEM fields cost between $65,000 and $80,000, but engineering degree costs, and other disciplines of study that require laboratory work are significantly higher. Those STEM fields that primarily require classroom time rather than lab work—such as mathematics and statistics, and the SBE disciplines in social science and psychology—are some of the least expensive degrees that colleges and universities produce.

[1] The remaining costs are paid for with state appropriations, endowment income, or other revenues.

Where an individual obtains a degree, whether it is a STEM, SBE, or any other degree, has a major impact on what they are asked to pay. The largest universities, public research universities, awarded half of all STEM undergraduate degrees in 2010–11. However, URM students were somewhat less likely to have obtained their STEM degrees from these types of institutions than others[2]: 44 percent of URM students compared with 51 percent of non-URMs graduated with STEM degrees from public research universities. Public research universities also awarded the largest share of SBE undergraduate degrees, 43 percent. Differences by minority status across the types of institutions were relatively small.

One of the most interesting differences is that 11 percent of URM students, compared with only 4 percent of non-URMs, received STEM undergraduate degrees from private for-profit four-year institutions. Although Dr. Kirshstein's study did not collect data on degrees earned in specific STEM disciplines, other data show that most of the four-year STEM degrees earned at for-profit institutions are in the computer sciences (National Science Board, 2012).

Today, most undergraduate and graduate students do not pay the posted tuition, or "sticker price." Grants and scholarships reduce the price for students, and indeed all colleges and universities are now required to provide a "net price calculator" on their websites to give students an idea of what others with similar academic and economic backgrounds pay. The net price paid in different types of colleges and universities was compared for students who were about to graduate with a STEM and SBE degree. URM students in each of these groups were also compared with non-URM students.

For students obtaining degrees in both STEM and SBE fields, the net price for URM students was less than that for non-URMs. This was the case in all different types of colleges and universities, both public and private. For example, the net price paid by URM STEM majors attending private research universities was $19,986 compared with $27,065 for non-URMS in these same types of institutions. URM STEM majors in public research institutions paid $11,687 while non-URMs paid $13,443.

However, these lower net prices do not translate into lower debt. In all types of colleges and universities, URM STEM majors were more likely than non-URMs to graduate with more than $30,000 in debt. Again, in private research universities, the most expensive in terms of both sticker and net price, 42 percent of URMs graduated with more than $30,000 in debt, whereas only 17 percent of non-URMs owed this much. Scholarships and grants, although they reduced the net price of URM STEM majors considerably, did not eliminate the need to borrow.

The debt of individuals receiving STEM and SBE Ph.D.s was also examined. Interestingly, 63 percent of individuals receiving STEM Ph.D.s *and* 63 percent of individuals receiving SBE Ph.D.s entered graduate school with no undergraduate debt. The percentage of individuals receiving STEM and SBE Ph.D.s graduating without debt is much higher than the percentage of undergraduates graduating with debt, which is 35 percent.

The story changes, however, when graduate debt is examined. In all racial groups, individuals receiving SBE Ph.D.s are much more likely than individuals receiving STEM Ph.D.s to have

[2] The other institutional types examined included public bachelor's, public master's, public research, private bachelor's, private master's, private research, and for-profit four-year institutions.

more than $30,000 graduate school debt. Among African Americans, for example, 25 percent of individuals receiving STEM Ph.D.s had more than $30,000 in graduate debt, whereas 58 percent of individuals receiving SBE Ph.D.s had debt at this level. More than half of all STEM Ph.D.s in all racial groups had no graduate debt; this ranged from 51 percent of African Americans to 64 percent of Hispanics to 73 percent of non-URMs, indicating that STEM graduate students are receiving more financial support for their advanced degree pursuits than SBE graduates students.

How Do College Financing Strategies Affect STEM Pathways?

Dr. Lindsay Malcom-Piqueux, assistant professor of higher education at The George Washington University, presented trends in financing education, reviewed research, and highlighted the need for additional studies examining the relationship between financial aid policy, student financing strategies, and STEM access and outcomes. Drawing from data from the National Survey of Recent College Graduates (2003), Dr. Malcom-Piqueux examined key points in the STEM undergraduate's pathway where educational pathway decisions are made based financial aid policy and financing strategies.

> Is debt a deterrent to attending graduate school? This question is raised by the fact that 63 percent of individuals receiving Ph.D.s in both STEM and SBE had no undergraduate debt, whereas only 35 percent of undergraduates nationally graduated with no debt.

To set the stage, Dr. Malcom-Piqueux alerted participants *to three significant policy trends:* (1) tuition increases over decades; (2) a shift from grants to loans to finance postsecondary education, including the declining purchase power of the Pell grant; and (3) a shift in financial aid programs from low-income to middle-class students.

Although research on broadening participation in STEM has been directed to specific leverage points such as STEM aspirations, precollege preparation for STEM, STEM departmental climate and retention/attrition, and STEM faculty interaction, Dr. Malcom-Piqueux found that financial barriers and financial strategies were highly salient with respect to student pathways to STEM postbaccalaureate outcomes. For example, she found college choice and debt were related to students' financing strategies, which in turn was related to student social class and race/ethnicity. With respect to STEM outcomes, Dr. Piqueux's research suggests that the financing strategies used by low-socioeconomic status and URM students were a disadvantage to these students with respect to STEM outcomes.

Dr. Piqueux's research examined eight college financing strategies: loans, work study, scholarship/grant, parental/familial support (gift), parental or familial loan, employer support, earnings, and other sources. Self-support and distributed support strategies (i.e., drawing on support from multiple sources), including primarily loans, scholarships/grants, earnings, or employer support were used by URMs more than White and Asian students. In particular, distributed support strategies that included drawing on a combination of loans, scholarship/grants, earnings, and employer support were found to most disadvantage student pathways and outcomes in STEM. These financing strategies were associated with students attending community college, choosing less selective institutions, and completing a STEM degree with more student loan debt.

Opportunities for Broadening Participation

What does the price and cost and financial policies of STEM and SBE degrees have to do with broadening participation? In the current fiscal and policy environments, these ideas are related. Data presented by Dr. Kirshstein revealed that financial aid reduces the sticker price for underrepresented groups majoring in STEM and SBE, but URMs still graduated with more debt than non-URMs. Dr. Malcom-Piqueux illustrated the choices that financial conditions impose on a student's STEM pathway. This research provides institutions with data that can potentially assist them in their efforts to broaden participation through better institutional financing efforts and better financial supports for students.

For example, the costs incurred by colleges and universities can also impact opportunities to broaden participation. Because it generally costs higher education institutions more to offer STEM courses and produce STEM degrees than it does non-STEM courses and degrees, they have to think about how to balance their shrinking budgets. These budget concerns need to be considered with the pressing need not only to produce more STEM degrees but also to attract underrepresented students, who at times, may need additional financial and academic supports to ensure success. Some colleges have implemented differential tuition policies—charging students more for some courses and majors that cost more to offer than others—but this practice could discourage students from majoring in STEM. At the time of the symposium, Florida was considering charging STEM majors *less* than other majors to attract them to the field. This type of differential tuition policy should be monitored and followed to learn whether and how it may incentivize rather than detract students from STEM degree programs.

Institutions and departments may be in a position to better support historically underrepresented groups of individuals in STEM if they can develop policies that account for the financial dilemmas that many URMs face. As one attendee noted, majoring in STEM requires a greater time commitment than majoring in many other fields. Courses can be more intense, requiring more study time, and laboratories require a considerable amount of out-of-class time. To truly understand and integrate into the scientist role, undergraduate and graduate students should be involved in faculty research projects that provide stipends and/or other forms of tuition assistance. In addition, or alternatively, institutions and departmental leaders can better inform and recruit students into on-site campus jobs that do not take them away from campus or require long commutes. However, this latter suggestion should be considered with caution and likely is less effective than research positions. The time demands that STEM majors experience means that, for many students, working at on- or off-campus jobs to earn additional money is not feasible or is nearly impossible to balance with advanced degree pursuits in STEM fields. They accrue debt or may drop out altogether if they feel forced to choose between their studies and wages.

Considerations for Broadening Participation

Solutions to increase the number of STEM degrees must therefore consider the cost to students, the cost to higher education institutions, and the cost to society, particularly if the demand for STEM workers is not met. These presentations not only suggested a threefold focus on research, policy, and education but also raised important questions that must be answered and accounted for if fiscal strategies are going to effectively increase the participation and retention of URMs in STEM academic pathways.

Dr. Kirshstein's presentation raised the following questions:

- To what extent is debt a deterrent, both in majoring in STEM and pursuing a graduate degree?
- What types of institutions are sending STEM bachelor's recipients to graduate school?
- What is the specific role of minority-serving institutions?
- What is the cost of attracting and retaining minority students?
- What is the cost of not attracting and retaining minority students?
- How can developmental education be improved, particualrly in mathematics, to ensure that all students have equitable access and opportunity in STEM?
- What is the cost of developmental education to students and to institutions?

Dr. Malcom-Piqueux prepared recommendations based on current policy directions and information needs.

- *Institutions should collect and analyze data on the impact of financial aid on student decision making and outcome.* Admissions and student financial aid administrators should consider the impact of financial aid on decision making and on college and postbaccalaureate outcomes by examining data on aid by race/ethnicity and socioeconomic status. College administrators should prepare and conduct financial education programs for college students to help them plan how they will finance graduate school.
- *Parents and students should be provided more information on financial aid policy and debt.* Parents and students need better and more transparent information about what is manageable debt and the current debt forgiveness and repayment programs. This information should be provided by institutions, but state and federal policymakers also need to play a role. These policymakers need data on the implications of increasing, maintaining, or cutting funding for graduate students, changing Pell grants, and the needs of financing STEM education to support stronger and more effective financial aid policy.

Discussion

Social science research offers important insights into the biases and barriers groups traditionally underrepresented in STEM encounter in their postsecondary degree and career pursuits. These insights provide a more nuanced understanding of the subtle and implicit factors that could be contributing to the loss of talented individuals from STEM education and workforce pathways and that can help institutions of higher education improve their STEM diversity efforts. For example, institutions of higher education can use social science research findings to develop more effective programs that build capacity to broaden participation in STEM.

In September 2013, AIR hosted a symposium, *Using Research to Inform Policies and Practices in STEM Education,* to facilitate conversations among STEM faculty, administrators, and social science researchers to support a stronger connection and application of research to broadening participation in STEM practice at institutions of higher education. This symposium brought these stakeholder groups together to explore ways that STEM academic departments can use the findings of social science research to provide more welcoming environments for URMs and women of all races and ethnicities in academic science. Symposium discussions were stimulated by presentations that explored the results of research studies and program evaluations. Symposium participants were asked to consider and share potential actions that could be implemented in their own settings and to raise questions for future research that could further support their own efforts and benefit the broader field. The overall theme of the symposium, expressed by the symposium keynote speaker, Lindsey Malcom-Piqueux, emphasized that an *ecological* approach to broadening participation in academic science is required—one that effectively creates opportunities, strengthens minority-serving institutions, and provides supporting individuals to underrepresented individuals.

The following four topics were selected to organize the proceedings and presentations

- Developing a science identity
- Stereotype threat
- Chilly climates
- Science education in the current fiscal environment

Research Findings Related to Opportunities for Broadening Participation

For each topic, symposium presenters introduced research-based key factors that, when addressed, were likely to lead to broadening participation.

Studies of science identity conducted by Dr. Charles Lu, Director of Academic Advancement and Innovation at the University of Texas at Austin, Dr. Jane Stout, Director of the Center for Evaluating the Research Pipeline at the Computing Research Association, and Dr. Sharon Fries-Britt of the University of Maryland addressed the image students hold and perceptions of who “does” science. Gaining a sense of belonging in STEM and an individual’s ability to self-identify with studies and careers in science often require students to negotiate and reconcile personal and academic identities. Effectively doing so were said to be critical factors in supporting students' success in progressing through academic and career pathways in science.

Unfortunately, the research on stereotype threat is limited. Findings from existing studies indicate a dual focus on triggers of stereotype threat for research and programs: Students may not be aware that a particular policy or practice will trigger a threat and faculty may be unaware they are triggering this type of threat by their actions. The overall result of stereotype threat may be poor student performance, departure from a program, and even difficult relationships between students and between students and faculty. In the right environments, however, students can develop a different perspective on their participation and performance in STEM and learn to view their experience and performance as developing and growing. At the University of California–Berkeley, Dr. Colette Patt is overseeing the launch of a new effort aimed at reducing stereotype threat for underrepresented groups in STEM. Much of this effort engages faculty in learning about stereotype threat and how student experiences of stereotype threat can derail students' performance and advancement in high-stakes STEM coursework and testing. When armed with this knowledge, faculty can play an active and positive role in mitigating students' experience of stereotype threat in ways that may support increased student retention.

The concept of chilly climates for underrepresented groups of individuals in academic environments has been discussed and researched for over 30 years (see for example, Hall & Sandler, 1982; Stanly, 2006a, 2006b). Chilly climates refers to academic environments that can interfere with the educational process for individuals who are treated differently, through the overt or subtle actions of faculty, colleagues, and/or peers, on the basis of their gender, race/ethnicity, or other dimensions of their identities (Hall & Sandler, 1982). Indeed, after many years of concern about the continued disparities in the participation and advancement of underrepresented groups in STEM, the notion of the chilly climate remains an important barrier that must be overcome to encourage greater opportunity for all individuals in STEM.

The climate for diversity on individual campuses is shaped by the interaction of a series of external and internal (or institutional) forces that can affect historically underrepresented groups of individuals' experiences and progress in STEM. For several years, research has indicated that a chilly climate exists for women and URMs in STEM. This chilly climate arises out of overt and subtle biases against these groups of individuals that culminate over time and can perpetuate stereotypes and hinder efforts to broaden participation in scientific fields.

The fiscal environment is affecting student participation and completion in STEM fields. Dr. Rita Kirshstein and Dr. Lindsay Malcom-Piqueux used national data sources to illustrate the price and cost of STEM degrees, the participation of URMs by type of institution, and the impact of financial support strategies on student institutional selection and financial outcomes for URMs seeking a degree and postbaccalaureate outcomes in STEM fields.

Considerations for Developing an Ecological Approach to Improving Conditions and Outcomes for URMs and Women in STEM

Across the symposium sessions, presenters and participants agreed on the importance of adopting an integrated approach when designing interventions and planning further research on the factors that affect the conditions and outcomes for URMs and women of all races and ethnicities in STEM. Key recommendations for improving and implementing institutional or departmental interventions or initiatives aimed at broadening participation in STEM include the following:

- In planning interventions or initiatives, a one-size-fits-all approach will not work. Administrators and faculty must realize assumptions about ways students experience and negotiate identities and experiences could sabotage the goals and outcomes of the program. This is true even when the intervention is based on a body of research that points to certain salient factors.
- Institutions of higher education must evaluate strategies and programs to generate knowledge and improve practice at the local level and in the broader higher education community. Although findings from localized efforts may not be generalizable, important lessons and insight can be gained from the experiences, challenges, and successes of other institutional efforts—efforts that include social and academic integration supports as well as efforts to collect and use data on student pathways and financial status. These types of data can inform both recruitment and retention efforts because students' decisions to pursue and persist in STEM occur not only when in graduate school but also in the process of applying and making commitments to certain institutions and departments.
- Interventions and initiatives should include a component of capacity building. Any comprehensive and sustainable effort will require the involvement of faculty in identifying talent, cultivating talent, or assessing talented students. To engage faculty effectively, it is critical to identify the level of faculty understanding of variations in student experiences and the faculty knowledge of the appropriate social science literature, and then subsequently to develop supportive social structures for faculty to design and meaningful engage in the efforts.
- Interventions and initiatives must reflect and address both internal and external realities. Internal forces include compositional diversity that can affect the availability and array of role models to graduate students in STEM, historical legacies of inclusion and exclusion, implicit and explicit biases against underrepresented minorities and women, and cultures that perpetuate academic environments that are unwelcoming of diversity (Hurtado et al., 1998). External forces may include government or institutional policies, practices, or initiatives that privilege some but limit opportunities for others (Hurtado et al., 1998).

Final Word

In sum, building institutional capacity to support and sustain broadening participation efforts will require the commitment and engagement of multiple stakeholders. These stakeholders must have a firm understanding of the myriad factors affecting underrepresented individuals' experiences and abilities to persist and succeed in STEM for their efforts to prove fruitful. Broadening participation efforts will require a context-based approach, but an approach informed by the broader research and the lessons learned by the work of other institutions and department engaged in similar activities. They must also include multiple supports and strategies, or an integrated, ecological approach. When these components are in place, the potential for reversing chilly climates and biased policies and practices and for more effectively identifying, cultivating, encouraging, and welcoming a diversity of talent in STEM education and academic science is heightened.

The multimedia presentations, associated handouts, and audio recording are available at http://www.broadeningstem.org/index.php/stem-symposium

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Appendix A. Symposium Agenda

Using Research to Inform Policies and Practices in Science Education

Conversations With Faculty and Administrators

September 26–27, 2013

American Institutes for Research
1000 Thomas Jefferson Street NW
Washington, DC

Agenda

September 26, 2013

7:30 a.m.–5:00 p.m. **Registration/Information**

8:00–8:30 a.m. **Breakfast**

8:30–9:45 a.m. **Welcome and Keynote Address**

AIR Welcome

- Gina Burkhardt, Executive Vice President, and Director, Education Program, American Institutes for Research

Keynote Address

- Lindsey Malcom-Piqueux, The George Washington University

9:45–11:15 a.m. **Plenary: Developing a "Science" Identity**

Panelists

- Sharon Fries-Britt, University of Maryland, College Park
- Charles Lu, The University of Texas, Austin
- Jane Stout, Computing Research Association
- Dina Myers Stroud, Vanderbilt University

Discussant

- Carlos Rodriguez, American Institutes for Research

11:15–11:30 a.m. **Break**

11:30 a.m.–12:15 p.m.	**Discussion Breakout Sessions 1, 2, and 3**
12:15–1:15 p.m.	**Lunch**
1:15–2:15 p.m.	**Plenary: Stereotype Threat** Presenter ▪ Colette Patt, University of California–Berkeley Discussant ▪ Marcia Williams, North Carolina A&T State University
2:15–2:30 p.m.	**Break**
2:30–3:15 p.m.	**Discussion Breakout Sessions 1, 2, and 3**
3:15–4:15 p.m.	**Panel Discussion: Doctoral Program Experiences** Panelists ▪ Maleka Brown, Howard University ▪ Brittny Davis, University of Maryland, Baltimore-County ▪ Katy Keenan, National Institute of Standards and Technology ▪ Charles Lu, The University of Texas, Austin Moderator ▪ Carlos Rodriguez, American Institutes for Research
4:15–4:30 p.m.	**Wrap-Up Discussion**

September 27, 2013

8:00 a.m.–3:00 p.m.	**Registration/Information**
8:00–8:45 a.m.	**Breakfast**
8:45–9:30 a.m.	**Welcome to Day 2 and Keynote** AIR Welcome ▪ Tracy Gray, Managing Director, American Institutes for Research Keynote Address ▪ Michael Kubiak, Chief Research and Evaluation Officer, Citizen Schools
9:30–10:30 a.m.	**Plenary: "Chilly Climates"** Presenters ▪ Mia Ong, TERC ▪ Kevin Stassun, Vanderbilt University Discussant ▪ Jackie Huntoon, Michigan Technological University
10:30–10:45 a.m.	**Break**
10:45–11:30 a.m.	**Discussion Breakout Sessions 1, 2, and 3**
11:30 a.m.–12:30 p.m.	**Lunch**
12:30–1:30 p.m.	**Plenary: Science Education in the Current Fiscal Environment** Presenters ▪ Rita Kirshstein, American Institutes for Research ▪ Lindsey Malcom-Piqueux, The George Washington University Discussant ▪ Jane Wellman, Independent Policy Analyst
1:30–1:45 p.m.	**Break**
1:45–2:30 p.m.	**Discussion Breakout Sessions 1, 2, and 3**
2:30–3:15 p.m.	**Concluding Remarks and Closing Discussion**

Appendix B. Biographies of Key Speakers

AIR Presenters

Gina Burkhardt was the former executive vice president of American Institutes for Research (AIR) and director of AIR's Education program. Burkhardt's expertise includes leadership development, organizational development and systems change, district and school improvement, and the application of research to policy and practice efforts. She led the transformation of the North Central Regional Educational Laboratory, a single federally funded contract, to Learning Point Associates, which merged with AIR in August 2010. A lifelong educator, Burkhardt began her career as a middle school mathematics and science teacher in upstate New York. She has held positions in higher education, managed school reform projects at the regional educational laboratories, and consulted nationally and internationally on education policy and practice as well as education systems design. She has authored publications, including a book on organizational change and has given multiple presentations on 21st century learning environments, data-driven decision making, organizational change theory, and the application of effective research and development in education. She currently holds and has held several professional appointments, including serving as a board member for the Partnership for 21st Century Skills; the Consortium on Chicago School Research at the University of Chicago; Editorial Projects in Education, which publishes *Education Week*; Knowledge Alliance; and Manufacturing Renaissance. Burkhardt earned an M.Ed. and completed her doctoral coursework in educational psychology from the University of North Carolina. In addition, she completed coursework in the Executive Education Program at University of Chicago Booth School of Business.

Tracy Gray, Ph.D., is a managing director at AIR, where she directs AIR's Center for STEM Education and Innovation. Dr. Gray has directed three national technology centers funded by the U.S. Department of Education, Office of Special Education Programs—the National Center for Technology Innovation, the Center for Implementing Technology in Education, and the Center for Technology Implementation. These centers promote the development and implementation of evidence-based technology practices and tools to improve the educational achievement of struggling students. Dr. Gray is a nationally recognized expert in education and technology who has led numerous initiatives in the United States and abroad that examine the impact of technology on educational achievement. She has published and lectured widely on issues related to the effective implementation of technology, particularly for those with special needs. Prior to her work at AIR, she led the philanthropic initiatives to integrate technology in afterschool programs as the vice president for youth services at the Morino Institute. During the Clinton administration, she served as the first deputy executive director and chief operating officer for the Corporation for National Service that launched AmeriCorps throughout the United States. Previously, Dr. Gray served as the deputy director for the first American Red Cross AIDS Public Education program. She also coauthored, *Breakthrough Learning: Advancing Educational Innovation With Assistive Technology* (2011), which focused on innovations in teaching and learning. Dr. Gray earned her Ph.D. in education and psychology from Stanford University.

Rita Kirshstein, Ph.D., is a managing director in the Education program at AIR where she directs the higher education practice area. She has dedicated much of her professional career to studying higher education and ways to ensure that all students seeking a college education can attend and obtain a degree. She has analyzed a wide range of issues that include programs designed to increase minority participation in higher education overall and in science, technology, engineering, and mathematics programs specifically; financial aid policies at the national and state levels; the causes and consequences of rising tuitions; institutional spending patterns; and faculty roles and responsibilities. In January 2012, Dr. Kirshstein became the director of the Delta Cost Project, which focuses on college affordability through an understanding of the relationships among tuition, institutional spending, and student subsidies. In addition, she has led evaluations and provided evaluation support to a number of different education initiatives including an alternative to traditional writing remediation programs in community colleges, correctional education in male prisons, federal technology programs, federal reading programs, the Fund for the Improvement of Postsecondary Education, and several National Science Foundation programs aimed at increasing doctoral degrees among underrepresented minorities. These projects, and others, have led to an understanding of the issues involved in translating federal and state initiatives into practices that improve the delivery of education and education outcomes. Dr. Kirshstein's knowledge of higher education and interest in working with students of all types has resulted in appointments to the board of directors of College Bound, a college access program based in Washington, D.C., and to the board of trustees of the University of the District of Columbia. She also was an adjunct professor in the sociology department at The George Washington University where she taught graduate courses on the sociology of higher education. Dr. Kirshstein earned her M.A. and Ph.D. in sociology from the University of Massachusetts, Amherst.

Carlos Rodriguez, Ph.D., is a (former) principal researcher in the Education program at AIR. Dr. Rodriguez is a nationally recognized expert with more than 25 years of high-level experience in STEM research, evaluation, and education. With particular expertise on STEM diversity in the postsecondary and workforce arenas with AIR, he has served as principal investigator for major National Science Foundation research and evaluation grants on doctoral education and broadening participation in STEM throughout the educational spectrum. His seminal work has contributed significantly to the knowledge base on accelerating success in STEM education and workforce pathways especially for members of underrepresented populations. Dr. Rodriguez authored the national report, *America on the Fault Line: Hispanic American Education* (1997), which informed the enactment of the Hispanic Education Action Plan to guide federal agencies in Hispanic educational initiatives. He delivered an address on the Educational Landscape of Hispanics at the First White House Conference on Hispanic Children and Youth convened by First Lady Hilary Clinton in the East Room at the White House in Washington (1999). Dr. Rodríguez holds an appointment as Scholar-In-Residence at American University in Washington, D.C. He is also a Spencer Foundation Fellow of the Woodrow Wilson Foundation for his research, *Minorities in Science and Engineering: Patterns for Success*. He earned his master's degree in bicultural and bilingual studies from The University of Texas, San Antonio, and his Ph.D. in higher education from the University of Arizona.

Symposium Presenters

Maleka Brown is a final-year graduate student in developmental psychology and neuropsychology in the doctoral program at Howard University. Her prior research has focused on inhibitors to academic achievement (e.g., stereotype threat) as a McNair scholar and National

Institutes for Mental Health–Career Opportunities in Research Fellow. As an extension of this work, and as a National Science Foundation (NSF) Graduate Research Fellow, Brown is currently an avid qualitative and quantitative researcher with expertise in enhancing youth, adolescent, and family outcomes via various protective factors despite a multitude of environmental challenges. She investigates how cultural socialization and parental involvement buffer the effects of discrimination and violence exposure, promoting academic achievement and social outcomes among youth of African descent, including first-generation immigrants. Brown is the only student to receive the prestigious NSF Fellowship in Howard University's Psychology Department and the third student to receive the fellowship in the history of Howard University. Furthermore, she has engaged in numerous research projects, collaborative projects, presentations, grant writing, and academic writing, as well as teaching and mentoring experiences. As a Preparing Future Faculty Fellow, Brown enjoys teaching and inspiring students to challenge themselves to make innovative contributions to their communities through a research career, as she consistently seeks to increase the number of underrepresented minorities in the sciences making significant impacts to the field.

Brittny Davis is a Ph.D. candidate in chemistry at the University of Maryland, Baltimore County. As an undergraduate at Jackson State University, she participated in both the Minority Biomedical Research Support's Research Initiative for Scientific Enhancement and Minority Access to Research Careers–Undergraduate Student Training in Academic Research programs. Davis was a National Science Foundation Bridge to the Doctorate Fellow and an Extreme Science and Engineering Discovery Environment Scholar for the 2011–12 academic year. She is currently a Graduate Meyerhoff Fellow (National Institutes of Health Initiative for Maximizing Student Development). Her dissertation project is titled, "Determining the Molecular Origins of Allostery for the RNA Polymerase From the Hepatitis C Virus," and she recently received a National Research Service Award (F-31) grant from the National Institute of General Medical Sciences to complete her dissertation research. She expects to graduate by December 2014, and her research interests include structural biology and computer-aided drug design.

Sharon Fries-Britt, Ph.D., currently serves as an associate professor in the College of Education at the University of Maryland, College Park. For 30 years, she has been a consultant on issues of race equity and diversity for organizations in and outside of higher education. She is a nationally recognized keynote speaker and maintains ongoing consultations with several organizations including The Johns Hopkins University, Princeton University, and the U.S. Office of Personnel Management. Previously, she was a visiting professor at the Harvard Graduate School of Education. Her research on minority high achievers examined their experiences in the academy. In addition, she was a consultant and research associate for the National Society of Black and Hispanic Physicists, exploring patterns of success in STEM majors. She also served as a consultant for the MIT Study on Faculty Race and Diversity and was a co-principal investigator on a grant to study race, equity, and diversity in the 23 southern and border states funded by the Lumina Foundation. Prior to her academic appointments, she served for nearly ten years as the assistant to the vice president for student affairs at the University of Maryland, College Park. She was a consultant and senior faculty of the Eastern Management Training Center for the U.S. Office of Personnel Management. Dr. Fries-Britt has dedicated extensive service to the profession regionally and nationally, and she has been the recipient of numerous awards including the 2012 Faculty Achievement Award at the University of Maryland and the Association for the Study of Higher Education Mentor of the Year Award. Dr. Fries-Britt earned her M.A. in college student personnel from The Ohio State University and her Ph.D. in education and policy leadership from the University of Maryland.

Jackie Huntoon, Ph.D., is associate provost and dean of the Graduate School at Michigan Technological University. As dean, she has led her university's efforts to increase enrollment and improve quality in graduate education. Previously, she served as the program director for diversity and education in the Geosciences Directorate at the National Science Foundation. Dr. Huntoon is active in several national organizations and currently serves as the vice president for programs for the National GEM Consortium and as a member of the Boards of the American Geosciences Institute and Midwestern Association of Graduate Schools. She is a former member of the Board of the Council of Graduate Schools and is a Fellow of the Geological Society of America. Dr. Huntoon is a geologist by training, and her geologic research focuses on the record of long-term changes in climate and sea-level during the Late Paleozoic and Mesozoic Eras in western North America. She is also active in teacher preparation and professional development in the areas of earth science and engineering. She earned her master's degree from the University of Utah and her Ph.D. from Pennsylvania State University.

Katy Keenan, Ph.D., is a National Research Council postdoctoral scholar at the National Institute of Standards and Technology (NIST) in Boulder, Colorado. At NIST, she develops reference objects for quantitative magnetic resonance imaging (MRI) standardization. For example, in collaboration with the University of California–San Francisco, she is testing a breast mimic that will be used nationwide, in more than 20 research centers, next year. She also manages the NIST small-bore MRI system and conducts MRI research in the areas of nanoiron imaging and temperature mapping near metal. At Stanford University, she worked with Drs. Garry Gold, Scott Delp, and Gary Beaupré to determine MRI techniques that can detect cartilage-based predictors of osteoarthritis. Dr. Keenan earned her M.S. and Ph.D. in mechanical engineering from Stanford University.

Michael Kubiak is chief research and evaluation officer at Citizen Schools, where he manages the national evaluation portfolio, focused primarily on measuring student outcomes, strengthening partnerships, and measuring organizational effectiveness across the Citizen Schools national network, which includes 32 middle school partnerships and leverages 10,000 "Citizen Teacher" volunteer professionals to serve more than 5,000 students in the 2013–14 school year. Citizen Schools accelerates student engagement and learning through an innovative expanded learning time model that is rigorous and evidence based to include academic practice, college knowledge, and real-world apprenticeships. Kubiak also acts as the liaison to Citizen Schools' external evaluation partners and manages the evaluation strategy for Citizen Schools' U.S. Department of Education Investing in Innovation Fund (i3) project focused on building STEM interest and achievement through STEM apprenticeships. He has several years of experience providing technical assistance to urban school systems and community-based organizations. Currently, he serves nationally as the cochair of the Wallace Foundation's national Expanded Learning Opportunities Professional Learning Community Measurement and Evaluation committee and locally as a member of the Boston Partnership Council, which is charged with devising and implementing a collaborative city-wide "education pipeline" strategy to support children from birth through college with a specific focus on building STEM pathways. Prior to his work at Citizen Schools, Kubiak held programmatic, research, and policy positions at the Annenberg Institute for School Reform, the Clinton HIV/AIDS Initiative, the University of

Michigan, and the YouthVote Coalition. He is the author or coauthor of several research and practice guides including the Annenberg Institute's *Beyond Test Scores: Leading Indicators for Education*. Kubiak holds an M.Ed. from the Harvard Graduate School of Education and an M.B.A. from Boston College.

Charles Lu, Ph.D., is the director of academic advancement and innovation at the Longhorn Center for Academic Excellence within the Division of Diversity and Community Engagement at The University of Texas, Austin. Previously, Dr. Lu conducted cross-cultural research in Kaohsiung, Taiwan, as part of the U.S. Department of State's Fulbright Fellowship. Dr. Lu has served as a school director and academic coach and was also the recipient of the 2009 Toyota International Science Teacher of the Year award. Dr. Lu earned his M.A. in secondary education from Loyola Marymount University and his Ph.D. in higher education administration from The University of Texas–Austin.

Lindsey Malcom-Piqueux, Ph.D., is an assistant professor of higher education administration in the Department of Educational Leadership in the Graduate School of Education and Human Development at The George Washington University. Her research interests center on the relationship between higher education policy and access and success for URM in the STEM fields. She is particularly interested in exploring the ways in which institutional and college financing pathways structure opportunity and outcomes for URMs in STEM. Much of Dr. Malcom-Piqueux's research focuses on the role of the community college as an entry point to postsecondary education for minorities interested in STEM fields. She also studies the organizational cultures of minority-serving institutions (i.e., historically Black colleges and universities, Hispanic-serving institutions, and tribal colleges) and examines the congruence of the minority-serving designation and academic outcomes for students of color. Dr. Malcom-Piqueux's earned her M.S. in planetary science from the California Institute of Technology and her Ph.D. in urban education with an emphasis on higher education from the University of Southern California.

Mia Ong, Ph.D., is a senior project leader and evaluator in the Education Research Collaborative at TERC, a science and mathematics education nonprofit organization in Cambridge, Massachusetts. She is also the founder and director of Project SEED (Science and Engineering Equity and Diversity), a social justice collaborative affiliated with The Civil Rights Project/*Proyecto Derechos Civiles* at the University of California–Los Angeles. For nearly 20 years, she has conducted qualitative research focusing on gender and race in STEM in higher education and careers. She is currently coleading two research studies with Dr. Apriel Hodari sponsored by the National Science Foundation that are focused on life stories of racial/ethnic minority women in physics, astronomy, engineering, and computer science. Dr. Ong also has evaluated several STEM diversity/inclusion programs in higher education, including the New England Alliance for Graduate Education and the Professoriate and the National Institutes of Health Minority Scholars Program in biomedical engineering at City College New York. Dr. Ong's work has appeared in journals such as *Social Problems, Harvard Educational Review,* and *Communications of the ACM*. Previously, she directed an undergraduate physics program for minority and female students at the University of California–Berkeley for which she was a corecipient of a U.S. Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring. In addition, she served on the U.S. delegation to the 2nd and 4th IUPAP International Conferences on Women in Physics in Brazil and South Africa, respectively.

Dr. Ong also has served on several national advisory committees, including the Committee on Equal Opportunities in Science and Engineering, a Congressionally mandated advisory committee to NSF and Congress; the NSF Social, Behavioral, and Economic Sciences Advisory Committee; and the Social Science Advisory Board of the National Center for Women and Information Technology. Dr. Ong earned her Ph.D. in social and cultural studies in education from the University of California–Berkeley and held postdoctoral/lectureship positions at Wellesley College and Harvard University.

Colette Patt, Ph.D., is the director of diversity programs in the mathematical and physical sciences at the University of California–Berkeley. Her research focuses on academic life and institutional change in higher education. Dr. Patt currently conducts research on sociological and psychological questions related to achievement and advancement in the scientific community, with a focus on ethnicity and gender. She also directs the Mathematical and Physical Sciences Diversity and Education Center. In this capacity, she directs the following programs: California Alliance, Berkeley Science Network (in partnership with the Kapor Center for Social Impact), Berkeley Science Network Scholarship Program (NSF–S-STEM), Berkeley Science Connections (NSF-Innovation through Institutional Integration), and Berkeley Edge Program (Kapor Center and Sandia National Laboratories). Dr. Patt consults with and advises university administrators, academic departments, student organizations, faculty, students, and national organizations. Dr. Patt earned her Ph.D. in social and cultural studies from the University of California, Berkeley.

Keivan Guadaloupe Stassun, Ph.D., is a professor of physics and astronomy at Vanderbilt University and an adjunct professor of physics at Fisk University. In addition, he serves as codirector of the Fisk-Vanderbilt Master's-to-Ph.D. Bridge Program. Prior to his work at Vanderbilt, he was a NASA Hubble Space Telescope Postdoctoral Research Fellow. A recipient of a CAREER award from the National Science Foundation and a Cottrell Scholar Award from the Research Corporation, Dr. Stassun's research on the birth of stars and planetary systems has appeared in *Nature*, National Public Radio's *Earth & Sky*, and in more than 100 peer-reviewed journal articles. In 2007, the Vanderbilt Initiative in Data-intensive Astrophysics was launched with Dr. Stassun as its first director. He serves on the executive committees of the Sloan Digital Sky Survey, the Large Synoptic Survey Telescope, and the National Research Council's Decadal Survey of Astronomy and Astrophysics. In 2012, he was named Fellow of the American Association for the Advancement of Science and was recognized in 2009 by the Fletcher Foundation for "contributions advancing the spirit of *Brown v. Board of Education*." Dr. Stassun also served as chair of the American Astronomical Society's Committee on the Status of Minorities. He has served on the Congressional Astronomy and Astrophysics Advisory Committee and presently serves on the Congressional Committee for Equal Opportunity in Science and Engineering. In 2010, Stassun was invited to give expert testimony on "broadening participation in STEM" to the U.S. House of Representatives Committee on Science and Technology. Dr. Stassun earned his Ph.D. in astronomy from the University of Wisconsin–Madison.

Dina Myers Stroud, Ph.D., is the executive director of the Fisk-Vanderbilt Master's-to-Ph.D. Bridge Program and research assistant professor of physics and medicine at Vanderbilt University. Dr. Stroud provides direct student mentoring support, organizes professional development activities, oversees the day-to-day operations of the Fisk-Vanderbilt Bridge

Program, and maintains an active research program. After her postdoctoral fellowships at the University of California–Los Angeles and New York University, Dr. Stroud returned to Vanderbilt as a research instructor. She earned her Ph.D. in molecular biology from Vanderbilt University.

Jane Stout, Ph.D., is the director of the Computing Research Association's newly founded Center for Evaluating the Research Pipeline, where she leads a team of social scientists who evaluate the efficacy of programs aimed at increasing diversity in computing fields. In graduate school, Dr. Stout focused on understanding the many reasons why women pursue and persist in the physical sciences, technology, engineering, and mathematics less often than men. She continued this program of research as a postdoctoral research associate for two years at the University of Colorado–Boulder. She earned her Ph.D. in social psychology from the University of Massachusetts–Amherst with a concentration in quantitative methods.

Jane Wellman is an independent policy analyst specializing in public policy and postsecondary education in the United States. She is an expert in state and federal policy for higher education, with particular expertise in public budgeting, cost analysis and cost management, institutional governance, and change management. She currently serves as the staff director for the Association of Governing Board's National Commission on Higher Education Governance, is a senior regional advisor for the Smarter Balanced Assessment Consortium, and consults with the National Association of System Heads. She is a public member of the Senior Commission for the Western Association of Schools and Colleges regional accrediting commission. She has held numerous leadership positions in higher education in the nonprofit and government sphere, including the executive director of the National Association of System Heads, the Founding Director of the Delta Cost Project, vice president for Government Relations for the National Association of Independent Colleges and Universities, deputy director for the California Postsecondary Education Commission, and staff director of the California Assembly Ways and Means Committee. Her work on increasing transparency for college and university costs won her the Education Writers' Association best essay award in 2011 and Money Magazine's "money hero" honor in 2012. She earned her M.A. from the University of California–Berkeley.

Marcia Williams, Ph.D., is the director of STEM/Sponsored Programs in the College of Engineering at North Carolina A&T State University and has more than 20 years of experience in organizational development, strategic planning, proposal development, and grants implementation and administration. As co-principal investigator and statewide project director for the North Carolina Louis Stokes Alliance for Minority Participation program and co-principal investigator and administrative manager for the National Science Foundation (NSF) Innovation through Institutional Integration (I-3) project, she is a strong advocate for broadening the participation of underrepresented populations who major in and complete STEM undergraduate and graduate degrees. Dr. Williams has been instrumental in garnering more than $8 million in grants to support undergraduate research and interdisciplinary outreach programs and has facilitated faculty-led research experiences on campus and at Argonne, Brookhaven, and Lawrence L. Livermore national laboratories. Dr. Williams' commitment and passion for undergraduate research as critical to the pursuit of graduate education and the development of future professionals and faculty is evident through her participation in various undergraduate-focused research initiatives. These initiatives include councilor in the Undergraduate Research Program Directors Division of the Council on Undergraduate Research, the CUR Broadening

Participation Task Force; and service on advisory boards for the NSF Historically Black Colleges and Universities Undergraduate Program, the NIH Minority Access to Research Careers program, the NSF Research Internships in Science and Engineering program, and the Institute for Broadening Participation. She also served as team leader for the American Association of Colleges and Universities Preparing Critical Future Faculty program at North Carolina A&T that centered on the professional development of female minority faculty in STEM fields. Dr. Williams earned her M.B.A. in management from Wake Forest University and her Ph.D. in leadership studies from North Carolina A&T State University.

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