UNDERSTANDING INTERVENTIONS

That Broaden Participation in Science Careers

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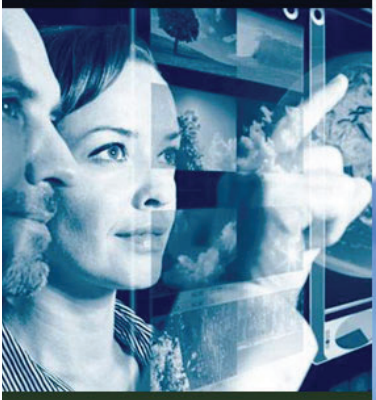

Volume VI

GROWING THE COMMUNITY

Anthony L. DePass and Daryl E. Chubin, Editors

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UNDERSTANDING INTERVENTIONS
THAT BROADEN PARTICIPATION IN RESEARCH CAREERS

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Growing the Community

SUMMARY OF A CONFERENCE
BALTIMORE, MARYLAND, MAY 16–18, 2014

Anthony L. DePass and Daryl E. Chubin, Editors

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Preface

The sixth Understanding Interventions That Broaden Participation in Research Careers conference, which was held May 16–18, 2014, in Baltimore, Maryland, marked a major turning point for a community that has been growing and evolving since the first conference was held in 2007. A major grant from the National Institute of General Medical Sciences (NIGMS) of the National Institutes of Health (NIH) has provided a stable base for the community's ongoing activities. The grant will make it possible to continue the conferences and disseminate the conference summaries, expand and enhance the Understanding Interventions website (www.understanding-interventions.com), and build online communications to strengthen flows of information and resources among members of the Understanding Interventions community. The NIGMS grant is enabling the construction of the infrastructure that the community has envisioned since it first began working together on these issues.

The Understanding Interventions initiative was begun to bring together researchers and program practitioners to foster hypothesis-based research, and that remains its core objective. But this objective has both broadened and deepened over time. Solving the problem of underrepresentation of minorities in biomedical and behavioral research and throughout the sciences is going to require that many different solutions be developed and applied simultaneously. Developing and applying these solutions in turn requires new ideas and new people, and both can be seen in the continuing evolution of the Understanding Interventions conference and community.

In the past, the Understanding Interventions conferences have been based largely on ideas in abstracts submitted by prospective presenters. But this approach left relatively unexplored several topics of immediate relevance to our community. Several such topics received expanded consideration at the

2014 conference, and Chapters 1–4 of this summary of the conference expand on these themes.

Chapter 1 focuses on a set of issues that have emerged from previous conferences as critical to the development of minority researchers: identity, bias, and self-efficacy. The perceptions that a student has of his or her identity and ability and of others' opinions and beliefs, though difficult to measure, can determine whether a student thrives or falters in a research environment. Yet these same perceptions provide a powerful means of broadening participation in research, since interventions that alter these perceptions through the provision of social and academic support can have an indelible influence on students' lives. Many of the programs and initiatives discussed in this report act, directly or indirectly, on students' sense of identity and self-efficacy.

Chapter 2 examines how identity and self-efficacy, along with other factors, influence the retention of students in science, technology, engineering, and mathematics (STEM) education. Students underrepresented in STEM fields enter college intending to major in those subjects in the same proportions as non-underrepresented students, but their attrition rates are much higher at both the undergraduate and graduate levels. Understanding in detail the forces that cause students to give up their STEM ambitions is essential in changing those forces.

Chapter 3 further reinforces the importance of identity and self-efficacy by examining the roles of advisors, mentors, and coaches in the lives of students and beginning researchers. As Richard McGee points out in that chapter, nothing is more central to research development than mentoring. Yet this relationship is itself extremely complex. Many students can benefit from a relationship more accurately described as coaching than mentoring. And advisors, mentors, and coaches often need help themselves to optimize the value of these relationships.

Chapter 4 turns to a subject of abiding interest in the Understanding Interventions conferences: data, methods, and measures. Quantitative and qualitative measures of interventions and the effects of interventions are becoming even more important in an era of big data, where the fusion of data gathered in many different contexts and from many different sources has unprecedented potential to increase understanding of educational and research pathways. Even intensely personal relationships, such as that between a mentor and student, can benefit from the insights yielded by careful analysis and measurement, as the programs described in this chapter demonstrate.

The final three chapters of this report revisit the themes of the first four chapters in an institutional context. Chapter 5 discusses how colleges and universities have been applying approaches discussed in the Understanding Interventions conferences to broaden participation in research. Chapter 6 describes several initiatives undertaken by professional associations that could be much more widely adopted. Chapter 7 returns to the federal role in fostering more representative participation in research, including the intersection of the federal role with some of the themes discussed earlier in the report.

As this brief summary of the 2014 conference makes clear, the complement to new ideas is new people. Every year, during the talk-back session that traditionally has concluded the conferences, several first-time participants

stand up and say how delighted they are to have discovered, quite unexpectedly, a group of people who share their interests and concerns. Many more people could have the same experience if they knew about the conference and were able to attend. A very broad range of individuals and institutions will need to be involved in this effort if it is to be successful. Just to take one example, many underrepresented minorities who go on to earn PhDs in STEM fields begin their college education in community colleges. Greater recruitment in community colleges, minority-serving institutions, tribal colleges, K–12 education, and other venues could greatly boost both the size and intellectual momentum of the movement.

The body of knowledge created as a result of the Understanding Interventions initiative has achieved one of the key attributes of a scientific discipline: it has become cumulative, so that new research projects and interventions are building on a continually expanding base of understanding. The support of NIGMS promises that this body of knowledge will continue to grow and benefit not only the research enterprise but also the broader society that relies on research for improvements in its health and well-being.

Anthony DePass
Daryl Chubin

1

Identity, Bias, and Self-Efficacy

One of the most powerful influences on the experiences of students underrepresented in science, technology, engineering, and mathematics (STEM) fields is also one of the most difficult to measure: the perceptions a student has of his or her ability and of others' opinions and beliefs. Students of all backgrounds can experience stress in navigating STEM fields, but underrepresented students of color and women frequently experience additional strains because of feelings of isolation, unwelcoming or hostile climates, racial and gender stereotypes, and perceptions of unequal treatment and bias. At the same time, perceptions of social support can improve academic outcomes and increase resiliency to stress. Several speakers addressed these issues and described research aimed at explicating their effects.

CHANGE, FLIP, AND UNDERSTAND

Before 1941, David Asai's father, who had a bachelor's degree from the University of California, Berkeley, but worked as a gardener, was a member of a small community of Japanese Americans on Terminal Island in Long Beach, California. When the United States entered World War II, he was sent to a concentration camp in Arizona. He later relocated to Michigan and worked as a janitor, after which he trained to be a minister in a seminary just outside Boston. As a congregational minister, he worked in small churches in Vermont, where David and his brother joined the family. The family then moved to Kansas, where the boys were the only nonwhites in their schools.

Knowing how race shaped his father's life has informed his thinking on ethnicity, race, and diversity, explained Asai, who is senior director of science and education programs at the Howard Hughes Medical Institute (HHMI). He cited Scott Page's book *The Difference*, which explains the importance of

diversity.[1] First, diversity is a property of a group, and science depends on groups. Diversity also adds perspectives, interpretations, and tools, all of which are crucial to solving the problems of science. And diversity trumps ability when a problem is hard and large numbers of people are working on it.

"The good news," Asai said, "is that in this country we have a huge opportunity to take advantage of a diverse set of scientists." However, he explained, the United States, and the science professions in particular, have done a poor job of diversifying the workforce. Today the talent pool is about 29 percent minorities who are underrepresented in science, technology, engineering, and mathematics (STEM) fields—including African Americans, Hispanics, Asian/Pacific Islanders, American Indians, and Native Hawaiians—while the scientific workforce remains at only about 9 percent underrepresented minorities (Figure 1-1).

"This is a real challenge for any organization that's interested in advancing science," Asai said. If the U.S. population were to remain steady at 30 percent underrepresented minorities, it would take the country about 100 years to establish a representative population of PhDs. But the minority population is growing and is projected to exceed 50 percent by 2050.

Studies that control for preparation of students entering college find that minority undergraduate students leave STEM fields at a rate twice that of white and Asian students. "There's something we are not doing right at the undergraduate level," Asai said. About 30 percent of entering undergraduates who intend to study science are underrepresented minorities, reflecting the U.S. population well. However, by the time those freshmen receive science baccalaureates, the proportion who are underrepresented minorities is only about 17 percent underrepresented, and by the time they receive PhDs the number drops to 9 percent (Figure 1-2). This trajectory suggests a great need to prepare undergraduates for success.

Asai suggested that research universities in particular are underachieving. In natural sciences, these schools enroll about 3.3 million undergraduates, of which 18 percent are underrepresented minorities. The research universities graduate about 73,000 baccalaureates in the natural sciences per year, of which about 12 percent are underrepresented minorities.

About 4,200 students with baccalaureate degrees from the top research universities receive science PhDs each year, representing 5.7 percent of the annual production of science baccalaureates. But only 280 minorities from these universities receive a PhD each year, a yield of just 3.1 percent of the 9,000 underrepresented students who receive baccalaureates.

Asai presented three ideas for improvement—change the metaphor, flip the formula, and understand difference. The first is the easiest, he said. Metaphors are very powerful, and they influence the way we behave. The domino theory is one example; fiscal cliffs are another. In science education a common metaphor is the pipeline, which has a beginning and an end with leakage along the way.

[1]Scott, David. 2007. *The Difference: How the Power of Diversity Creates Better Groups, Firms, Schools, and Societies.* Princeton, NJ: Princeton University Press.

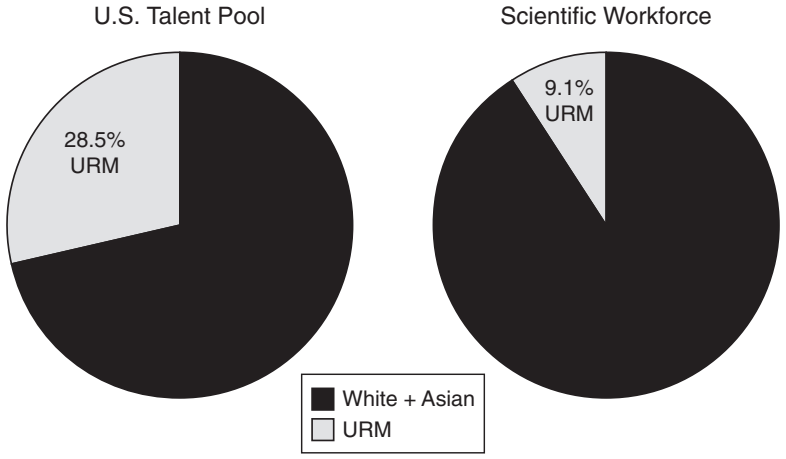

FIGURE 1-1 Though 28.5 percent of the U.S. workforce consists of minorities underrepresented in STEM fields, underrepresented minorities (URM) account for only 9.1 percent of the scientific workforce. Source: National Science Foundation.

This is not a good metaphor for student persistence, Asai argued, because today's students often do not have a very linear story. "They have many experiences that my generation didn't have," he pointed out. One example is transfer students, who are an important source of talent. Among students getting a baccalaureate degree in STEM fields, 50 percent have studied at a

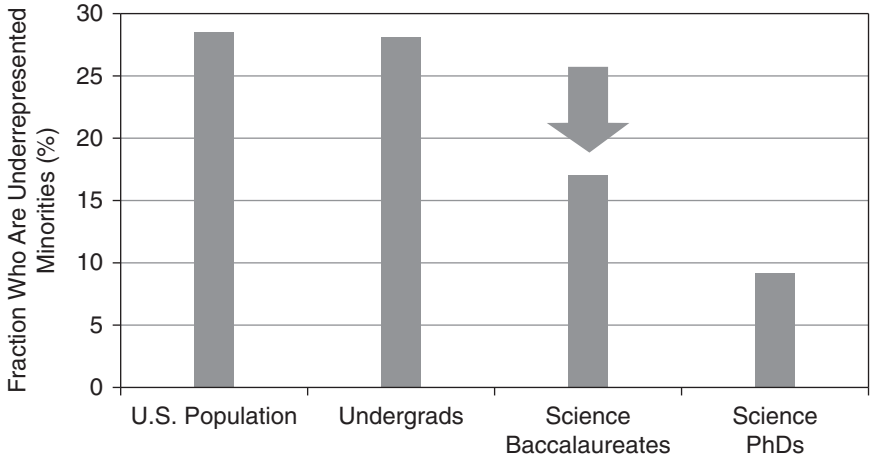

FIGURE 1-2 Underrepresented minorities leave STEM fields at higher rates during their undergraduate (arrow) and graduate years. Source: National Science Foundation.

community college. They also may have experiences with work, the military, or other sectors along the way to a degree.

Instead of a pipeline, Asai suggested the watershed as a metaphor. The Chesapeake Bay watershed has 150 different tributaries and involves six states. It has input from many sources, with different pathways and velocities. The boundaries between stages are not always exact and can change with conditions. The outcomes are many and diverse. This may not be the perfect metaphor, he said, but rethinking the pipeline metaphor is essential.

Asai's second suggestion involved looking at investments and payoffs differently. Undergraduates have an opportunity to learn the processes of science, and it is important for them to become comfortable with uncertainty and to learn how to explore the unknown. One way to foster a spirit of scientific inquiry is to engage students in research experiences. HHMI runs a course where freshmen isolate bacteriophages from soil samples, sequence the DNA, and annotate the genomes, with more than 2,000 students at 73 schools currently taking the course. Over six years, the students have isolated more than 3,000 new viruses and have identified 48,000 genes, of which 865 were never seen before.[2] The students have better grades in their elective courses, and they stay in school at a higher rate.

The cost of the program is about $200 to $250 per student. But a summer research experience costs between $5,500 and $10,000 per student, Asai said. In an informal survey, HHMI asked research universities how much they spend per student on introductory biology lab courses, excluding faculty salaries. The answers fell in a range between $10 and $337 per student. Asai suggested that instead of choosing top students to engage in expensive summer research courses over the summer, universities could invest in improving the research experience during the school year and reach a broader pool of undergraduates. "Advanced courses aren't the best place to put the money, because those students have mostly already decided," Asai said. "You miss the kids who never make it that far."

His third point addressed the issue of understanding difference. Understanding difference takes practice and has to do with listening, understanding privilege, and changing behavior. He emphasized intent versus impact, explaining that when someone has privilege in a relationship, his or her intent does not matter. What matters is the impact of what they say or how they treat the other person.

Asai cited two examples to illustrate this point. The first was a study, involving 6,500 faculty members in 89 disciplines at 259 universities, who were sent an email with a fictitious name containing a request from a student to work with that faculty member in graduate school. The emails with the

[2]Jordan, T. C., S. H. Burnett, S. Carson, S. M. Caruso, K. Clase, R. J. DeJong, J. J. Dennehy, D. R. Denver, D. Dunbar, S. C. Elgin, A. M. Findley, C. R. Gissendanner, U. P. Golebiewska, N. Guild, G. A. Hartzog, W. H. Grillo, G. P. Hollowell, L. E. Hughes, A. Johnson, R. A. King, L. O. Lewis, W. Li, F. Rosenzweig, M. R. Rubin, M. S. Saha, J. Sandoz, C. D. Shaffer, B. Taylor, L. Temple, E. Vazquez, V. C. Ware, L. P. Barker, K. W. Bradley, D. Jacobs-Sera, W. H. Pope, D. A. Russell, S. G. Cresawn, D. Lopatto, C. P. Bailey, and G. F. Hatfull. 2014. A broadly implementable research course in phage discovery and genomics for first-year undergraduate students. *MBio* 5(1):e01051-13.

names of women and minorities were ignored at a higher rate than requests from white males. The response rate decreased with higher paying disciplines and more elite universities.[3] Also, response rates were the same regardless of race and gender of faculty respondent.

The second example had to do with the mismatch hypothesis, which posits that if black and Hispanic students are placed at a school that is not a good fit for them, underperformance is more likely because they are less academically prepared than the students with whom they have to compete. Two researchers in 2013 tested that hypothesis by looking at students in the University of California system in 2004, when a budgetary problem led to offers to students from the less elite campuses to have a guaranteed transfer option to more elite schools. A total of 491 students accepted the option. The mismatch hypothesis predicted they would not succeed, but the data show that the GPAs of the transfer students were statistically the same as the other students at those schools, and they were no more or less likely to drop out.[4]

The implementers of interventions believe that they know what kinds of activities will make a difference for minority students, Asai said. He encouraged the conference attendees to question those beliefs and examine why they have chosen certain interventions and whether those interventions have achieved the desired outcomes. The Understanding Interventions conference, he emphasized, is a critical place for communities to come together and ask these kinds of questions.

In his keynote plenary address, Asai also announced the Meyerhoff Adaptation Program, which is an experimental effort to adapt components of the highly successful Meyerhoff Scholars Program to work with existing programs at Pennsylvania State University and the University of North Carolina, Chapel Hill. (The initiative is described in detail in Chapter 5.) The experiment will last five years and will attempt to find out whether Meyerhoff components can be successfully adapted, what the desired outcomes are of those components, how to measure progress of the various programs, and what pieces might be helpful to other universities.

Asai concluded by quoting Supreme Court Justice Sonia Sotomayor's dissent in the case *Schuette v. Coalition to Defend Affirmative Action*, which powerfully describes the experiences many students face in trying to pursue a career in science:

Race matters for reasons that really are only skin deep, that cannot be discussed any other way, and that cannot be wished away. Race matters to a young man's view of society when he spends his teenage years watching others tense up as he passes. . . . Race matters to a young woman's sense of self when she states her hometown, and then is pressed, "No, where are you *really* from?" . . . Race matters to a young person addressed by a stranger in a foreign language, which he does not understand because only English was

[3]Milkman, K. L., M. Akinola, and D. Chugh. 2014. What happens before? A field experiment exploring how pay and representation differentially shape bias on the pathway into organizations. Available at SSRN: http://ssrn.com/abstract=2063742.

[4]Kurlaender, M., and E. Grodsky. 2013. Mismatch and the paternalistic justification for selective college admissions. *Sociology of Education* 86:294-310.

spoken at home. Race matters because of the slights, the snickers, the silent judgments that reinforce that most crippling of thoughts: "I do not belong here."

ATTITUDES AMONG AFRICAN AMERICAN MALES TOWARD STEM COLLEGE MAJORS AND CAREERS

The lack of a viable STEM workforce increasingly threatens the position of the United States as a leader in science and technology, said LaVar Charleston, assistant director of the University of Wisconsin Equity Inclusion Laboratory (WeiLAB). In particular, the nation's declining scientific workforce, specifically as it relates to participants of color and Black males, will continue to jeopardize the country's ability to solve complex technological challenges. STEM jobs are expected to grow 17 percent by 2018, while non-STEM jobs will attain only 10 percent growth over the same period, Charleston observed. Meanwhile, despite higher wages, interventions, and recruitment and education efforts, minorities remain underrepresented in STEM fields. Approximately 238,000 Black men are scientists and engineers, compared with 5 million who are white and 840,000 who are Asian or Asian American. African Americans represent 13 percent of the U.S. population but less than six percent of all faculty members at American colleges and universities.

The higher the academic level, the lower the participation rate among minorities. In 2007 the total number of black doctoral recipients was just under 2,000, or about 4 percent of the total—705 men and 1,251 women. In 1977, 754 doctoral degrees were awarded to African American men, and 440 to African American women. Thus, males went from 63 percent of African American doctoral degree recipients in 1977 to 36 percent in 2007. From 1977 to 2007, Black males were the only males from an ethnic or racial group whose numbers for doctorate attainment dropped.

In 2008 the State of Arizona created an organization called the State of Black Arizona to bring together representatives from the academic community, the research community, and the government community to explore and understand issues of concern for African American citizens. The idea was to compel the community and educational entities to make a concerted effort to help improve the experiences of African Americans in the state. Charleston and his colleagues were brought in to do evaluations, looking at educational attainment. Key partners include the Arizona Community Foundation, Arizona Public Service, the Greater Phoenix Urban League, Arizona State University, and Rio Salado Community College.

The issues facing African Americans in Arizona mirror those in the rest of the country. African American degrees in STEM are not keeping up with the growth of the STEM economy within Arizona, which is projected to produce about 4,000 new jobs per year up until 2018. By that year, the state will have tens of thousands of jobs filled or available in such fields as computer and mathematical occupations, engineering, and the life and physical sciences. It is critical for the state's well-being that these employees come from within the state, Charleston said. Yet more than 70 percent of African American students in Arizona from grades four to eight have yet to reach proficiency in critical

mathematics and science courses. The State of Black Arizona has a vested interest in ensuring that this population of individuals receives the education necessary to fulfill these roles. In particular, key goals of the initiative are to focus attention on academic achievement in elementary and secondary schools and increase exposure and promote STEM fields as career options early in students' academic trajectories.

Charleston and his colleagues have been conducting an evaluation of the initiative, with a particular focus on self-efficacy. Research has found that vocational interest alone is not a significant predictor of persistence in a career field. However, self-efficacy and interest contribute to unique variances with regard to occupational considerations. For example, students with stronger self-efficacy in mathematics are more likely to choose science-based majors than students with lower self-efficacy. "Given the role of self-efficacy in career development, the theory provides a means to explain the match between confidence and the decision to pursue educational or occupational careers in STEM fields," Charleston said.

Their research is looking at two questions: first, do attitudes toward STEM fields among African American males in Arizona influence decisions to pursue college degrees and careers in these fields after controlling for other personal characteristics; second, what are the significant factors that lead to pursuit of STEM education or occupation amongst this population? Data came from the State of Black Arizona STEM Attitudes survey, a statewide investigation that targeted 24 churches, two community events, and five community centers in Phoenix, Flagstaff, and Tucson. The researchers received 634 usable surveys, with 62 percent female respondents and 38 percent male. The average age of survey respondents was 48 years.

A logistic regression analysis of the data measured dependent variables such as STEM majors and jobs in STEM-related fields and independent variables that included age and parental status. It also considered 14 attitudes about STEM, including whether respondents felt STEM careers were difficult, interesting, and well respected.

The results showed that African American males who seriously considered selecting a major in STEM were more likely to pursue STEM majors and careers. Although that sounds fairly intuitive, Charleston said, it reveals that individuals must be exposed to opportunities that help to present STEM majors and careers as options. It points toward self-efficacy as a predictor of workforce-related desires and interest, with self-confidence in one's ability increasing the likelihood of aspiration toward STEM.

The results also showed that African American males who felt that STEM majors led to high paying positions were less likely to pursue STEM careers. This could point to misunderstandings about what majors and careers belong to STEM fields, Charleston pointed out. The career development literature talks about being able to socially identify with a career area and excluding other career areas that do not seem to be a good fit. One possibility is that some respondents think that these high-paying jobs are not ones in which they would succeed.

Another finding is that African American males who felt they get more opportunities for self-development and growth in STEM fields are more likely

to pursue STEM majors. Thinking about how STEM could be beneficial to you, your development, your desires, and your lifestyle can motivate people toward those careers, Charleston said.

African American males whose families support their efforts to pursue a STEM degree were more likely to pursue STEM majors and careers. Prior research has documented the role that social networks, including family and friends, play in shaping career decisions and aspirations. While a certain level of aptitude is necessary, considerable research has found that persistence rates are mainly socially constructed. In addition, many minority students are drawn to the helping professions. By helping these students connect STEM fields to these professions, the potential of STEM professionals can be further illuminated.

Overall, the data and findings emphasize the importance of promoting strategies that encourage the involvement of African American males in extracurricular activities while building a support system for their college and STEM pursuits, Charleston said. These efforts need to start earlier in an academic trajectory, he continued. This can be done by engaging students in fun activities, such as science clubs, fairs, and robotics competitions, which are all avenues through which students can engage with STEM professionals and apply science and mathematics to something visible. "We're dealing with a time where kids really need immediate gratification to see results," he said.

Partnerships with STEM-related businesses and colleges can give students opportunities to participate in research as soon as possible, Charleston suggested. Introducing programming and coding in middle school can help students enjoy computer classes and see the impacts of what they are learning. Another valuable tool for African American males that can help build community support around succeeding in STEM is living and learning community. More and more research is showing that living and learning communities are a productive way to increase participatory rates and persistence rates in STEM fields for underrepresented students, he said.

Self-efficacy needs to be attained at each level of the educational trajectory. Thus, it is important to identify and develop strategies for promising practices that engage students at each stage of the transitional points on the education pipeline. For example, research has found that students in computer science who achieved measures of success at the bachelor's level need to reestablish efficacy in outcome expectation for the master's level, which is also true for students moving from a master's to a PhD. The fast-moving rate of change in technology could contribute to this need, he pointed out, because concepts are always changing. Engaging students' interest, challenging them, building communities around them, and helping them build identity around scientific and technological knowledge will all help students build confidence.

Identifying mentors early in the educational trajectory is also important, Charleston said. For example, the Institute of African American Mentors in Computer Science has built a program around in-person and virtual mentoring. Without such programs, minority students can go through the computing trajectory and never see another person of color, particularly at the PhD level.

Given the importance of families in STEM success, strategies for the involvement of families need to be developed. At WeiLAB, researchers re-

cently received a $15 million grant to expand Families and Schools Together (FAST), which has a robust curriculum centered on bringing families together and helping them support their children's education. Charleston also cited a fatherhood initiative in Detroit that centers around encouraging children and promoting the importance of education.

Success will continue to come from the formation of new partnerships involving K–12 schools, colleges and universities, community organizations, and business and industry, Charleston concluded. Policymakers, business owners, community members, and university faculty and administrators all share the goal of improving the academic success of African American males. The State of Black Arizona can help achieve that goal by tapping into additional resources and bringing people together.

A MOTIVATIONAL FACTOR IN BROADENING PARTICIPATION AMONG UNDERREPRESENTED MINORITY STUDENTS

National data on the results of science training program investments suggest that training programs that provide students with support and resources are necessary but not sufficient for meeting the nation's broadening participation and diversity aims, explained Dustin Thoman, assistant professor of psychology at California State University, Long Beach. He and his colleagues have been seeking to identify theoretically driven elements that could be added to improve these interventions.

Thoman cited the recent approach from NIGMS's Training, Workforce Development, and Diversity Division to capitalize on the cultural strengths of underrepresented minority students and to remove cultural roadblocks in science education, in addition to providing support and resources. This is consistent with higher education theory, he said, and particularly with Shaun Harper's work on anti-deficit theory. Whereas traditional deficit approaches examine what underrepresented minority students might be missing that majority students have, anti-deficit or cultural strengths approaches emphasize changing institutions instead of the students. By changing the nature of science education to capitalize on cultural strengths, interventions could be much more effective at sparking and holding the interest of traditionally underrepresented students.

Research has demonstrated that, when students perceive cultural roadblocks in STEM, they tend to see themselves as not fitting the "science image" and ultimately leave, observed Thoman (Figure 1-3). Many of these students are talented and have other options, so it is more attractive to find a place where their cultural and academic identities can feel more connected. Researchers have documented the fact that students who feel these cultural barriers struggle to integrate their identity as a scientist with their cultural identity, which may lead them to choose an area where they feel a better fit. This idea of "fit" is seen throughout the psychological and sociological literature.

The population Thoman and his colleagues have studied consists of advanced undergraduate students who are already working in faculty biomedical research laboratories. These students have demonstrated their ability

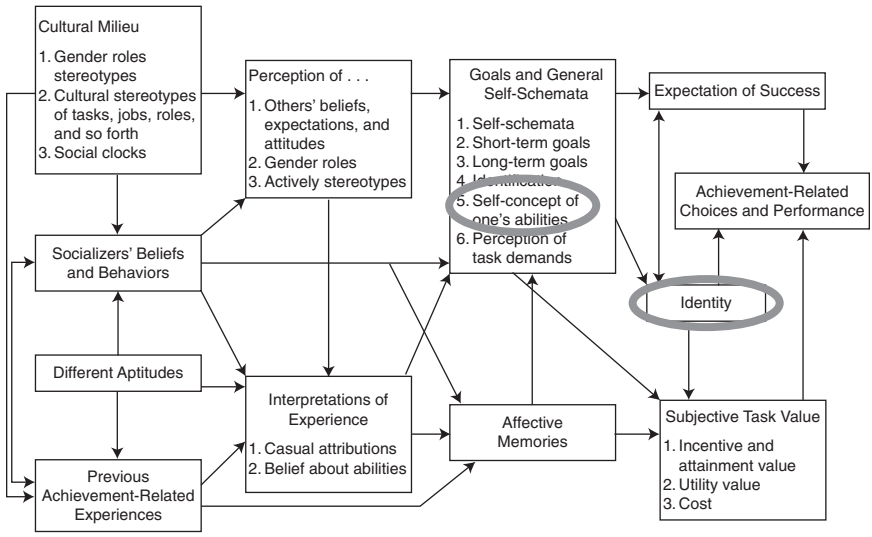

FIGURE 1-3 Among the factors that might explain disparities in minority representation in STEM fields, self-concept and identity are critical. Source: Wigfield, A., and J. S. Eccles. 2000. Expectancy-value theory of achievement motivation. *Contemporary Educational Psychology* 25(1):68-81.

to be invited and accepted by faculty members; the researchers are therefore interested in whether they maintain an interest in scientific research. Psychological theory has consistently shown that the fit between personal goals and perceptions of what is afforded by a situation or a career is highly predictive of career interests, Thoman explained. The researchers sought to explore this fit by asking about students' goals and perspectives on their future careers.

One of the cultural barriers identified in the research literature for underrepresented minority students in biomedical research is the perception that science is driven only by an intrinsic purpose. However, underrepresented minority students and majority students alike value passion, problem solving, and curiosity, which is usually what they cite when people ask why they do science: "I'm interested, I'm passionate, I enjoy the process." Secondary or multiple motives for underrepresented minority students can include wanting to help or wanting to give back to their communities, which is a cultural connection, Thoman said.

Research findings suggest that these secondary motivations matter for interest in addition to, not instead of, the intrinsic motive for science for underrepresented minority students. Thus, part of the barrier in science education, Thomas suggested, is the focus on the individual. Within the context of text-based analysis, few science educators and very few education materials include communal connections, anything about social agency, or information

about how science can be used to help. Most science education is focused on understanding and basic knowledge without communal or social context.

Preliminary evidence from a survey of undergraduates and interviews with graduates looking at the importance of social change as a work value found that it was more important for underrepresented minority students in STEM fields. It also was found to be a predictor of choosing to leave or stay for those students but not for majority students. The study also found that students who redefine for themselves what science is about and bring a social agency perspective into it are more likely to stay in STEM fields. Some interviews from 2008 asked alumni of minority training programs what they believed were the two most attractive aspects of pursuing a PhD in science research. Number one was satisfaction and interest, but number two was helping members of their community.

However, psychological research has shown that people are good in describing why they think they do what they do but bad at knowing the real cause. People tend to underemphasize many of the social-contextual features that drive their behaviors. Thus, Thoman and his colleagues approached their work with a multiple goals perspective. They built upon previous data from interviews and retrospective data by using a prospective study design with qualitative multivariate analysis. They wanted to build stronger study designs to account for the relationship between altruistic and career interests while also controlling for other motivations.

As part of a larger four-year longitudinal study, data were collected from 337 students from two universities and seven tribal colleges in Montana, including 100 underrepresented students, who were recruited through faculty biomedical research laboratories. Initial survey data were collected six weeks into the semester, with a follow-up survey conducted at the end of the semester. The study asked whether perceptions of altruistic affordances predict higher involvement in laboratory work and greater career interest at the end of the semester. It also analyzed whether the altruistic affordances matter even when controlling for effects of other motives.

The baseline measurements asked students about their personal values—including altruistic, intrinsic, and extrinsic types of items—and whether those values were likely to be fulfilled by research laboratory work. Follow-up measures included level of laboratory involvement and career interest. Psychological data point to high correlations between measures of research career interest, particularly at the end of undergraduate study, and actual behavior.

Underrepresented minority students in the study said that it is more important to pursue science for intrinsic goals, and their answers were not statistically different from majority students. However, altruistic goals for underrepresented minority were equally high, whereas for white students they were significantly lower.

To determine what higher altruistic affordances predict, the researchers did a multiple regression analysis and looked for statistical interactions. For white students, the researchers found that fulfilling altruistic goals did not matter for laboratory involvement, but it made a significant difference for underrepresented minority students. Those who saw that the research work allowed them to fulfill greater altruistic goals expressed higher engagement

and higher involvement in their laboratories, with the same pattern appearing in career interest. When the analysis was repeated in a logistic regression, underrepresented minority students who perceived high versus low altruistic affordances were more than three times more likely to have high involvement and two-and-a-half times more likely to have high career interest.

To find the relative contribution of altruistic affordances, the researchers did a multivariable analysis that accounted for all three goals. They found that intrinsic goal affordances predicted research involvement and career interest for everyone, not moderated by ethnicity, and that even controlling for intrinsic and for extrinsic values, altruistic affordances significantly predict career interest for underrepresented minority students. From subsequent statistical mediation analysis, they concluded that the effect of altruistic goal affordances on career interests for underrepresented minority students is driven through greater laboratory involvement.

These findings suggest that the altruistic motivation for doing science is important in addition to, not instead of, intrinsic motivation for underrepresented minority students. Young students have different reasons for approaching a domain than mid-career scientists, and framing interventions from that perspective could result in a greater positive effect. Thus, it may be important to change how scientists talk about science, without needing to change the science itself, to broaden participation. Thoman advised principal investigators to talk to their students about how research helps communities and policymakers. "They are being educated in a culture that often sees science as narrow, objective, and disconnected," he pointed out. Scientists can help change this culture by talking about why science is important in the broader world.

2

Prediction and Retention on STEM Pathways

Upon entering college, the members of groups underrepresented in STEM fields express an interest in STEM majors and careers at the same rate as do their majority peers. Yet while the number of baccalaureate degrees awarded in the natural sciences and engineering have been going up for more than a decade, the number of these degrees awarded to underrepresented minorities has been flat (Figure 2-1).

The factors underlying attrition on STEM pathways are clearly central to the problem of minority underrepresentation in these fields. Several speakers at the conference addressed these factors, including methods to predict persistence in STEM fields. Not surprisingly, bias and STEM identity are powerful influences, as described in the previous chapter.

ADVANCING WOMEN OF COLOR IN STEM FIELDS

Women of color graduate from high school at the same rate as their white peers and enter college in about the same proportion, noted Lydia Villa-Komaroff, chief scientific officer at Cytonome/ST in a plenary presentation on advancing women of color in STEM. However, they are less likely to graduate from college, obtain a PhD in science or engineering, or obtain a tenure-track job at a non-minority serving institution. There is a 40 percent attrition rate on the road to a bachelor's degree for women of color, Villa-Komaroff said. Women of color are also more likely to end up at minority serving institutions and in jobs with less power.

Villa-Komaroff presented data from a recent conference entitled "Seeking Solutions: Maximizing American Talent by Advancing Women of Color in Academia" under the Committee for Women in Medicine, Engineering, and Technology at the National Academy of Sciences (NAS) and National

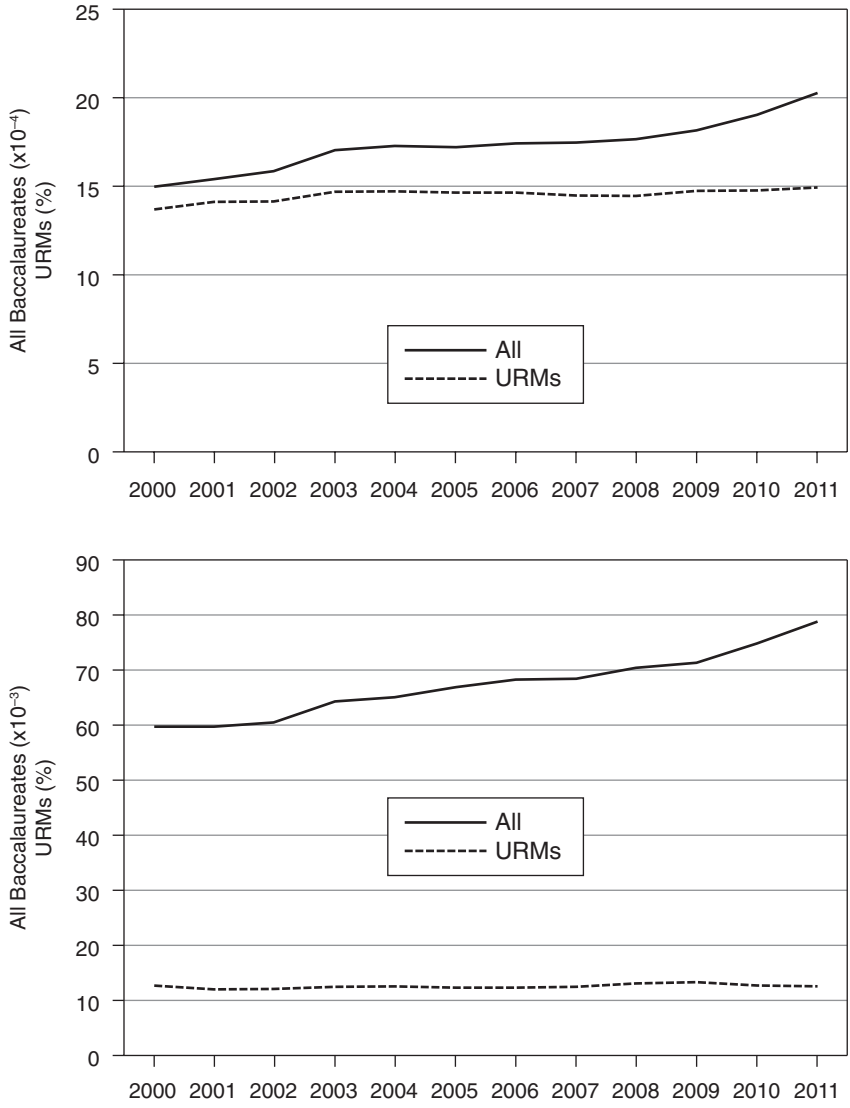

FIGURE 2-1 Baccalaureate degrees awarded in the natural sciences (top) and in engineering (bottom) have been increasing overall since the early 2000s but have remained largely the same for underrepresented minorities. Source: National Science Foundation.

Research Council. The conference produced a 300-page report, along with a 16-page summary, both of which are available online.[1]

Of the women of color who graduate from college, the percentage of STEM graduates is similar to that of their white peers (19 percent versus 21 percent). But only 6.8 percent go on to achieve a PhD, versus 18.6 percent for white women. Some of the fields and categories in the data set were so small that it became difficult to break them down, Villa-Komaroff explained, so the conference also examined data from a faculty survey of about 11,000 faculty, including 272 women of color, at over 600 institutions. This survey found that women of color disproportionately occupied positions of the least power and influence within an institution. The survey also found that the stress levels reported by women of color were higher than for the other populations surveyed. Lack of personal time was the highest source of stress, followed by self-imposed high expectations, household duties, underprepared students, institutional budget cuts, personal finances, and research or publishing demands.

Another study discussed at the NAS conference analyzed biases that affect women, including women of color. This study revealed an attribution bias, where women's success is more likely to be attributed to luck, while men's success is attributed to ability. Mistakes women make are considered more serious than those made by men. And evaluations tend to be polarized, where a very small percentage of high-achieving women receive higher evaluations than men, but women whose performance is "excellent" receive much lower evaluations than men who perform similarly.

This study found that African American women are judged more harshly than white women or African American men, while their success is more often attributed to luck or lower standards. Hispanic women are subject to assumptions of even lower competence. They often are assumed to be new immigrants, with the associated negative class and competence biases. Asian women are viewed either as technically competent but not fit to lead or as too passive and thus less competent.

The maternal wall, or gender bias triggered by motherhood, is an order of magnitude stronger than other forms of bias, according to this study. Motherhood provokes very strong negative assumptions about an individual's competence and commitment. For example, a CV mentioning involvement in a parent-teacher association (PTA) was evaluated substantially lower than an equivalent that did not refer to the PTA.

Villa-Komaroff emphasized the importance of understanding that every institution has a different culture and different state of development. For the Seeking Solutions conference, 25 professional societies submitted written testimony on strategies they use to increase the population of women of color in their organization, which were boiled down to the following practices:

[1]The summary and report are available at http://sites.nationalacademies.org/PGA/cwsem/minoritywomen/index.htm.

- The establishment of boards and committees (including diversity office) within its governance structure to focus on issues of women of color and address their challenges.
- The creation of professional development programs (including mentoring programs).
- The creation of programs and awards that support women of color by providing travel funds, scholarships, research grants, etc.
- The promotion, endorsement, and conduct of surveys and studies to improve the collection and evaluation of data on women of color.
- The inclusion of "diversity" in the professional societies' mission, core value, and strategies.
- Programs to help improve institutional climate in academia, to initiate, or to sponsor diversity events.
- The development of partnership among professional societies, with federal agencies, universities, and other entities.
- Engagement of students in the pipeline and increased recruitment and retention.
- Recognition of women of color's achievement and accomplishments; and encouragement and nominations of women of color for awards/memberships.
- The integration of training and networking opportunities into the societies' meetings.
- The engagement of women of color in leadership positions.
- Federal programs to increase the recruitment and retention of women and the minority workforce.
- Dissemination of effective practices and successful program experiences.

Though not all of these practices are universally applicable, they can make a big difference. "If you are persistent and recognize the culture of your institution, you can accomplish a remarkable amount," Villa-Komaroff said.

Villa-Komaroff cited several specific examples of successful interventions. One was implemented at the University of Michigan, where senior faculty became engaged in the Strategies and Tactics to Increase Diversity and Excellence (STRIDE) program. Over ten years, the university has increased women on their faculty by double digits in every department. Villa-Komaroff added that the university recruited faculty to the program by convincing them that if the issue of diversity was not addressed, the institution would suffer.

At Jackson State University, faculty members were asked what was preventing them from being successful and then received increased access to resources such as a summer writing retreat, group travel experiences, and support for grant writing. The program increased feelings of self-confidence and bonding among the group of women and gave them a feeling of ability and competence.

At Harvard Medical School, the Biomedical Science Careers Program was established to match students of color with mentors. That program grew into an office of diversity, and in 2001 Joan Reede became the first Harvard Medical School dean of diversity and community partnership.

In addition, the NIH has established the Women of Color Research Network, which is a forum aimed at investigators that offers resources and support and is open to everyone interested in diversity issues.

Villa-Komaroff closed with some remarks written by Shirley Malcom, at the AAAS, almost 40 years ago. Malcolm cited the need for data disaggregated by race, sex, citizenship, and other traits and called for awareness of unconscious bias, transparent institutional policies, and customizable tools for institutions to implement to increase diversity. Institutions need to ensure that the selection of faculty is more equitable throughout the recruitment and advancement process, Malcom said, and that need remains critical today.

In response to a question, Villa-Komaroff noted that it is difficult, if not impossible, for women of color to advance without the support of men. One way of starting the conversation is to include conversations on cultural sensitivity in faculty and chair development and search committee training. Trying to do too much too fast can be less effective, she said in response to another question about self-preservation for women initiating change in a traditional environment. It is important to know an institution well, to have conversations, not confrontations, and to think creatively about allies and strategies. For example, small groups have more difficulties achieving success, and other underrepresented groups can be important allies.

ISSUES AT HISTORICALLY BLACK COLLEGES AND UNIVERSITIES

The second speaker in the plenary session was Goldie Byrd, dean of the College of Arts and Sciences at North Carolina A&T State University. "Often when we think about intervention regarding women of color, our minds go directly to the majority institutions," Byrd said, but issues and biases exist at historically black colleges and universities (HBCUs) as well. North Carolina Agricultural and Technical State University is the largest HBCU in North Carolina. The school has a College of Arts and Sciences and a College of Engineering, over 10,700 students, and nine PhD programs. The school brings in approximately $60 million a year for sponsored programs.

To prepare for her talk, Byrd looked at the North Carolina A&T faculty and found that women are underrepresented in almost every area. Most female faculty members have not progressed beyond the associate professor level (Figure 2-2), a pattern that also is apparent at the national level (Figure 2-3). Women, when asked about the inequities, cited involvement in activities that take them away from what they need to do to advance. Female faculty are disproportionately advising large numbers of students, directing training programs, advising student organizations, and sitting on campus-wide committees where they do not necessarily have a strong voice, Byrd said. Women are 26 percent of the STEM faculty, but only 3 percent or less are at the full professor level.

While the university has a wonderful strategic plan, Byrd said, it does not always address the reality of the situation. Their vision is for the school to become an institution that is proactive in creating an environment conducive to the advancement of all faculty in an equitable and progressive way.

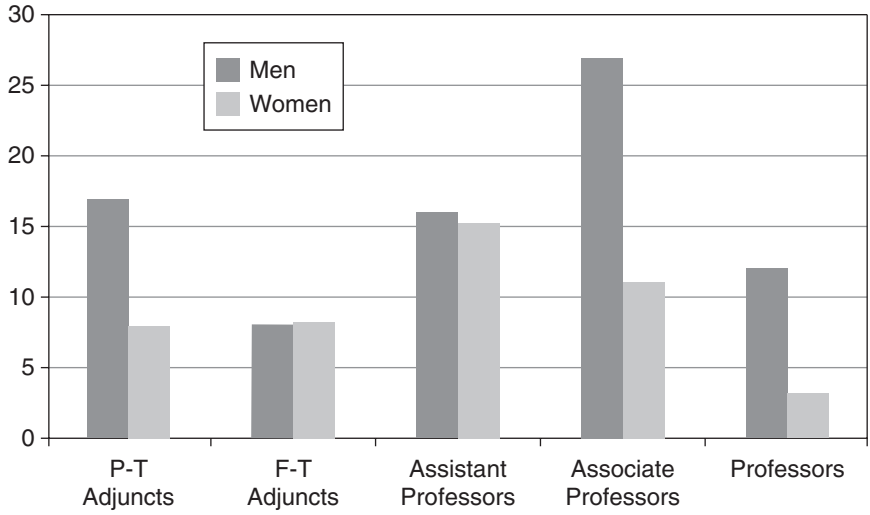

FIGURE 2-2 Women in the College of Arts and Sciences at North Carolina A&T State University are underrepresented at every level of the STEM faculty ranks, and especially at the highest levels. Source: North Carolina A&T State University.

This requires the collective engagement of women and men, she pointed out, because without men's understanding, change cannot happen.

Byrd discussed some of the needed changes North Carolina A&T has sought to improve equity and opportunity for women of color, though not every strategy will necessarily be successful at other colleges. A pathway to tenure and promotion is critical, as is a feeling of inclusion among women. A survey of faculty at North Carolina A&T, which yielded 200 responses, revealed that women wanted more time, more networking, and more support for research, teaching, and mentoring.

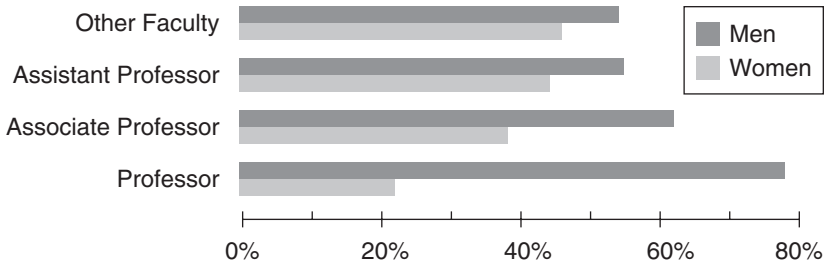

FIGURE 2-3 The underrepresentation of women among STEM faculty in the United States increases with faculty rank. Source: National Science Foundation.

The inclusion and advancement of women needs to be an institutional issue, Byrd said. There are a number of things women faculty can do for themselves, including working to understand the climate of the university, learning to negotiate well, and familiarizing themselves with the requirements for advancement. Knowing the balance of power within a department is also an asset. Byrd recommended that women join a writing group, strive to be leaders in service, and create networks for themselves.

Department chairs have a heavy responsibility in giving women more opportunities for development. The department chair needs to be a successful leader and to set an example in teaching, research, and service. Chairs also must advocate for faculty and find funds to devote to faculty development.

Equity in salary and workload is critical, Byrd said. Research found that women at A&T were overburdened, so the university developed a workload policy for each school and college.

One of the hardest things to do, Byrd said, was to revise fuzzy tenure and promotion guidelines. Clarifying those guidelines helped both male and female faculty and the university. North Carolina A&T also provided training for each of the faculty and chair search committee members.

One thing chairs have done at North Carolina A&T, she said, is to begin writing annual mentoring letters, which let junior faculty know where they are on the path to tenure and promotion. A mentoring review is required every five years. In addition, North Carolina A&T now provides a letter or note from the chair to the faculty member. The university has reduced advising loads and committee loads for new faculty and has endeavored to provide summer funding when it is available to help faculty members get research projects off the ground.

Collaborative proposal development is another strategy that has been useful at North Carolina A&T, Byrd said. The college created an innovation fund from which faculty members can get grants to help move their research to the next level. There is also space on campus for collaborative work. "The idea is for these collaborative proposals to be facilitated by our office," Byrd explained, "so when people have an idea and want us to connect them with persons either inside or outside, we bring them to this space."

The college is working to bring in infrastructure grants and create shared laboratory space where people with common interests can work together. It has hired a biostatistician, a grounds manager, and a part-time editor to assist faculty, along with raising a million dollars through a campaign to diversify strategic partnerships with alumni.

Deans have an important role in making faculty development a priority. Deans can contribute by building a strategic plan that includes diversity and equity and by including faculty development in proposals. Endowments and special funds from private agencies can help to support research and student training. Deans also should be examining how best to support women, advocating for their female faculty, and facilitating the growth of women in leadership roles.

At North Carolina A&T, Byrd explained, a number of women decided they did not want to go back to laboratory research after being away from it for an extended period, so the school requested that the scholarship of teach-

ing and learning be considered an important piece of tenure and promotion. Within the College of Arts and Sciences, the STEM Center of Excellence for Active Learning was created and received a $1.7 million gift from the North Carolina GlaxoSmithKline Foundation. Byrd said that the goal is for women to publish on teaching and learning, developing resources that other institutions can use.

The college is also working to link research to active engagement. For example, faculty members from the biology, journalism, sociology, and other departments have connected to the Center for Outreach in Alzheimer's Aging and Community Health, where they are able to translate their research into action and engage with a population outside of academia.

Some flexibility is essential with strategic plans. Byrd acknowledged that the implementation of many strategies can be an uphill battle, and success comes partly from finding advocates and understanding who has the power to effect change. "We have to begin at the faculty level," she said, "but we need the leadership at all of our institutions . . . to be concerned about and to synergize these kinds of changes."

In response to a question about resilience and persistence, especially when recovering from errors, Byrd suggested that leadership is crucial. Deans and chairs can create an environment that allows women to rebound successfully rather than leave the pipeline. She also suggested finding creative resources for women trying to overcome obstacles. Losing promising faculty costs an institution money, which can get the attention of everyone in power.

Byrd thanked the NIH and North Carolina A&T for allowing room for creative problem solving. Just having the initial conversations about what a school needs and thinking about how faculty members reach leadership positions, she said, can produce great progress.

PARTICIPATION IN COLLEGE LABORATORY RESEARCH APPRENTICESHIPS AMONG STUDENTS CONSIDERING CAREERS IN MEDICINE

Many federal agencies, private foundations, and universities support programs for college students to participate in research, said Dorothy Andriole of the Washington University School of Medicine in St. Louis. At least some of these students may be aspiring to careers in medicine, and some medical schools report considering research experience when they select applicants. However, very little is known about the extent to which students aspiring to medical careers may choose to participate in research during college and about whether doing so increases their chances of getting into medical school.

With funding provided by the National Institutes of Health's National Institute of General Medical Sciences (R01 Grant GM094535), Andriole, along with her colleagues Donna Jeffe, also at Washington University School of Medicine, and Robert H. Tai, at the University of Virginia, investigated participation in a College Laboratory Research Apprenticeship (CLRA) program, the characteristics of participating students, and whether that participation was associated with medical school acceptance. They operationally define students who are seriously considering medical careers as Medical College

Admission Test (MCAT) examinees. Although the majority of people taking the MCAT do not go on to enroll in a Liaison Committee for Medical Education (LCME)-accredited medical school, Andriole pointed out, they do complete a very lengthy and detailed questionnaire (the Pre-MCAT Questionnaire [PMQ]) prior to taking the test, with over 400 items about demographics, parental education, occupation, student debt, experiences in college and high school, work and volunteer experience, and 20 or 30 attitudinal items related to their interests in science and in professional careers.

The American Association of Medical Colleges (AAMC) administers the PMQ, and the AAMC was able to provide Andriole and her colleagues with individualized de-identified records for all PMQ respondents over a six-year period. These records were linked with further data collected from and about the respondents through June 2013, providing a minimum of seven years of data and as much as twelve years of follow-up in some cases.

Using multi-variable logistic regression analysis, the researchers looked at independent predictors of participating in CLRAs and of getting accepted to a U.S. LCME-accredited medical school. Their study sample was about 250,000 individuals, 58 percent white, 21 percent Asian/Pacific Islander, 8 percent Black, 8 percent Hispanic, less than 5 percent unknown or multiple races, and 0.3 percent Native American/Alaska Native. Given the size of the sample, Andriole explained, they were able to analyze each group separately.

Of the entire sample, nearly 30 percent had reported CLRA participation. The highest levels of participation were reported among Asian/Pacific Islander and Black students; markedly lower levels were reported among Native Americans/Alaska Natives. By gender, slightly more women than men reported CLRA participation. The levels of participation of women and Black students were encouraging, Andriole said, but there is a clear need for more targeted programs for Native Americans/Alaska Natives.

By Carnegie classification of undergraduate institution, students who had been enrolled at baccalaureate arts and sciences colleges reported the highest level of CLRA participation. Participation also was high among students at very high research activity universities and lower among students at all other types of institutions. Less than 10 percent of students reported participation in a summer laboratory research program during high school, but of those who did report such research in high school, two-thirds went on to participate in CLRAs. When controlling for all other variables, students who had done research in high school were over five times more likely to report CLRA participation.

The researchers then looked at medical school application status. As of June 2013, one third of individuals in the database had never applied to any U.S. LCME-accredited medical school, 41 percent had applied to and been accepted to medical school, and 26 percent had applied and not been accepted to medical school. Andriole pointed out that most U.S. LCME-accredited medical schools use a holistic admissions process, and the variables in their models do not account for all factors that these medical schools might consider when reviewing applications. Student persistence in reapplying and the types and numbers of schools they apply to likely also vary substantially among applicants. However, after controlling for gender, race/ethnicity,

MCAT score, and undergraduate institution, the researchers found that CLRA participation independently predicted a greater likelihood of getting into medical school. The difference was roughly equivalent to a one-point boost in MCAT score, which can have a substantial impact, Andriole explained. Summer high school laboratory experience was also independently associated with an increased likelihood of getting into medical school. These observations add to the previous evidence base for the role of CLRA in promoting the success of students who want to pursue careers in medicine, as CLRA participation was previously shown to be associated with a lower likelihood of medical-school attrition and, among medical school graduates, those who participated in CLRA had a greater likelihood of being appointed to an academic medicine position.[2]

Many college research programs are not necessarily intended to help students get into medical school, Andriole explained, but the experience nevertheless predicts a greater likelihood of acceptance. "There are very substantial positive benefits of CLRAs that are of tremendous value to students," she said.

One limitation of the study was that little information is available about the routes taken by students who did not attend medical school. Andriole said they are hoping to partner with other organizations to get more information about the pathways of those students to give a fuller picture of the decisions students are making at different points and what variables might impact those decisions.

UNDERSTANDING THE PSYCHOSOCIAL CONTEXT OF RESEARCH INTERVENTION PROGRAMS

Many students experience stress due to the difficulty of their curriculum, lack of finances, family issues, relationship issues, and other challenges, observed Angela Ebreo of the University of Michigan. Underrepresented minority students can experience additional stressors relating to their status. Women may experience gender harassment. Ethnic minorities may face stereotype threat, harassment, and an unwelcoming climate. The literature in counseling psychology and school adjustment points out that social support can counteract feelings of social isolation and give students confidence that they can get help when they need it, Ebreo noted. This literature also has shown that self-efficacy and other strengths facilitate students' ability to cope.

Ebreo and her colleagues have been examining several STEM-related interventions outcomes, including research plans, pursuit of a PhD, and pursuit of a career as a faculty member. They have data for these indicators in four cohorts of students who applied to the Summer Research Opportunity Program (SROP) at the University of Michigan and other universities represented by the Committee on Institutional Cooperation (CIC). They are interested in examining objective barriers to student success, subjective perceptions of barriers, and various social psychological strengths that students bring to

[2]Andriole, D. A., and D. B. Jeffe. 2012. The road to an academic medicine career: A national cohort study of male and female U.S. medical graduates. *Academic Medicine* 87:1722-1733.

their situation. "We need to acknowledge the fact that there are other roles in life that students play outside academics," Ebreo said. This work is part of a larger program of research funded by NIGMS based on the role strain adaptation model developed by Phillip Bowman at the University of Michigan, which says that the success of underrepresented minority students in interventions can be impeded by role strain and stressors that may be either objective or subjective.

Two kinds of models in the social support literature relate interventions to outcomes. The first is the direct or main effects model, which states that predictors have a direct effect on outcomes. In this case, the relevant question is whether the CIC-SROP program affects career plans, whether social support is directly related to these plans, and whether student stress is directly related to these plans.

The second model posits a moderation or interaction effect, where the presence of a third variable affects the relationship between the first variable and the outcome. In this case, student stress is hypothesized to be negatively related to career plans. The higher the stress level, the less likely it is for students to pursue a PhD and a faculty career. However, in conditions where students believe support is available, the relationship between stress and career plans is weakened, making it more likely for them to pursue a PhD and faculty position.

The data are from a cohort of 243 students who applied to the program during the summer of 2011. Of those, 60 percent were female and 65 percent were underrepresented minorities. The intervention outcome is related to student certainty that they will pursue a PhD. The predictors are informal social support, student stress, self-efficacy, intervention strength, gender, and underrepresented minority status.

While one way of assessing interventions is by looking at participation, another way is to look at the number and type of components offered to students, Ebreo explained. Rather than looking at participation, the researchers created an intervention strength measure by summing the number of different sorts of intervention components across everyone in the study. If students were not in a program or had not been in any sort of research experience, they received a zero, and values ranged from one to 18. This variable allowed the inclusion of students who were not participating in programs.

The student stress measure had seven categories: health, finances, employment, friends, relationships, problems with people off campus, family problems, and problems with friends at home. Students were asked to state how bothered they had been by these problems in the past month. The focus, Ebreo said, was mainly on trying to identify some of the best models that could be used to explain the mechanism through which social support and self-efficacy are related to outcomes.

The researchers first looked at the direct effects of intervention strength, student stress, adaptive strengths, and interaction effects. The first interaction effect answered the question of whether or not the effects of the intervention differ with high or low levels of self-efficacy and social support. The second interaction analysis had to do with interaction between student stress and social support and student stress and self-efficacy. The primary analysis method

was hierarchical regression modeling, which consisted of entering variables in stages depending on the theoretical concept for the influence of variables on outcomes. The researchers entered the intervention strength variable first, followed by student stress, then social support and self-efficacy, and finally demographic characteristics.

The intervention strength was a statistically significant predictor of pursuit of a PhD, Ebreo said. The stronger the intervention, the more certain it is that a participating student will pursue a PhD degree. Contrary to what was expected, student stress was not related to pursuit of a PhD, and self-efficacy, but not social support, was also related to pursuit of a PhD.

None of the interaction effects had statistical significance, and neither did the demographic variables, she explained. This is an interesting result because it suggests that problems experienced by students earlier in an intervention have nothing to do with later career paths. The researchers' conclusion, she continued, is that it is important to assess motivational factors and understand self-efficacy and how interventions affect levels of self-efficacy.

One of the reasons student stress is important is that social support is negatively related to student stress and depressive affect, meaning that the more stresses a student experiences the more depressed they are. Depression is important because it is related to outcomes as well as to student ratings of their certainty that they will pursue a PhD. While student stress may not have a direct effect on intervention outcomes, it does have a depressive effect, which in turn predicts outcomes.

The researchers also hope to test the role of self-efficacy and adjustments as mediators in explaining how interventions are related to short-term outcomes.

IMPROVING GRADUATION RATES IN STEM

Andrew Grosovsky, dean of the College of Science and Mathematics at the University of Massachusetts, Boston (UMB), presented a case study on how the institution has improved student success rates in STEM fields. In 2007, he explained, the six-year graduation rate for students in the overall university was 33 percent for first-time freshmen and 58 percent for transfer students. In the College of Science and Mathematics, the graduation rate was about five points lower than for the university as a whole, which is not unusual but also is not desirable, he said. The graduation rate for students who started in a STEM field and eventually got a baccalaureate was in the low teens.

The University of Massachusetts, Boston, has many commuter students, Grosovsky explained. As a result, many have relatively little engagement on campus because they leave when they are not in class. They have jobs and family obligations and often do not develop a sense that their education is something greater than the collection of courses they complete.

In 2007, enrollments at the College of Science and Mathematics had more than doubled in a five-year span and were projected to continue to grow. Within the college, 56 percent of students were students of color and 50 percent were women, with large numbers of low-income and first-generation stu-

dents. Two-thirds of the students entering the college had freshman standing, putting an even greater emphasis on the fact that many were inadequately prepared to undertake challenging work.

Students at the university were advised centrally, with no differentiation among disciplines, despite the major differences between the curricular pathways for students in humanities and students in natural sciences. Students were told to "explore" in their early education and only later settle on a path, Grosovsky said. They were not systematically encouraged to plan for graduation within four years, despite the importance of staying on track in STEM fields.

In the baseline year of 2007, two-thirds of freshmen were not appropriately placed into disciplinary introductory courses. For about one-third, their coursework did not match a declared major; the other third were not enrolled in any science course. One-third of freshmen were not on track to complete the college calculus requirement, and nearly a quarter were not in a mathematics class at all. "This is basically a disaster," Grosovsky said. Student success required supporting the sequential and hierarchical nature of the science curriculum, with students taking a full load of credits to be on track for four-year graduation.

The college also needed a greater sense of engagement and belonging. Grosovsky's team wanted to develop a proactive outreach model for advising and academic support by taking advantage of their knowledge of the curriculum and by reaching out to students with multiple forms of advising and academic support. Most important, he said, they wanted to create an impact at scale.

Their approach was to create college-specific intake and first-year advising, stressing four-year plans for graduation. They introduced supplemental instruction for gateway courses and other important courses and made student success the college's highest priority and commitment. They changed the culture in a variety of ways, using data, strong faculty participation, programming, and communication.

The centerpiece of their program has been academically centered freshman learning communities. These communities create a small home base for up to 24 students in what otherwise might be a large and complex institution. Each community has a network of other students, faculty mentors, peer mentors, and academic staff supporters. A science gateway seminar meets the university's first-year seminar requirement. Academically similar students are co-enrolled in relevant introductory coursework. Even in a large lecture, a laboratory section is set aside for the freshman learning communities. These steps create bonding and give staff and faculty the opportunity to reach out to students in many different ways.

One reason why this approach is scalable, he explained, is that each community is a kind of cellular structure built of various easily replicable parts. At the core, the college is simply doing things more intentionally and in a more organized way.

The early impacts of the program were a 20 percent improvement in students placing into pre-calculus or better between 2008 and 2010 and a 20 percent decrease in students who were off track in mathematics. The most

important reasons for these changes were more effective communications and follow-up on unsatisfactory placement scores. Students were encouraged to study and retake the exam, which helped double the number of students who were on track. They were enrolled in the correct mathematics class, were in the correct set of courses, and had declared a major.

Enrollment in the College of Science and Mathematics is growing much faster than is the case nationwide in STEM fields, which Grosovsky attributed to students who love the program and act as ambassadors for it. Full-time enrollment has improved even more, he said. The first year, the college had two communities serving 46 students. It now has 13 serving 260 students, which covers two-thirds of freshman in the college. In 2010 the University of Massachusetts retention rate was 75 percent, and the rate for students in the College of Science and Mathematics but not in a freshman learning community was 70 percent. Now the retention rate for students in a community is 86 percent.

The program has enrolled 800 students and will probably have more than 1,100 by next year. It has also had a tremendous impact on improving persistence in STEM majors, which is up 20 to 30 percent, Grosovsky said. Furthermore, student satisfaction is high, with 100 percent saying they would choose to join a community again.

BECOMING A GRADUATE STUDENT AND FUTURE SCIENTIST DURING POSTBACCALAUREATE RESEARCH EDUCATION PROGRAMS

"The perspective that I'm giving you today comes from the voices of students," explained Robin Remich of the Northwestern University Feinberg School of Medicine. Her research team conducted one-on-one interviews with participants in the Postbaccalaureate Research Education Program (PREP) to examine how they change as a result of their participation in the program and what mechanisms enable those changes.

PREP currently has programs at 31 research-intensive institutions and medical centers, and those programs serve a high percentage of students underrepresented in biomedical graduate programs. Participants in PREP programs are not being evaluated as students, or getting credit, she explained. They receive stipends up to just over $27,000 a year and spend 75 percent of their time in a research laboratory doing a mentored research project with an emphasis on independent research. The other 25 percent is spent doing academic enrichment activities. The programs usually meet once a week and enroll between five and ten students who have already received a baccalaureate degree, with an average of eight students per year.

Remich's study involved 48 participants from seven PREP sites, most of whom were from underrepresented minority groups. Data from interviews at the beginning of PREP focused on why they started a PREP program and found five patterns of expectations. A very small number of students wanted to try research for the first time. Many were using it to transition to a new field. Four wanted to prepare for higher prestige institutions. The two biggest groups were students still deciding whether to do a PhD and students trying to enhance their credentials for graduate school.

Remich and her colleagues are now focused on the interviews from the end of the PREP program to learn how students change during PREP and whether and how the program meets their needs and facilitates entrance into PhD and MD PhD programs. In the population of 48 students, 85 percent went on to a PhD or MD PhD, and 15 percent did something else. Of that 15 percent, only two did not go on to some graduate program.

Student responses revealed three themes for program benefits: readiness for research, readiness for academics, and readiness to present oneself. This last theme particularly stood out as something new and novel, Remich explained. For each theme, students progressed along a continuum. For example, in learning to do research, they first acquire basic laboratory skills, then build to a deeper level of understanding, and then begin to interpret results from experiments. Finally, they begin to see themselves as researchers and feel ready to take on that lifestyle and design their own experiments. They feel increased independence and project ownership and increased clarity of interests. She explained that PREP participants attributed this growth to extended time in the laboratory and research mentors who held high expectations for them to be independent and take ownership of their research projects.

The theme of getting ready for academics, at its most basic level, is about increasing knowledge. Students have the opportunity to take classes during PREP, although they are not getting credit, and these help them build content knowledge in their disciplines for graduate school. As well, they learn what might be expected in a graduate-level class. Finally, they begin to talk about themselves as knowledge producers, with the ability to critique articles and define their own truth based on the research. Working alongside graduate students and faculty, taking graduate-level classes, experiencing a close connection between class research and papers, and having the time to read those papers facilitate progress along this continuum. Students become more comfortable asking questions and begin to see themselves as learning with and alongside faculty, Remich said.

The third continuum involves communication skills and a readiness to present oneself. At the most basic level, students are acquiring writing and presentation skills and learning to organize ideas. Then they learn to see communication as an integral part of thinking about science. Readiness to present oneself leads to recognition of themselves as scientists and the importance of others' recognizing their potential as graduate students and scientists. Students become aware that evaluators are not just looking at credentials but are looking for, as one interviewee said, "what type of person you are." Formal and informal opportunities to practice written and oral skills, workshops, community conversation, and experience working on manuscripts facilitated the development of this awareness.

The research team saw a range of outcomes, Remich explained. Students felt more confident in graduate school interviews and more comfortable seeing themselves as PhD students after the PREP program. They became more careful consumers, using multiple criteria to choose a graduate school and take ownership of their careers. Each could develop through various parts of these continua to take them beyond their starting points, and most were successful matriculating on to graduate school.

Their conclusion, Remich said, is that very high expectations for future success help facilitate this change and development. The PREP students are treated like graduate students, and they get a sense of that future. They were both getting ready to apply to graduate school and getting ready to present themselves as researchers and young scientists. Student-centered mentoring was mentioned in the interviews, as was the gift of having time. Because PREP encompasses a whole year, the participants have time to make meaning of their experiences in a safe environment, which fostered confidence for decision making to attend and choose graduate schools.

3

Mentoring, Coaching, and Careers

The effect of mentoring and coaching on careers was another theme of the conference. Mentoring has a demonstrated impact on the persistence of students and young researchers in STEM fields, as several presenters at the conference observed. At the same time, many students and faculty members can benefit from a somewhat different relationship provided by individuals more accurately seen as coaches than mentors.

FROM MENTOR TO COACH: BROADENING IMPACT TO COMPLEMENT THE WORK OF MENTORING

Nothing is more central to research development than mentoring, said Richard McGee, the associate dean for faculty recruitment and professional development at Northwestern University Feinberg School of Medicine. Science is not magic, he pointed out—it's a learnable skill. "What is the best way to develop talent? What does it look like? Let's forget what we normally do. That's where we're coming from today," he said.

McGee's research group has been working on two things aimed at understanding and improving the mentoring process: an empirical longitudinal study of over 200 PhD students, and a coaching intervention to complement research mentoring. In each case, they are using four social science theories as lenses to understand how researchers develop in a social environment. Identify formation theory focuses on how people choose a path and create identity for themselves as students and professionals. Social cognitive career theory breaks down the decisions people make as they progress along pathways. Cultural capital theory reveals what people acquire while growing up in any particular setting, and particularly the things people absorb about how they are supposed to act, which is a critical factor in persistence. Finally, all

of these changes take place in a socially constructed space, a community of practice.

Looking in more detail at each of these theories, McGee explained that identity—who we are, what we want to become—is not fixed but is continually changing. Identity also develops in multiple domains, so someone can identify as a scientist, a woman, and an African American. Identities can intersect and conflict, and socioeconomic status has a tremendous impact on identity. Considerable research in recent years has shown that acquiring a sense of identity as a scientist is a pivotal step for students choosing to go on to graduate school.

Identity formation relies on internal recognition and external reinforcement, both of which can be fragile in the early stages of a research experience or career. Conflicting identities affect development and create a cognitive and psychosocial drain on the individual. Current intervention programs are very valuable in this process, McGee said, because they provide an environment for building an identity and helping it grow. Any person moving into a group is trying to become a legitimate member of that group and fit into a broader social environment.

Social cognitive career theory, which was developed in the 1980s, identifies a set of key variables that affect decisions about and progress toward careers, McGee explained. One of the core elements is self-efficacy, which is acquired through experience and learning and involves both self-assessment and external recognition and feedback. Another is outcome expectations, whether people gather real or perceived information about what their life would be like if they end up in a particular career. Understanding how these variables work together to guide career decisions gives faculty and researchers a way of analytically thinking about students' needs and choices.

The theory of cultural capital was developed by a French sociologist, Pierre Bourdieu, who was trying to understand why the children of those in power disproportionately attain positions of power. It posits that people in power consciously and unconsciously promote those who act, look, and sound like them. Changing these ingrained patterns is almost impossible, because they feel so normal, but cultural capital can be taught to those who did not grow up with access to it, and some mentors do a lot of work to cultivate it. Cultural capital also changes continually as students move from the undergraduate level to the graduate level and then to faculty positions. It is not a fixed commodity, so mentors and coaches cannot assume that once individuals reach a certain stage they no longer need any guidance or support.

Regarding communities of practice, every group has written and unwritten rules and shared practices that new members are trying to figure out, McGee said. Newcomers may be marginalized in that group, and stereotyping can play a powerful role. "We as a community function as a bizarre world of unwritten rules." Every laboratory, every graduate program, and every university is different, so each time a student transitions among communities they go through this process again. The community of practice is powerful, because anyone who does not fit has a much higher risk of not being seen as legitimate. Coaching can help people understand these processes and how to demonstrate their legitimacy as a member of a community.

McGee and his colleagues chose to use multiple theories because no individual theory can explain everything that is happening, he said. The combination presents a more complete picture and gives the researchers a way of characterizing what they are seeing.

Their longitudinal research program uses these frameworks to interpret the experiences and reactions of PhD students and, ultimately, to provide ideas about what could be done differently in the development of scientists, McGee explained. They are conducting annual in-depth interviews with more than 200 PhD students, with the goal of looking at the critical steps and decisions made along the path to a PhD. "We want to see whether there are patterns," he said.

One intervention they use is to create a community where people can find other people like themselves, because it can be difficult to find a safe space on campus. In particular, it can be costly and risky to make yourself vulnerable to the people with whom you work. Mentoring and coaching can help create a space to talk about difficulties and develop strategies. An important aspect of this interaction is to help mentors and coaches begin without assumptions. Mental models of a situation are based on a person's experience, he said, but individual perspectives inevitably have limitations.

Mentoring is situated within the research context, McGee said, and fits well with the theory of a community of practice. Good mentoring adapts to every individual and maximizes variation. However, it is often based on untested philosophies that are very dependent on the individual mentor, and it is hard to get people to question their own philosophies.

Another challenge to quality mentoring is time. Devoted mentors tend to be incredibly squeezed for time, which can have a huge impact on their ability to do a good job. Another challenge is the inherent conflict for mentors between trying to help someone develop and exercise independence and being dependent on that person for laboratory work.

Communication between mentors and mentees is also complicated by the challenge of communicating across difference. Many of those conversations are not safe or easy, McGee said, and they can get in the way of the mentoring relationship. In addition, mentors are expected to evaluate their mentees, which can create tension.

This is where the idea of career coaches comes in, McGee explained. Coaches can be drawn from a pool of experienced academic scientists with established records as effective mentors, well-documented success in leadership positions, and demonstrated experience with diversity initiatives. The difference between a coach and a mentor, McGee explained, is that coaches do not play an evaluative role and do not depend on the work of the mentee—in fact, they are not allowed to write recommendation letters for those they are coaching. They also are trained in how to handle difficult conversations.

In the intervention McGee has designed, after a day and a half of intensive training, coaches are matched with ten students who are away from their home institution. In a randomized controlled trial, one arm of the study has ten groups of beginning PhD students, the other six groups of students nearing completion of their PhDs. Among the coached groups, a larger community has grown, McGee said. The groups spend intensive time together,

and the coaches continue to fulfill their roles, using a variety of strategies, when students return to their home institutions.

The researchers created artificial groups where there is no majority and no minority—each group has five men and five women, five underrepresented students, and five majority students. There is no alignment of research interests or geographic location among the groups. In at least three instances, McGee said, students have reported that they would have dropped from their PhD programs if not for their coaches.

The things coaches discuss in their sessions with students range from what graduate school is like and how to balance classes and rotations to developing communication skills and understanding different communication patterns. All play a role in the success and perception of success, he said. The job of the coaches is to figure out how to impart cultural capital to students and how to get them up to speed quickly so they have the opportunity to do their best work.

Coaches can help point students to resources at their home institution as well, he said. They should not be supplanting what goes on at the home institution but helping students identify what they need and helping them find it. Sponsorship often comes into play at the postdoctoral level, for example, and coaches can connect students with potential postdoctoral mentors.

The best mentors play the role of coaches, McGee acknowledged, but the research he and his colleagues are conducting is trying to formalize that role and train coaches in an organized way. "We can't risk the probability that just because of bad luck someone ends up in a setting that doesn't provide them with the mentoring and tools to become talented in the field," he said.

Early evidence, he said, is that the coaching process is producing a greater sense of achievability in academic careers among the students involved.

ESTABLISHING A SUSTAINABLE MENTORING NETWORK TO INCREASE DIVERSITY IN SCIENCE

An academic career contains many decision points, and underrepresentation continues and intensifies over the course of academic careers, said Colette Patt of the University of California, Berkeley. Definitions of success changes for individuals as they progress through a career, yet intervention programs tend to focus on a particular educational stage, a particular transition, or a long-term career outcome. UC-Berkeley has a less conventional way of addressing long-term career success, she explained, as exemplified by two connected programs: one founded by the support of the Mitchell Kapor Foundation Center for Social Impact, and one supported by NSF.

These programs work to advance students and facilitate their success in the mathematical, physical, and computer sciences, fields where the underrepresentation of minorities is the most severe. Both programs emphasize advancement, not exclusively recruitment or retention, and the focus is on building self-sustaining networks that will grow over time and not require a constant infusion of intervention resources.

The NSF-funded program is called the Berkeley Science Connections Program. It involves a high-touch approach that builds bridges from the

undergraduate to the graduate levels, Patt explained. The program provides professional development and research activities that are necessary for advancement in science, resources that NSF typically has in all its programs. The ICubed program at NSF supports the program, she said, and it asks program administrators to leverage and build across existing NSF programs in an attempt to counteract the historical fragmentation seen between programs that address underrepresentation in science. The program also attempts to support local communities of scientists, reinforce the authenticity of programs they have developed, and replicate activities that work within those existing efforts.

One example of this approach is Explorations in Science Research, a recruitment program that began in the statistics department. The same model has been applied to chemistry, computer science, and mathematics. Each discipline is building capacity for a new kind of intensive recruitment approach to bring undergraduates of color into graduate programs.

The second program Patt described is the Berkeley Science Network, which focuses on relationships and works to build academically embedded social networks. Both academic aspects and social networks are important, Patt emphasized. The program works across generations of scientists of color, she explained, from high school seniors in a very targeted program run by the Level Playing Field Institute to graduate and postdoctoral students and faculty. By linking students, postdocs, and faculty across generations within these like disciplines, each individual becomes a mentor and also receives mentoring within the network.

Once students reach the graduate level, they are also connected to a mentor or coach in an adjacent discipline, whom Patt described as someone who sits a little outside a field but understands enough about it to be able to support a graduate student's advancement. The idea is to build a network over time, even after participants leave the institution. The key, said Patt, is building connections among people that are meaningful and where people intentionally contribute to a community over time.

Patt also described an annual event that brings the community together to establish mentoring relationships. Attendees were invited to bring their families, and all those who attended were asked for comments, which were overwhelmingly positive. Having a family-friendly event humanized the science professions, Patt said, which is crucial to increasing diversity and representation in scientific fields.

The program uses technology differently than do most other mentoring relationships. It seeks first to build a community of people who know each other in person, and only then move to an electronic format that can sustain those connections over time. Patt and her colleagues are currently working on the development and programming of a matrix that will allow for consistent input of information, resources, tools, and advice that can be systematically disseminated to students, faculty, mentors, and formal advisors. This system is intended to allow the mentors to focus not on collecting information about what kinds of fellowships are available, but rather to help students decide which fellowships they ought to compete for and how to go about doing so. The program also has integrated social science concepts by working hard to

familiarize the community with existing social science research that is relevant to the advancement of people of color in science.

Systematic research is exploring both the effects and the effectiveness of these programs. An example is the Berkeley Life and Science Study (BLASS), a survey that looks systematically for possible connections between the psychology of students and their professional and educational outcomes. The psychological measures evaluated are one's sense of belonging, trust in the institution, trust in the faculty, a sense of membership, comfort level, and self-confidence. The survey asks students questions about experiences and perceptions and tries to tease out the differences between advising and mentorship for students. It also looks at student experiences in their department and at their involvement in campus groups.

For examples of career progress, the measures include experience in research, contribution to published papers, talks at conferences, fellowships and scholarships, awarded prizes, and advancement to the next level. The survey population encompasses all undergraduates of color and all graduate students of color at Berkeley; a random sample allows for statistical significance with non-minority men and oversampling of non-minority women, which enables gender comparisons. However, recruitment and sampling of subjects have been difficult, Patt said. The research team has just completed data collection and has barely begun the analysis.

Very preliminary results reveal some gender differences in psychological based measures, with underrepresented minority students feeling that they are getting less encouragement and research guidance than non-minorities. Continued administration of the survey will allow for the assessment of changes over time.

A NOVEL COACHING INTERVENTION FOR ADVANCED-STAGE PhD STUDENTS IN THE BIOMEDICAL SCIENCES

Social science can produce greater understanding of why underrepresentation in the sciences persists, explained Simon Williams of Northwestern University. Northwestern is building a research-based intervention, with a prominent coaching component, based on this research. Known as the Academy for Future Science Faculty, the intervention targets PhD students from U.S. medical schools and biomedical departments and seeks to address some of the limitations of traditional research mentoring.

Over the first year of the intervention, Williams and his colleagues have been testing the effects that the Academy has had on participating students compared to a control group regarding perceptions of the achievability and desirability of academic careers. Rich qualitative data have emerged from the intervention, he said, that help answer some of the questions at the heart of the Understanding Interventions conference.

Williams emphasized the importance of focusing on PhD students as well as undergraduates. Many diversity efforts tend to emphasize getting underrepresented students up to the starting line of the PhD but offer little support beyond that point. Yet interest in academic careers declines over the course of the PhD.

The researchers have deconstructed interest into two sub-components, achievability and desirability, which are interrelated but conceptually distinct. The recent report from NIH on the biomedical workforce observed that only 26 percent of PhDs were moving to tenure track positions, which helps explain the lack of perceived achievability.[1] The report also describes other deterrents such as long training periods and relative salary disparities. Other studies have documented additional disincentives for underrepresented racial and ethnic minorities and female scientists, such as gender stereotyping and harassment. In addition, underrepresented minority students often feel as if they are alone in their fields, Williams pointed out.

Many programs have sought to improve the quality of mentoring, Williams said. But mentoring is operationally and conceptually limited by definition, so other ways of providing guidance and support outside of research mentoring are needed. The intervention at Northwestern views coaching as a more systematic and theory-based alternative to mentoring. Coaches do not have conflicts of interest in the same way as mentors, because the coaches in the study come from different institutions than the students they coach and are bound by confidentiality agreements. Mentors, however, can have conflicts of interest between their own research, their grant writing, and their students' career interests. Coaches, in contrast, are tasked with furthering and guiding students' careers. In addition, they have social science training, dedicated space and time, and the expertise of other coaches to draw upon as needed.

Williams and his colleagues have been looking at whether the Academy is affecting how students perceive an academic career in terms of achievability and desirability. They hypothesized that the Academy group would experience a greater increase in perceived achievability of an academic career over the 12 months compared to the control group. The intent of the Academy was not necessarily to impact desirability, but the researchers nevertheless expected it might influence this measure. The Academy is not telling students that an academic career is the only path, but it provides the skills, tools, and pathways for those who want to take advantage of these opportunities. The researchers also thought that putting students in contact with successful coaches might make a difference, and they hypothesized that achievability and desirability would impact females and underrepresented minority students more than well-represented male students.

For this randomized controlled trial, Williams and his colleagues recruited six coaches among leaders of research training and diversity efforts from biomedical departments across the United States. Inclusion criteria for students were that they be approximately 18 months within submission of a PhD dissertation or dissertation defense and have a pre-stated interest in an academic career. Students were randomly allocated to either the Academy or control group, and the researchers decided to oversample underrepresented minority students into the Academy group to create symmetry where no students were in the minority. The sample consisted of 120 students, 60 at the

[1]Biomedical Research Workforce Working Group. 2012. *Biomedical Research Workforce Working Group Report.* Bethesda, MD: National Institutes of Health.

Academy and 60 controls, with the Academy split into six coaching groups of 10 members. Each group was substratified so that no race, ethnicity, gender was a clear majority.

The intervention itself consisted of two days of in-person annual meetings in Chicago, presentations, panel discussions, and an academic career boot camp. The in-person meetings were supplemented during the intervening year by computer-mediated communication, but there is no real substitute for in-person coaching or mentoring, Williams said. Students and coaches talk about career development, postdoctoral planning, completing and defending the dissertation, professional networking, and interpersonal skills. Surveys administered to all students at the outset and at meetings asked about perceived achievability and desirability on a scale of one to ten. The analysis used two separate models, one for achievability and one for perceived desirability.

The researchers found that there was a significant study group-by-time interaction, Williams said. Perceived achievability decreased in the control group over time but increased in the Academy groups over time.

A significant desirability-by-time interaction was also observed. Desirability decreased for the whole sample, in keeping with research showing that interest in an academic career decreases after a few years of a PhD. There was, however, a greater decrease in the control group compared with the Academy group.

Looking at underrepresented minority students—with the caveat that sample sizes are small—the researchers found that achievability increased in both underrepresented minority and non-underrepresented minority students in the Academy group, with a greater increase among non-underrepresented minority students. Achievability was higher for both groups at baseline, but there was a positive mean change in the Academy group and a negative mean change in the control group. No significant gender-by-time interaction occurred, but a significant study group-by-time interaction occurred, with achievability decreasing more in the control group than Academy group, Williams explained.

The researchers found that desirability decreased in both underrepresented minority students and non-underrepresented minority students in the Academy group but that the decrease was greater among non-underrepresented minority students. Interestingly, Williams said, desirability was slightly higher among underrepresented minority students at baseline. Desirability was significantly higher among underrepresented minority students versus non-underrepresented minority students at follow-up.

There were no main effects of study group and gender when looking at desirability, but time did have an effect. There was a significant gender-by-time interaction and a significant study group-by-time interaction, with desirability decreasing more rapidly in the control group. Males in the control group also experienced a significantly greater decrease than males in the Academy group.

In conclusion, Williams said, PhD students in the Academy who are nearing the end of their PhD feel that an academic career is more desirable and achievable than they do 12 months prior. The Academy is therefore achiev-

ing its goals of increasing perceived achievability and offsetting or buffering declining desirability.[2]

DREAMS OF BALANCE: GRADUATE STUDENT PERCEPTIONS OF WORK–LIFE BALANCE AND ACADEMIC CAREER TRAJECTORIES

Work–life balance has evolved as an active area of scholarship over the last several decades, said Adriana Brodyn of Northwestern University, and it is particularly important to scholars in understanding the challenges of women's persistence in science and academia (Figure 3-1). However, Brodyn and her colleagues have been thinking about work–life balance as an issue that affects both men and women as they progress through graduate school and into their careers. They are exploring perceptions of the issue across a diverse sample, paying particular attention to the perspectives of groups that are underrepresented in the biomedical sciences.

Work–life balance can be particularly problematic in the sciences because scientific work can entail long hours and commitment. Students in biomedical sciences often have to contend with disciplinary norms that encourage work styles demonstrating dedication to science regardless of personal interest and identity contingencies. Research on the lives of scientists, Brodyn said, suggests that work demands often conflict with personal lives and may lead to stress and attrition.

Their study asked first-year biomedical graduate students about their perceptions and concerns regarding their current and future work–life balance. They drew on interviews with 52 doctoral students in the biomedical sciences, completed at the beginning of their PhD and again after the first year. The sample included 14 women and 12 men from underrepresented groups, along with 13 women and 13 men from well-represented groups

When beginning graduate school, Brodyn said, non-underrepresented minority men and women reported satisfactory work–life balance, which the researchers defined broadly as maintaining interests and activities outside of science. Those who were in married or committed partnerships at the time of the interview also reported satisfactory work–life balance. Underrepresented minority men and women were more varied in their reports of work–life balance, and underrepresented minority women in particular reported less satisfaction and said that much of their time and energy was devoted to science. Some underrepresented minority students were working to change their life balance arrangements and reported that they did not have time for socializing and doing the things they wanted to do.

Women held two prominent views of future work–life balance. One perspective, more common among underrepresented women, was that problems were unlikely or could be managed. However, almost half of all women in the sample anticipated significant obstacles, some noting that family rearing

[2]Thakore, B. K., M. E. Naffziger-Hirsch, J. L. Richardson, S. N. Williams, and R. McGee. 2014. The Academy for Future Science Faculty: Randomized controlled trial of theory-driven coaching to shape development and diversity of early-career scientists. *BMC Medical Education* 14:160.

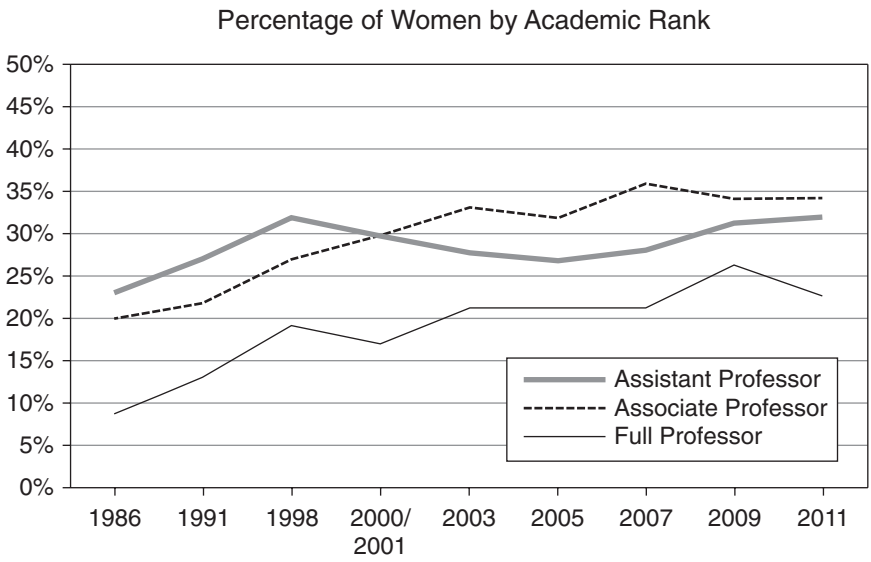

FIGURE 3-1 Women were 24 percent of faculty members in 1998 and only 29 percent in 2011. Source: National Science Foundation.

duties fall disproportionately to women. Some felt that they could figure out these arrangements when the time came, but did not articulate a concrete strategy, while other women were more optimistic.

Men were concerned with work–life balance and the future as well. Some underrepresented men stated that they would delay family plans until their careers were established, and others saw work–life balance as an issue of prioritizing science, interests outside of science, and family life. Non-underrepresented men had a variety of viewpoints, but the most prominent was that work–life balance required prioritizing science, other interests, and family. They also anticipated having egalitarian relationships with a future partner, and a small portion of non-underrepresented men reflected the view of delaying family until careers were established.

Prominent in their findings, Brodyn said, was the dichotomy between reported ideals of work–life balance in the future and the lived realities of work–life balance as graduate students. The majority of students were seriously concerned for the future, which suggests that the norm of committing all energy to science is unrealistic and undesirable for women and men of all racial and ethnic groups. Only five of 52 students were not concerned with future life balance, and these students noted that they would be willing to forgo family and personal life for the sake of their careers.

Work–life balance is an important concern for both men and women in biomedical graduate programs, Brodyn concluded. Existing norms may be helping to keep a more diverse population out of academic science.

4

Data, Methods, and Measures

The Understanding Interventions conferences, since their inception in 2007, have had a strong emphasis on data, methods, and measures as a means of learning more about interventions that broaden participation in research. The 2014 conference elevated this emphasis to a major theme. Several of the presentations focused specifically on the use of data to study mentoring and coaching, thus elaborating on the theme of the previous chapter. But these same methods and approaches can be applied much more broadly to educational interventions.

DETERMINANTS OF DEGREE ATTAINMENT IN STEM FIELDS

Big data sets have tremendous potential to shed light on the determinants of degree attainment in STEM fields. In the third plenary session of the conference, Cory Koedel, associate professor of economics and public policy at the University of Missouri, demonstrated this potential through an analysis of graduation gaps at four-year colleges in Missouri.

Administrative data from the state of Missouri enable individual transcript data for most students to be linked to the administrative files that follow students from high school to college. Success gaps between African American and white students in college were defined in two ways—general graduation, and attainment conditional to STEM entry. The paper that emerged from peer review, he explained, mostly addressed the general graduation gaps, and the STEM findings are still preliminary.

Nationwide, there is a gap of about 17 percentage points in four-year graduation rates between African American and white college students, Koedel noted. Also, African Americans are underrepresented in STEM fields, and African American students are significantly more likely than their white peers to move out of STEM fields over the course of their college careers.

There are 13 four-year public universities in Missouri, which the researchers divided into four groups based on selectivity. The top group was the most selective schools, including Truman State University, the University of Missouri, Rolla, and the state flagship University of Missouri, Columbia. The second group was urban campuses in Kansas City and St. Louis. The third group included moderately selective destination campuses, where most students would have to move to attend school: Missouri State University, Northwest Missouri State University, Southeast Missouri State University, and the University of Central Missouri. The fourth group was the least selective and included Missouri Southern State University, Missouri Western State University, Lincoln University, and Harris Stowe State University (the last two of which are historically black universities). The University of Missouri, Columbia, and Missouri State University account for 40 percent of total enrollment.

Using administrative micro data files from the Missouri Department of Higher Education, which picks up students when they enter the system, Koedel focused on non-transfer full-time Missouri-resident college entrants at one of the 13 four-year public universities in the state. The data encompass six cohorts entering college between 1996 and 2001. Key pre-entry data included entrance exam scores, ACT mathematics and reading scores, and high school attendance and class rank. The students' majors upon entry were coded as STEM or non-STEM. The final analytic sample included 63,135 students, including 6.3 percent African American students.

Koedel charted total African American enrollment representation throughout the Missouri system, finding that the University of Missouri, Columbia, was the third highest in African American enrollment at 22 percent, and Missouri State University was sixth with 18 percent. African American students were underrepresented at the most selective schools, and overrepresented at the urban campuses. The average preparation index was highest at the most selective schools, which also had the largest percentage of STEM enrollment. The two university groups where African Americans were overrepresented included the colleges with lower graduation rates.

The analysis decomposed the gaps into four contributing components: college sorting, major sorting, high school quality, and other observable pre-entry skill differences. The main results are based on models that define a positive outcome as one where the student graduates within eight years of initial enrollment in a public university system.

Pre-entry skills, measured by high school class rankings and entrance exam scores, were the most important determinants of black–white graduation gaps in college. These skills explain 65 percent of the gap for women and 86 percent of the gap for men for all subjects. ACT scores and other measures did not contribute very much to the graduation gap. In addition, the preliminary STEM analysis suggests that pre-entry skills explain close to 90 percent of the success gap for both genders.

Another interesting finding, Koedel said, was that African American students were attending significantly worse high schools, and African American women were attending worse schools than African American men. In the distribution of preparation, white women were most prepared, followed by white men, African American women and African American men.

Changes in how African Americans sort to universities can also meaningfully impact outcomes, Koedel explained. By sorting the African American students using parameters from observationally similar white students, the researchers were able to predict how graduation rates might change with shifts in college sorting. They also were able to adjust distribution of high school quality and pre-entry skills, determining what portion of the graduation gap could be attributed to those variables. They found modest but meaningful effects of college sorting in Missouri. Sorting explained 15 percent of the graduation gap for women, and 6 percent for men.

As an economist, Koedel emphasized that he would be excited to help design and evaluate interventions using data that complement existing knowledge. Strong evaluative strategies, he stated, can achieve generalizable results that help build long-term evidence around successful interventions. These models also could be used to predict student performance in college and to build outcomes-based measure of high school quality.

STRONG FACULTY MENTORING FOR UNDERREPRESENTED STUDENTS ACROSS THE STEM PIPELINE

Mentored research experiences are important not only in doctoral and undergraduate programs but at earlier stages as well—in high school and middle school. The work of Phillip Bowman, founding director of the National Center for Institutional Diversity at the University of Michigan, is focused on the Summer Research Opportunity Program (SROP) at the 12 major research universities that are part of the Committee on Institutional Cooperation (CIC). Preliminary results from a study of that program illuminate the need for a more multidimensional mentoring approach and a framework within which a broader strengths-based approach is possible (Figure 4-1). Such an approach, he explained, would include strong mentoring and a focus on multi-level strengths within individuals, programs, and organizations.

A recent review of policy literature by the National Research Council of the National Academy of Sciences noted that mentors can provide underrepresented students with information, advice, guidance, and support both generally and at critical decision points.[1] Mentoring helps students take full advantage of a program and may be the difference between students completing or leaving a program. However, the broader literature still reveals little about the specific aspects of the faculty–student mentoring relationship that promote short-term and long-term outcomes.

Several major themes can be identified in the emerging literature, Bowman said. First, for undergraduates, faculty-mentored experiences have relatively high impact, especially on short-term outcomes and on students deciding to go to graduate school. Second, once in graduate school, some students tend to benefit more than others, but additional research is needed to clarify why this effect occurs; it is possible that they have different mentoring

[1]National Research Council. 2011. *Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads.* Washington, DC: The National Academies Press.

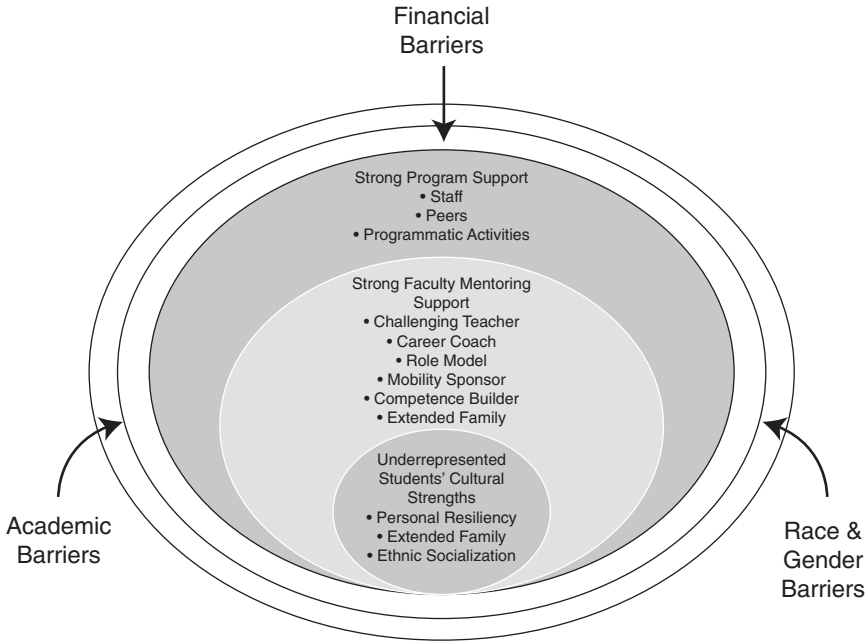

FIGURE 4-1 A comprehensive strengths-based approach can counter financial, academic, race, and gender barriers. Source: Bowman, P. J. (In press). Exemplary research opportunity interventions and STEM outcomes: Toward a comprehensive strengths-based approach. In P. J. Bowman and A. Ebreo, eds. *Rethinking STEM Interventions: A Strengths-Based Agenda for the 21st Century.* New York: AMS Press.

experiences. Qualitative studies support the complexity of the faculty–student mentoring relationship, but more theory-driven studies are needed to better understand the specific aspects of faculty mentoring support that shape both short-term and long-term outcomes.

Strengths-based studies, he said, emphasize the benefits of multiple components in a mentoring program, including formal program resources and informal support from staff, peers, and community members. In this context, mentoring is just one element of a more comprehensive strengths-based approach to understanding successful STEM outcomes among underrepresented minority students, he pointed out. Strong faculty mentoring interventions at several critical stages across STEM pathways can help close persistent career disparities faced by underrepresented students. Therefore, greater understanding of faculty mentoring support is needed at several transition points in STEM pathways, including the middle-to-high school, high school-to-college, community college-to-baccalaureate studies, undergraduate-to-graduate school, graduate-to-postdoctoral studies, and higher education-to-research careers transitions.

SROP is a nationally recognized pipeline program for talented undergraduates from several underrepresented groups that consists of a set of exemplary undergraduate faculty mentoring interventions. It was developed in 1986 by the CIC, which is an academic consortium of 14 major research universities. More than 15 percent of all PhDs in STEM fields are earned in CIC universities, which gives CIC-SROP a great deal of impact on the production of a STEM workforce. As of 2008, the program had provided more than 11,800 research experiences, and more than 3,000 of the participating students had pursued graduate studies as a pathway to a PhD and faculty research careers.

With support from the NIGMS, a research team at the University of Michigan is completing a study of 3,091 SROP applicants, with successive annual data collection between 2010 and 2013. The sample includes 1,338 SROP applicants at 12 CIC campuses and two comparison groups, one consisting of 680 applicants who participated in some other summer research experience for undergraduates, and a second group of 1,073 applicants without any summer research experience.

The CIC recruits sophomores and juniors from HBCUs, Hispanic-serving institutions, tribal colleges, and other institutions serving underrepresented students for an intensive summer research program with multiple components. As guided by broader national policy, the underrepresented students in the study include non-minority women who are underrepresented in STEM fields in general, as well as low-income students.

The CIC-SROP has received widespread national recognition for its success as a bridge to research and faculty careers. The program was designed to combine faculty research with multiple other components, including a wide range of skill development workshops such as GRE prep, graduate school planning, and enrichment activities to enhance research career socialization. A program coordinator and staff carefully implemented the program components to provide extensive formal, informal, and community support for 40 hours a week or more during the eight-week summer program.

Two basic assumptions guide the program, Bowman said. The first is that when undergraduate students are provided with the opportunity to have state-of-the-art research experiences with faculty mentors, they will be more likely to plan and pursue STEM trajectories. The second is that upon completion of the program they will be more likely to do research and be admitted to graduate school.

However, the multiple dimensions of strong faculty mentoring that help underrepresented undergraduate students overcome systematic barriers to short- and long-term goals is not well explicated in research itself, Bowman observed. He and his research team are therefore developing a strong mentoring support scale to assess the support functions that promote successful development among underrepresented students at critical education and career transition points. The scale has 28 items and was adapted from a related instrument designed to tap multiple mentoring dimensions and functions for employees in work organizations.

The adapted scale has five core functions or dimensions for strong faculty mentoring support: challenging teacher, career coach, mobility sponsor, role model, and affirming advisor. The basic hypothesis is that underrepresented

students who report stronger support from faculty mentors on these five functions will derive greater benefits than others from STEM education and career opportunities. For example, underrepresented students with higher mentoring scores may acquire higher scientific efficacy and identity and become better integrated into research teams and laboratories, Bowman said. Strong mentoring could also help buffer the adverse effects of barriers that underrepresented students face. Each core sub-function may contribute in a particular way to successful outcomes for underrepresented students at various stages in the career pipeline.

Comparison scores between SROP and other programs that provide research experiences indicate there is no difference between these programs in terms of the strong mentoring that students experience. However, there are major differences in terms of students' exposure to other components of the SROP, Bowman said. Part of the question is what difference these program components make and whether all students have the same experiences with faculty mentors. For example, the research team has found wide differences among individuals, some of which occur along racial and ethnic lines.

Bowman did not discuss the preliminary results in detail, but he included in a handout some of the findings along with a scale he and his colleagues have developed. He added that their team is currently working closely with the University of Michigan SROP coordinator to adapt the findings for use in planning faculty mentoring training. They also are examining the degree to which these kinds of functions can be met by the faculty mentor, the campus coordinators, and peer mentors.

USE OF THE EXPERIENCE SAMPLING METHOD TO COMPARE SUMMER RESEARCH PROGRAMS FOR UNDERGRADUATES

While mentoring confers many benefits on undergraduates, explained Chris Goode, the availability of mentors is a limiting factor. Chris Goode, the director of undergraduate studies at Georgia State University, and his colleagues therefore set out to develop research experiences that conserved mentoring resources while preserving essential mentoring experiences. They created a laboratory-based collaborative neuroscience research experience targeting novice researchers, with over-recruitment from underrepresented minority groups. Students participated in teams doing original research, and the researchers compared the experiences of students in the team-based groups to those participating in a traditional mentored research apprenticeship.

The program lasted from 2009 to 2012 and included 156 undergraduate students, 66 percent of whom were women and 44 percent of whom were from underrepresented minority groups. Of those, 60 percent were first- and second-year students, and the overwhelming majority were novice researchers. The researchers randomly assigned the students to participate in one of two groups. The first was a traditional apprenticeship, where students were integrated into an ongoing research project and pursued mentored research. At the end of that experience, they produced an individual research report. The other path was a guided laboratory course with peer research teams that trained undergraduates in a variety of neuroscience techniques

centered around crayfish. Students learned electrophysiology, some genetic and molecular methods, behavioral analysis, and drug delivery, and they worked in teams to pursue original research questions. Their end product was a mini-grant proposal based on their preliminary data. Students in both types of groups had a one-week orientation course in neuroscience and then participated in the nine-week programs; everyone participated in a closing poster symposium at the end of the program.

All the students were subjected to intensive assessment, Goode explained, using a mix of qualitative and quantitative methods. Electronic surveys at the beginning, in the middle, and at the end of the program probed constructs that may predict success and later STEM careers. These constructs included scientific research, self-efficacy, leadership and teamwork, and identity as a scientist. The researchers hoped the programs would reduce anxiety around science, specifically neuroscience, and measured the students' commitment to pursue a science career throughout the program. They also did interviews with every student throughout the program. They are still collecting data in the form of alumni surveys, which will be used to track longer term outcomes.

The survey data from the program revealed significant improvements in leadership, teamwork, and self-efficacy from before the program began to the middle and again from the middle of the program to the end. From the middle of the program to the end, the researchers also saw significant improvements in identity as a scientist and significant decreases in both science and neuroscience anxiety.

A key message from the data, Goode said, is that no significant differences arose between students in the collaborative group and students in the traditional mentored apprenticeships. "All of the benefits of the undergraduate research experience are the same across these different program models," he said. However, the researchers thought the process by which students attained these gains might differ, so they used the experience sampling method (ESM), an intensive survey technique that mixes quantitative and qualitative measurements, to probe possible differences. Multiple surveys are delivered at random times during the day, and students are prompted by text message to take the surveys. All in all, Goode said, the researchers sent out 2,800 prompts to fill out the surveys and received a 53 percent response rate.

Students were asked to record their social interactions at the time of the prompt, including whether mentors were with them or not. The surveys also probed levels of engagement, anxiety, collaboration, and confidence. Students filled out 16 items reflecting their cognitive and emotional status, including whether they were active or passive, interested or bored, engaged or disengaged, and focused or distracted. The researchers used these responses to probe students' status before the separation into traditional and collaborative groups and assess how students were feeling during different activities.

From the ESM surveys, the researchers learned that students in the collaborative group were at an advantage in terms of engagement. After averaging all of their responses over the course of the summer, they found that the collaborative students reported being generally more engaged during labs and that they were collaborating significantly more than the students in a traditional apprenticeship. However, that effect does not extend into the evening

hours, Goode pointed out. Using a multivariate analysis, they also found that the collaborative students generally reported less anxiety.

For most of the status indicators, he continued, underrepresented minority students reported less anxiety and more confidence than those students from majority groups. The collaborative program is "in some respects better than a traditional mentored apprenticeship," he concluded.

The researchers' next steps are to pursue a renewal of the grant so that they can institute the collaborative model in ways that benefit it the most. They are piloting the program in the summer at Clinton State University and plan on continuing their analysis of the ESM data.

MORE THAN MENTORING: DETERMINANTS OF INTEREST IN ACADEMIC CAREERS FOR RECENT PhD GRADUATES

A 2012 report from NIH on biomedical workforce pointed out that the long training period required along with disparities in earnings may make a career in biomedical research less attractive than one in other scientific disciplines or in other professional careers.[2] Interventions to broaden participation in biomedical research therefore face an inherent disadvantage, observed Kenneth Gibbs, a cancer prevention fellow in the National Cancer Institute.

Gibbs and his associates have been looking at how the career interests of recent biomedical science PhD recipients change over time. Their research focuses on people who have already received PhDs—and thus have navigated barriers to access, entry, and persistence and are deciding what to do with their careers. They are also looking for distinct interest patterns or changes based on social identities—specifically, race, ethnicity, and gender.

The research team conducted a survey in the fall of 2012, recruiting through LinkedIn and Twitter, using conference networks and the infrastructure that exists around workforce diversity training. They received 1,900 responses, with 1,500 of those people having received a PhD in the biomedical or behavioral sciences between 2007 and 2012. Respondents were from across the biomedical sciences, including laboratory science, neuroscience, public health, and bioinformatics. The majority were postdocs, associates, or fellows. About 86 were on a tenure track, and an equal number were in other academic positions. The sample was about 25 percent white and Asian men (i.e., well-represented racial/ethnic backgrounds), about 6 percent men from underrepresented minority backgrounds, 54 percent women from well-represented backgrounds, and 13 percent underrepresented minority women. The researchers assessed interest in four career pathways: faculty at a research-intensive university, faculty at a teaching-intensive university, a research career outside academia, and careers that are typically not based in research, such as science policy, science writing, law, and business. The study looked at these four career paths at three time points: PhD entry, PhD completion, and post-PhD.

[2]Biomedical Research Workforce Working Group. 2012. *Biomedical Research Workforce Working Group Report.* Bethesda, MD: National Institutes of Health.

Scientists in the sample described less interest in faculty careers and more interest in non-research careers, Gibbs said, with the surveys using a five-point scale, one being no interest and five being strong interest. When the respondents started graduate school they showed moderate interest or more than moderate interest in faculty careers at research-intensive universities, but that interest decreased at PhD completion and decreased further to their current status. Most of that decline occurred between PhD entry and completion. Interest in teaching faculty careers also declined, he added, but it was less steep. There was a significant increase in interest in non-research careers, with large changes happening predominantly in graduate school. Interest in research careers outside academia showed little change over time.

At PhD entry, women reported lower interest in research-intensive faculty positions than men, and underrepresented minority women reported interest levels that were significantly lower than all other groups. Interest in every group declined, with underrepresented minority women remaining lower than all other groups. Changes for interest in teaching-intensive faculty positions were consistent across the sample, and there was no statistically significant difference in interest in research careers outside academia. The gaps by social identity occurred only with interest in faculty careers at research-intensive universities. For non-research careers, everyone began with low interest and the whole group increased, with a slightly larger increase in interest among underrepresented minority women.

The researchers then assessed mean pair differences between the score at PhD entry and the score at PhD completion. All groups showed declines in research-intensive faculty interest, but well-represented men declined by 0.42 units on the five-point scale, while other groups showed larger declines of 0.62 to 0.75 units. Underrepresented minorities had a larger decline in interest than other groups. There were no significant differences between groups for interest in faculty positions at a teaching university or research careers outside academia. Interest in non-research careers increased across all groups, with a greater increase among underrepresented minority women.

A major research question is what explains career pathway interest at PhD completion, since most of the drop in interest happened during graduate school. Using a multiple logistic regression, they investigated the likelihood that people would finish the PhD with high interest in each career pathway. In addition to the data they had already gathered, they asked questions about graduate training, socialization, mentoring, and confidence in research ability. Evidence demonstrates that self-efficacy matters more than ability, Gibbs pointed out, so the research team felt that was an important factor to consider. They also used objective measures, including publications normalized by time spent in training, time to degree, what kind of institution the students attended, and measures of graduate socialization and advisor interaction. Adjusting for all of these variables, they assessed the likelihood that a student would have high interest in a research-intensive academic position at PhD completion.

All groups were statistically less likely than well-represented men to show high interest in a faculty career at a research-intensive university when they finished their PhDs, even accounting for productivity, where they started,

and advisor relationships. Well-represented women were about 35 percent less likely, underrepresented minority men were 40 percent less likely, and underrepresented minority women were 54 percent less likely than well-represented men to show strong interest. This might explain, Gibbs pointed out, why substantial increases in the number of underrepresented minority students with PhDs have not produced a proportional increase in minority faculty.

The study did not show a statistical difference for interest in teaching-intensive university positions and research careers outside of academia. However, underrepresented minority women showed significantly more interest in non-research careers at PhD completion.

The general trend away from faculty careers was particularly pronounced for careers at research-intensive universities and toward non-research careers, Gibbs observed. These trends were generally intensified for women and particularly for underrepresented minority women. Some data also showed that underrepresented minority women reported less belonging in their research group and their department intellectually and socially, he added, though they reported equal investment in their careers from advisors.

The next step is to learn more about why these trends occur, Gibbs said. His team is currently doing in-depth interviews to try to understand the mechanisms of career interest formation and career choice. Their goal is a sample that is 50 percent underrepresented minority, and they have preselected for a highly successful group of people to eliminate the role of differing skill levels.

Retention, persistence, and degree attainment differ from career choice, Gibbs added, since degrees are necessary but not sufficient for career attainment. Broadening participation in the workplace is linked to improving diversity along the entire training trajectory, but it may require additional measures.

Finally, careers in science that do not involve research are necessary and valuable careers, Gibbs noted. Reconsidering metrics of success might be necessary to reflect this value.

5

Institutional Responses: Colleges and Universities

The major themes of the previous four chapters emerged repeatedly in the presentations and conversations of conference participants on individual interventions. This chapter revisits these themes by summarizing several programs undertaken by colleges and universities. The next two chapters look at interventions by professional associations and the federal government, respectively. A particular highlight of this chapter is an adaptation of the highly successful Meyerhoff Scholars Program at the University of Maryland, Baltimore County, at two additional campuses.

THE INITIATIVE FOR MAXIMIZING STUDENT DIVERSITY PROGRAM AT NORTH CAROLINA STATE UNIVERSITY: PROMOTING A SENSE OF COMMUNITY AMONG UNDERGRADUATE RESEARCH SCHOLARS

The goal of the Initiative for Maximizing Student Diversity (IMSD) program at North Carolina State University, which has been in existence since 2008 with funding from NIGMS, is to increase the number of underrepresented minority students who receive a PhD in the biomedical and behavioral sciences, said Erin Banks, the IMSD program director. During the conference workshop, the presenters described strategies to increase program participants' sense of community. To date, over 51 undergraduates and 24 graduate students have participated in the program, and it has an 87 percent retention rate for students. So far, 29 of the undergraduate participants have received their bachelor's degrees, three students have received PhDs, and four students have finished master's degrees. Although the goal is to complete the PhD, Banks said, "we understand that we can't win them all, but we continue to motivate and empower students to obtain the terminal degree."

Over five years, the program has received $3.6 million. Graduate students are funded directly through IMSD for two years and then transition to T32 grants, which are institutional training grants or departmental funding through their respective departments and faculty mentors. Professional development opportunities, mentoring for students, and a variety of speakers are provided throughout the program. The program has partnerships with the Graduate School at NC State, the First Year College, the honors program, the Museum of Science, Duke University, the University of North Carolina, Chapel–Hill, and other NIH research training programs located in the Southeast. Program development facilitators work with students 12 months out of the year on a variety of topics, including email etiquette, dinner networking, and business card seminars, and students have access to tutoring and networking opportunities.

For the past three years, the program has held an annual fall retreat involving team-building exercises, guest speakers, and discussion of what the program means to the students. The students work together on a high ropes course and complete individual development plans that set their goals and ambitions for the coming year. At the end of the day, Banks explained, they have campfire sessions to reflect on the program and the day's activities. This is one of the activities that have made the program particularly proficient at building communities of scholars. "Ultimately, what matters is the success of these students and what factors contribute to that success," said Craig Brookins, professor of psychology and Africana studies at NC State who has been involved in the evaluation of the IMSD program.

The evaluators had students do a pre- and post-retreat survey and held a focus group during the retreat to collect observational data. In community psychology, said Brookins, a key construct is the idea of a psychological sense of community, which holds that the degree to which people are connected to a group will be the degree to which they do well both within that group and with whatever the objectives of that group might be. The construct has four elements. The first is membership, or whether respondents feel they are connected with the group. The second is influence, or how respondents feel capable of influencing the group's direction and deliberations. The third is integration and fulfillment of needs, which relates to the academic mission and goals of an individual and the group. The fourth is shared emotional connections, which extends beyond the academic to the individual and the degree to which they feel connected with others.

The evaluators asked retreat participants whether they felt specific activities were satisfying and useful, including the team-building exercises, seminars, campfire sessions, ropes course, and vision boards. The predominant response was that students were satisfied with the retreat, and in matching the pre- and post-retreat responses, scores increased across all dimensions. The data indicate, Brookins said, that the retreat was successful in building community around the program.

Amy Leonard, a rising second-year doctoral student in the psychology program and research assistant for the IMSD program at NC State, discussed the results of the focus group, which was held on the second day of the retreat. She explained that, because her position is more detached from the

students than that of the program leaders, she felt that they could talk more freely about their experiences. The focus group discussed three questions: What did students expect to gain from the IMSD program? Did they have any recommendations for improving the program? What did they hope to gain from the retreat?

The perspectives expressed were diverse, Leonard said, partly because the focus groups included students new to the program and also program alumni. The most commonly occurring responses to the first question were that students expected to gain research experience, a community of like-minded peers, networking opportunities, professional development, and opportunities to present at conferences. When asked what they gained from the retreat, they said it had strengthened and renewed relationships, provided a chance for personal growth, expanded their understanding of program expectations, and heightened academic motivation. Their recommendations for improvement centered around more social events and events geared toward specific majors in the program.

The students talked a great deal about the value of their peers and the role of those relationships in their success. These comments point to the importance of continued efforts to build community within the program beyond just the retreat.

The evaluators also investigated factors that appear to influence students' interest in research. They looked at that research interest in two ways—first, by using a psychometric scale that measured interest across a number of variables; and second, by asking students what they anticipated their involvement in research would be once they were done with school.

The primary predictor of interest in research was outcome expectancy, or the perception among students that doing research was valuable for their goals and would benefit them personally. The psychosocial dimension of their mentoring experience was also predictive of higher levels of interest in research. The evaluators used a comparison group of other students in the biomedical and behavioral sciences, and they plan to look at other ways of collecting data for the IMSD program and others like it.

Their other ongoing projects, said Banks, include looking at research success and academic success with IMSD students and with those not in the program. As part of the NC State, UNC–Chapel Hill, and Duke University Alliance, program administrators attend conferences with other schools to compare outcomes in the IMSD program and see where they are similar and where they differ.

One objective is to find a set of best practices, Banks explained. Their team is in the process of collecting data from current students and alumni and hoped to have shareable results shortly after the conference. They know from the focus groups and from talking to students that mentoring is critical. They are also looking at how to provide training to faculty members to improve their mentorship skills.

When the presenters opened the workshop for questions and comments, one participant commented that the biggest challenge for undergraduates was helping them plan their track and apply on time to graduate school. The IMSD program talks about graduate school all through senior year and con-

centrate on the GRE the summer before. "It's a lot of hand-holding," Banks acknowledged, but the majority of students in their program do go on to graduate school.

Students also need to understand that their advisor does not have to be their mentor, and that they can have support from other areas, participants in the workshop pointed out. An alumni of the program commented that mentoring was the number one reason that he finished graduate school. Although some students can be reluctant to admit that they want a mentor, they usually will see a benefit.

Another speaker asked about the importance of social networking in creating community. The students created their own Facebook page after the retreat, Banks said, and they socialize on Facebook, Instagram and Twitter. Social networking is one of the most difficult things to capture, Brookins commented, and they are trying to figure out how to measure such social support in a more quantitative way.

One participant raised the idea of using the retreat as a mitigating variable and looking at how the sense of community built in the retreat leads to increased interest in research. That is a more sophisticated analysis, Brookins said, and one they would like to explore.

Participants at the workshop noted that it is difficult to get the same emphasis on research career development versus medical career paths in preprofessional advising. They discussed the need to leverage the strengths that exist in clinical trajectories for research trajectories and how to apply aspects of the clinical track to research careers.

BUILDING CAPACITY FOR RESEARCH ON INTERVENTIONS AT HBCUs

About a third of African American STEM PhD recipients get their baccalaureate from an HBCU (Figure 5-1), noted Claudia Rankins of the National Science Foundation during a workshop on building the capacity for research on broadening prevention interventions at HBCUs. Of all STEM bachelor's degrees awarded to African American students, 20 percent come from HBCUs, even though these institutions make up only 3 percent of the total number of higher education institutions in the country. HBCUs "provide a nurturing and culturally sensitive environment conducive for students to succeed," Rankins said.

Non-HBCUs, which a majority of African American students attend, are less successful at graduating those students with STEM and other bachelor's degrees. HBCUs can offer these schools best practices, strategies, interventions, and resources for improvement, Rankins observed.

Workshop moderator Kelly Mack, the vice president for undergraduate STEM education and executive director of Project Kaleidoscope at the Association of American Colleges and Universities, added, "It's unfortunate, despite the data Claudia just quoted for us, that people still question the value of historically black colleges and universities." The work at HBCUs can progress so intuitively that it is hard to recognize exactly what is happening, she said. The workshop, which included three teams of HBCU representatives

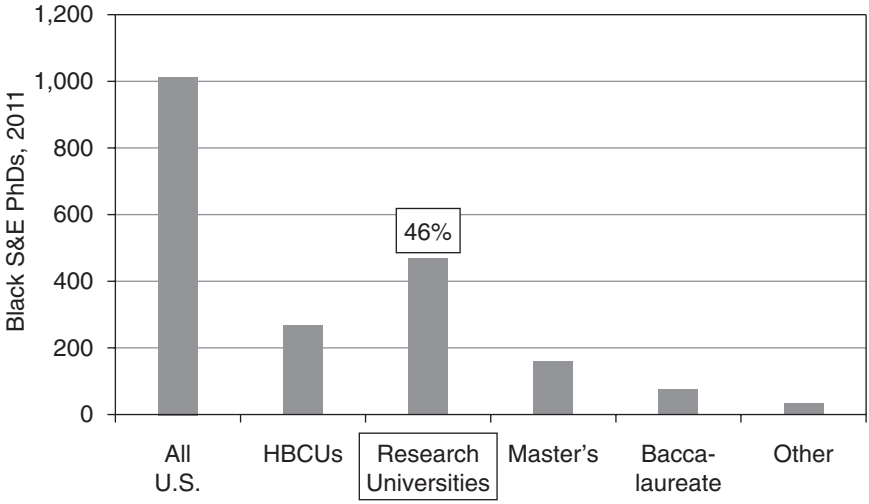

FIGURE 5-1 About one-third of Black science and engineering PhD recipients received their baccalaureate degrees from HBCUs. Source: National Science Foundation.

and social scientists, was designed to provide both a deeper understanding of activities and strategies at HBCUs within the context of social science theories and a better ability to articulate the theories informing intervention strategies. As Rankins said, the three teams of presenters sought to "establish a link between these culturally sensitive interventions and those who practice them and the underlying social science frameworks that define and explain them."

The first team was made up of Sandra DeLoatch, provost and vice president of academic affairs at Norfolk State University; Michael Keeve, associate dean for the College of Science, Engineering and Technology at Norfolk State; and Eileen Parsons, associate professor of science education at UNC–Chapel Hill. "All of us know that producing more STEM graduates is essential not only to our institutions but also for the U.S. workforce," DeLoatch began. To achieve this goal, Norfolk State has been instituting both novel and traditional programs to improve the number of STEM graduates who are entering the workforce and moving to higher education institutions. Some of those programs have produced higher graduation rates and retention. For example, among a 2007 cohort of freshmen who participated in a number of interventions, the graduation rate was more than double that of the overall student population. The challenge, said DeLoatch, is to implement the successful programs across the board.

The programs at Norfolk State, including course enhancements, technology integration, faculty development and recognition, summer bridge programs, and peer tutoring, have been extremely successful, said DeLoatch. For the purposes of this workshop, the presenters focused on living–learning communities and mentoring.

Living–learning communities, Keeve explained, connect classroom learning with on-campus living. Students participating in a living–learning community live together and attend courses together. The college provides activities such as service learning projects, dinner discussions, and field trips. The communities build lifelong friendships for students who share common interests. One of the oldest is a STEM living–learning community called DNIMAS (Dozoretz National Institute for Mathematics and Applied Sciences), which had its first set of graduates in 1990. Over 62 percent of graduates from that community have earned advanced degrees, Keeve said. To stay in the program, students are required to maintain a certain GPA and commit to tutoring and community activities. Events are coordinated by a residential life educator with help from a graduate assistant, students, and volunteers. Visiting scholars and community leaders come to speak on a weekly basis.

Nine of these communities were running in the 2014–15 academic year at Norfolk State, Keeve said. Some are oriented toward freshmen, while others have a more advanced focus.

Norfolk State also has a peer mentoring center, which was established in January 2009. The center has private meeting areas and a large common area for students to socialize. Peer mentors provide support, discuss time management and study skills, and help their mentees prepare for exams and manage their finances. The mentors say that the experience is rewarding, Keeve noted, while mentees report that it helps them tackle difficult coursework and provides a safe environment to discuss challenges.

In addition to peer mentoring, the college provides faculty mentoring through a summer research program, which supported 55 students in 2013. Each student worked collaboratively with a faculty member and participated in a variety of required activities to build speaking and research skills. The institution has a rich store of faculty members who are interested in mentoring, DeLoatch said, as well as a number of specialized laboratories for students to use. The students delivered technical presentations throughout the summer, as well as participating in seminars and learning a variety of skills such as how to read scientific papers. Participants in the program submit proposals and participate in a research symposium at the end of the summer.

A theoretical basis for action maximizes the impact of interventions and provides a language that others can understand, Parsons said. One of the theories appropriate to the work at Norfolk State is activity system theory, she explained, which integrates a number of elements to take a systemic approach to addressing the challenges of underrepresentation in STEM fields. At Norfolk State, for example, this approach incorporates psychological, cognitive, social, economic, and cultural elements.

The rules and norms of the communities that students will eventually enter in STEM fields, as well as the rules and norms of the communities on campus, are a critical part of the programs at Norfolk State, Parsons said. Career counseling and résumé writing makes those rules explicit, while interactions with faculty and understanding of the cultural norms gives students implicit understanding of how those communities operate. “One important fact that I think many people overlook when developing programs is the mediating artifacts, the tools,” Parsons said. Norfolk State provides such

tools as laboratories, communal dorms oriented around common interests, the tutoring center, and community events and speakers. Most important is the community component, which is established both formally through the living–learning programs and informally through the mentoring initiative. A common core of understanding connects the individuals involved, who in turn develop deeper understandings that guide what they do.

Parsons closed by describing Vygotsky's Zone of Proximal Development, which describes the difference between what learners can do without help and what they can do with help. At Norfolk, she explained, they are creating experiences that help students progress.

INTEGRATING SCIENCE AND CULTURE IN AN INTERNATIONAL CONTEXT

The second team of presenters consisted of Lycurgus Muldrow, director of sponsored research and integrated activities at Morehouse College, and Patrice McDermott, the vice provost for faculty affairs at the University of Maryland, Baltimore County.

Muldrow introduced the International Interdisciplinary Sustainable Energy Project, which is a combined program that draws on the Institute for Sustainable Energy (ISE) and the Morehouse Pan-African Global Experience (MPAGE). The mission of the ISE, he explained, is to build an institute involving all three academic divisions at Morehouse (mathematics and science, humanities and social sciences, and business administration and economics) and to create a student experience that embodies the connectivity between sustainable energy and global issues and will teach students to be global leaders.

The program has three core courses, one in physics, one in biology, and one that is interdisciplinary. The outcome for students will be a sustainable energy minor, which can supplement whatever major they choose. The program recruits and serves both STEM and non-STEM students, Muldrow said. Assessments done over the last several years to gauge student interest revealed that around 50 percent of both STEM and non-STEM students were interested in the minor, and 40 percent of STEM students expressed an interest in advanced degrees in sustainable energy.

The curriculum is also linked to international research and community outreach projects. The most significant of those is the MPAGE program, which is designed to teach students global citizenship and leadership and help them identify with the African Diaspora. The program originated in the sociology department, Muldrow said, but now has a strong STEM component. It consists of a six-week summer program where students spend the first week at Morehouse, four weeks in Ghana, and then another week back in the United States.

Course work for the MPAGE program consists of Pan-African cross-cultural dialogues, sustainability in development, and renewable energy, all of which can count as part of the elective course requirements for the ISE minor. If students take the three ISE core courses and participate in the summer program, they essentially complete the minor in sustainable energy. If

students want to do an extended stay in Ghana to undertake research, that is also an option.

The MPAGE program is based around the solar pioneers project, a community-based participatory research project where students go to Ghana, find communities without electricity, and work to install solar panels. They partner with local science and technology organizations to complete these projects over the course of three years. The students first work to locate social leaders who can oversee these projects, then learn the installation skills by partnering with local experts. In the past, Muldrow said, they have worked with the Kwame Nkrumah University of Science and Technology, which has an energy center and teaches an intensive workshop where students learn how to engineer and set up solar panels. After the students learn the technology, phase three is the actual installation. Each summer, students look for a new community to work with and check back on previous projects.

The MPAGE program is open to students outside Morehouse, Muldrow explained. Participating students in STEM fields increase their social analytic skills and learn to better understand community energy culture and resource assessment, he said, while non-STEM students acquire an increased capacity to carry out research within the sustainable development framework, particularly in developing nations.

The field of cultural studies, which examines how leveraging the political dynamics of culture can affect social change, is a useful tool to apply to the Morehouse intervention program, McDermott said. The MPAGE project relies on two major types of knowledge that students are expected to acquire, which come from different sources within the program. Taken together, these different types of knowledge increase the students' potential to act as catalysts for change, both in the project and in their own lives.

The first type of knowledge is scientific knowledge. From a cultural studies perspective, this type of knowledge has authority and provides particular rewards. "Universities are powerful social institutions that regulate the production and legitimization of knowledge," McDermott said. Tenure review, accreditation, and peer review are all mechanisms for regulating that knowledge. The Morehouse project is not simply bringing more highly skilled technical workers into the American workforce, she explained. "It is actually empowering and assigning agencies to students of color who historically have been denied access to this sort of privilege."

The second kind of knowledge is community based and originates within the communities of rural Ghana. The Morehouse project legitimizes the knowledge produced by the community while simultaneously being careful to recognize social and cultural authority. That cultural authority is rooted in the lived experience of the community rather than the more abstract understanding of higher education. In this way, the community itself becomes central to the building of knowledge among the students and anchors their work.

Because the scientific skills the students learn are combined with a cultural competency curriculum, McDermott said, the Morehouse students "operate in the nexus of opposing forms of knowledge and then come out of it more powerfully equipped not only to act as agents on their own behalf but also to emerge as an effective change catalyst in the larger setting." She added

that Morehouse and other HBCUs are transformative institutions because they have always done this kind of cultural work.

ADDRESSING GENDER DISPARITIES AT HBCUs

The third team of presenters was made up of Goldie Byrd, the dean of the college of arts and sciences at North Carolina A&T State University, and Cynthia Winston, a professor of psychology at Harvard University. Byrd began by discussing interventions for women in STEM at A&T, which is the largest HBCU in North Carolina, with about 10,700 students and 11 PhD programs. (The program at North Carolina A&T State University is also described in Chapter 2.)

When Byrd became dean three years ago, women were dismally underrepresented in leadership and tenured faculty positions, she said. Focusing on racial dynamics at HBCUs is important, she pointed out, but this focus should not come at the expense of attention to gender differences and inequities. Women faculty members were staying at the associate professor level for long periods of time, anywhere from 7 to 28 years, and were outnumbered in almost every category except for part-time professor positions. Women make up 26 percent of the STEM faculty, but only about 3 percent are at the full professor level, and only 6 percent have achieved full professor rank across all of the disciplines. Women also were disproportionately involved in advising, directing programs, and administering training programs. Of the university's 52 federal grants over the last three to four years, only 14 were won by women.

About three years ago, the university began to have focus groups with women from all disciplines across campus, asking what was preventing them from progressing. Participants shared many things about why they were not able to keep their research going or did not have time to write. The university also conducted a climate survey, hoping to begin a conversation about promoting equity and reducing barriers to recruitment. This led to discussion of how search committees were selected and whether they were inclusive of women.

The university implemented a number of interventions, Byrd said, with the goal of increasing the capacity of STEM departments to recruit, retain, and advance women in the professoriate and fostering greater self-efficacy for women in scholarship engagement and work–life balance. Interventions included mentoring plans for junior faculty, funds set aside for faculty development, and a workload policy that requires each school and college to limit not only teaching load but the entire workload. The university also sponsored a salary equity study.

A community of women came together and held meetings to discuss barriers to advancement, Byrd explained. As a result, search committee development has changed and there is a process for evaluating salary equity. The college created an innovation awards program where faculty can send proposals, and a physical space for writing collaborative grants. It also established writing groups for women and workshops in proposal development and mentoring, as well as off-campus events during the summer. There is funding for a STEM faculty development center with a spot for women only,

where faculty can come and receive support with design, statistical analysis, and grant applications. Finally, Byrd said, the university has implemented a new program through the STEM center of excellence for faculty who wish to participate in the scholarship of teaching and learning, so that they can do research and publish in that area. "We are being very intentional about what we do," Byrd concluded.

Synergy theory, which is drawn from the explanation of organizational behavior, is useful for explaining why the intervention approach at NC A&T has been successful, explained Winston. Organizational behavior is the study of the interface between human behavior and the organization. There are three levels of understanding: the micro or individual level, the meso or group level, and the macro or institutional level.

The interventions at NC A&T can be mapped in terms of those levels, she explained. For example, mentoring has both meso and micro level dynamics. Perceptions are also an important factor—how female faculty members perceive the organization to be operating.

Synergy theory suggests that there is a systematic process by which business units within diversified organizations may generate greater value through working as one system rather than as separate entities. There is a connection between how the individual faculty members interact at the college level and how the college level interacts with the level of the university. If these entities work together, Winston said, the gains are greater than when they work in isolation.

The work at North Carolina A&T is drawing on culturally relevant aspects of individual-level psychology and organizational-level psychology. Mentoring is a cornerstone component, and mentoring can also be used as a platform to strengthen organizational culture, offer development opportunities for underrepresented groups, enhance the leadership of the organization, develop high potential employees, and enable knowledge transfer.

IMPLEMENTATION ASSESSMENT OF THE MEYERHOFF ADAPTATION PROJECT

The Meyerhoff Adaptation Project (MAP) is the product of an alliance between the Howard Hughes Medical Institute and three universities—the University of North Carolina at Chapel Hill (UNC), Pennsylvania State University (Penn State), and the University of Maryland, Baltimore County (UMBC). The purpose of the alliance is to expand the number of long-term, high-expectations, ethnically inclusive undergraduate scholarship programs in STEM fields using the Meyerhoff Scholars Program at UMBC as a model. MAP aims to promote institutional cultural changes at colleges and universities where underrepresented student populations are in the minority. The expected outcomes are diversifying and increasing the number of PhDs and professional STEM leaders.

MAP has three notable facets, said Karen Watkins-Lewis of UMBC: formation, planning and implementation, and assessment. The partner institutions welcomed the collaboration as a way of addressing the call for universities nationwide to fill the void in recruitment, retention, and entry of undergraduate

students of diverse backgrounds into STEM PhD programs, Watkins-Lewis said. Both the Chancellor's Science Scholarship Program (CSSP) at UNC and the Millennium Scholarship Program (MSP) at Penn State have consulted extensively with the staff of the Meyerhoff Program and are adapting its multicomponent approach to developing outstanding STEM scholars.

The Meyerhoff program itself has a 26-year history of increasing diversity among future leaders in STEM and related fields, Watkins-Lewis noted.[1] The program has graduated more than 800 alumni who have spread out across the nation, and nearly 300 are currently enrolled in graduate and professional programs. The Meyerhoff community is a diverse group open to people of all backgrounds and committed to increasing the numbers of underrepresented minorities in STEM fields. The program's premise is that positive energy becomes contagious among like-minded students who work together closely to meet the demands of college-level work. The program is recognized by numerous and well-respected institutions and organizations as a national model for success.

Meyerhoff is a comprehensive program featuring 13 components: financial aid, summer bridge assistance, program values, advising and counseling, on-campus and summer research internships, faculty involvement, recruitment, study groups, program community, promotion of tutoring, administrative support, mentoring, and open communication with families. Of these 13, Watkins-Lewis highlighted the community aspect, which emphasizes the importance of establishing a supportive culture of achievement by encouraging scholars to seek out and provide help, beginning with recruitment. For example, the program encourages students to take advantage of university tutoring and resources. Students have their own advising teams and advisors, and the program strongly emphasizes a culture of peer support. Scholars are expected to participate in community service projects as way of building both community and character.

African American students who matriculate into the Meyerhoff program as freshmen are five times more likely to enter a PhD program than those who declined and enrolled at other institutions, Watkins-Lewis noted. Since implementing the Meyerhoff program, UMBC has become one of the nation's leading primarily white institutions to produce black graduates who earn STEM PhDs.

After the planning stage, the Meyerhoff Adaptation Project launched in spring 2013 at both UNC and Penn State. Both universities identified milestones for the first year, including their first selection weekend, summer bridge activities, completion of one academic year, and preparations for the second cohort. The MAP evaluation reviews all events preceding and during phase one of the implementation program. "Essentially we're preparing the story behind MAP's creation, planning, and implementation," said Watkins-Lewis. "We continue to document current and continuing accomplishments, challenges, and best practices relevant to these experiences."

Mariano Sto Domingo, also of UMBC, discussed MAP's assessment methodology, which has used a series of open-ended interviews conducted at

[1]Information about the program is available at http://meyerhoff.umbc.edu.

Penn State and UNC with the directors of the programs, top university and college administrators, and the university staff. The first round of interviews was held on site, and follow-up interviews were conducted over the phone in the spring, summer, and fall of 2013 and the spring of 2014. A total of 141 interviews were conducted with 57 key personnel across the two campuses, including three consultants from UMBC and the Meyerhoff Program who were asked about their views on the progress of MAP's implementation.

Round one of the interviews concerned program development, strengths, and challenges, including issues regarding leadership, university culture, and administrative structure. The following rounds involved questions regarding program implementation, progress, accomplishments, and challenges. The response rate was 78 percent, and all interviews were transcribed by a professional service and entered into a software analysis program. Thus far, data have been analyzed by reading the interview transcripts and identifying patterns of responses or themes across time. The evaluation team looked specifically for major events that led to the development of the program, challenges and accomplishments experienced or perceived by the interviewee, and responses or solutions to the implementation challenges they faced.

Important milestones have been reached by both universities during this initial phase of program implementation and development, including developing a leadership team, coordinating activities across key campus units, and generating startup funding. The MSP received early funding from the Eberly College of Science at Penn State and the office of the vice provost for educational equity. The CSSP at UNC received early funding from the chancellor's office, a committee on scholarship awards and student aid, the school of medicine, and HHMI. Most recently, the new UNC chancellor committed $2 million in additional funding at the national education summit hosted by President Obama in spring 2014.

Major milestones during the spring of 2013 included successfully organizing the first selection weekend, hiring a program director or coordinator, initiating data collection for program evaluation, and establishing the first cohorts. A large number of faculty members were involved in the selection weekends. National searches were conducted for a program director at both campuses, and assessment teams were developed with education faculty from Penn State and the psychology faculty from UNC. In both cases, the teams had a strong commitment to and extensive experience with research conducted with minority student populations.

A total of 44 students accepted offers of admission into the two programs, the majority of them underrepresented minority students and women. During the summer of 2013, the major milestone was implementation of the six-week intensive summer bridge program. Survey and interview assessments revealed that high levels of bonding and mutual support developed among students over the course of the summer program.

Major accomplishments during the academic year included strong academic performance from students, the institution of advising and academic support services, creation of a sense of community, submission of grant applications to HHMI for phase two funding, and revision and expansion of evaluation plans for the two programs. The vast majority of students achieved or

surpassed the minimum program required GPAs of 3.5 for Penn State and 3.0 for UNC, and in the fall semester students in both programs had mean GPAs of 3.7. Many students secured high-quality summer research internships, including a number of overseas positions. Plans were developed to include additional comparison samples for the outcome evaluation assessment and to assess theory-based components and specific process evaluation measurements, with additional funding from HHMI.

Throughout the first 24 months of MAP, the partnership between UMBC and the two campuses has developed on multiple levels, Sto Domingo said. The Meyerhoff director and the assistant director serve as the two primary program consultants, which includes biweekly phone calls with the MSP and CSSP program coordinators. The program leadership teams have met on multiple occasions to share developments and challenges and prepare their respective grant proposals. Finally, the evaluation teams have conducted regular phone meetings and have shared written materials, coordinated evaluation plans, jointly developed and adapted measures, and engaged in regular problem solving. Much has been accomplished quickly and effectively on both campuses, Sto Domingo reported.

Kenneth Maton of UMBC discussed some of the challenges in implementation. "It may seem easy, but it's incredibly difficult to replicate and implement the Meyerhoff Program," he said. A primary challenge that faces any campus is leadership. At UMBC the program had a fully committed, high-level leadership team from its inception in 1988. The leadership team worked effectively with clearly delineated responsibilities and decision-making processes.

The experiences of Penn State and UNC differ in many regards from those of UMBC, said Maton. At Penn State the dean of the College of Science is a strong supporter of the program, and the associate dean emerged as the program's hands-on champion, committing considerable time and resources to its success. The program director was hired to organize and run the day-to-day activities, and that fairly streamlined structure has been in place since the beginning.

At UNC the chancellor was the strong program proponent during the planning phases but then left the campus prior to the program's initiation. A multi-person leadership group, including a vice chancellor and two additional senior faculty members, served as the initial administrative leaders, with varying expertise and levels of involvement. Just prior to the summer bridge program, a program coordinator was hired. Leaders at both campuses have had to deal with difficult implementation issues, Maton explained, relating in part to the existing campus structure or culture. At Penn State, for example, it did not prove possible to work out planned collaborative relationships with the existing honors college, which led to some initial discord and tension.

At UNC the campus culture generally shies away from cohort building and privileges student individuality, Maton explained, which presented another implementation dilemma. In addition, the high-level leadership transition at UNC, coupled with different views on the necessity of strict adherence to the Meyerhoff practices, has presented challenges. On both campuses, the

inordinate amount of catch-up required by the newly hired program director or coordinator led to some implementation glitches.

A second challenge of adopting the Meyerhoff program relates to the way the program places great emphasis on the development of family-like cohesion and student character development, including commitment to excellence, personal sacrifice, and responsibility for other students' success. Key factors contributing to these outcomes are bonding experiences, interactions with students from older cohorts, and cohesion among program staff and leadership. During the summer bridge program, students work long hours, have limited access to cell phones or other devices, and sacrifice personal comforts to work hard and focus on group activities, Maton explained. The Meyerhoff Program staff have years of experience creating a balanced combination of supports and challenges for the students. During the ensuing semester, group cohesion, strict program rules, and the development of key character traits are continually reinforced, in part through intrusive advising, program meetings, the involvement of older cohorts, and strong backing from program and university leadership.

Replicating the family-like cohesion and student character development facets of the Meyerhoff program is not easy, Maton said. For example, both Penn State and UNC faced early challenges from students breaking the rules during the summer bridge program. More generally, due to time limitations, it was not possible to convey fully the guiding concepts of day-to-day practices developed from years of experience at UMBC. The active involvement of older cohorts to serve as role models and explain the rules and practices of a program is absent at Penn State and UNC. Furthermore, differences of perspective regarding student autonomy versus cohort building have challenged straightforward adoption of the Meyerhoff approach. It will be interesting as time goes on, Maton said, to determine the extent to which full adoption of the Meyerhoff practices of strict rules and character development is critical to group cohesion and program success.

Nevertheless, the accomplishments of Penn State and UNC are impressive, Maton concluded. The process going forward will be critically important, and evaluation teams on both campuses will be working with multiple comparison samples and theory-based mediating variables to determine how program components are linked to outcomes. At the same time, UMBC plans to play a more formative role by giving feedback during program development and by addressing the partnership's strengths and weaknesses.

6

Institutional Responses: Professional Associations

Professional associations can create particularly targeted and effective programs for broadening participation in research. Several sessions at the conference looked specifically at these programs in the context of the themes discussed in Chapters 1–4.

STRENGTHENING INTERVENTIONS THROUGH DATA: NEW CROSS-DISCIPLINARY RESEARCH FOR DEVELOPING MENTORING INTERVENTIONS

In one of five workshops held at the beginning of the conference, representatives of four of the eight organizations that make up the Collaborative for Enhancing Diversity in Science (CEDS) discussed the development of data standards for the study of educational interventions: Jean Shin, the director of the Minority Affairs Program at the American Sociological Association; George Wimberly, director of Professional Development and Social Justice at the American Education Research Association; Angela Sharpe, deputy director of the Consortium of Social Science Associations; and Craig Fisher, a senior legislative and federal affairs officer at the American Psychological Association. CEDS is group of professional associations and scientific societies, housed under the Consortium of Social Science Associations, that was formed in 2007, originally because many of the individual organizations had training funding through the National Institute of Mental Health. The members of CEDS represent different types of organizations, Shin explained, but all share the goal of enhancing diversity in science and making sure a range of views, perspectives, and backgrounds are represented in their communities.

CEDS has focused on recruitment and retention in the higher education pipeline, mentoring of underrepresented minority scholars, improved evalu-

ation of interventions and other programs, and the building of public support for diversity in science, Shin said. The organization has a leadership retreat where executive directors, executive officers, and presidents of associations and societies get together with representatives from funding agencies, universities and colleges, and private foundations to talk about how professional associations and scientific societies can work together. It also has held congressional briefings, has published workshop reports based on sessions it has held, and plans to develop a comprehensive literature review on mentoring as a tool for increasing diversity in STEM research. Professional associations and scientific societies need a unified voice that can bring issues to light for federal funding agencies and lend an interdisciplinary perspective to the social and behavioral sciences, Shin said. "Interventions aren't just about funding or mentoring. Sometimes you have to dig a little deeper."

In 2012, CEDS held a common data standards and measures workshop, which led to a congressional briefing on the topic. To design programs and practices that work, said Wimberly, a common source of data and understanding is needed that can bridge the gaps between different types of organizations. The recommendations from the workshop included establishing a federal interagency working group to find common data elements, which then would be required for all federally supported programs and individuals; CEDS suggested that the Office of Science and Technology Policy at the White House lead this effort, with NIH and NSF serving as coaches for the working group. That group would be charged with summarizing evaluation studies of program approaches and interventions and reviewing current data collection efforts to make recommendations for core data elements. The vision, Wimberly explained, is for a national data standard that universities, professional associations, scientific societies, private foundations, and other funding agencies all would use. This common language would allow datasets to be merged, allowing for better and more efficient evaluation of interventions and programs.

Wimberly also described the need to move toward more robust data categories than age, sex, and race, such as immigrant status, country of origin, disability status, and financial background. Understanding a student's current and past socioeconomic status is helpful, he explained, as well as having information on a student's parents. It is helpful to know what activities students participated in during high school and to find other achievement measures beyond grades and test scores, he said, although these measures are hard to standardize. "We're getting to a point where there's so much big data that we need strategies to link up all the different sources of information," he explained.

One conclusion that emerged from the workshop was the need to look at the mission, the culture, and the programs offered at colleges and universities. Diversity initiatives and interventions happen within that context, said Wimberly, and better understanding of the context will help investigators understand the public's attitudes toward diversity in sciences and the commitment within the institution to increasing diversity.

CEDS would like to develop a permanent central web-based repository for data on the diverse populations in the science pipelines. The American

Education Research Association is in the process of launching a set of fellowships focused on increasing diversity in the scientific workforce, and such a database would allow the organization to use public and private partnerships and consider recent research and best practices for structuring fellowships and training experiences.

Wimberly then invited input from attendees based around three discussion questions: what programs and interventions are you running, what type of data do you collect, and what type would you most like to collect? Among the responses from the other speakers and workshop participants were the following: Data on institutional climate and whether students feel included would be valuable. The quality of data is important. Data about students transitioning from undergraduate into graduate programs that is disaggregated by city and race are difficult to get, yet would be very useful. Acquiring longitudinal data is also challenging because of the difficulty of keeping track of students who fall out of academia. Unobtrusive data collection would be a major advance. Better knowledge about outcomes for students who do not complete a PhD would be useful. And a widely held definition of what constitutes a viable scientific career would provide a better understanding of STEM pathways.

BUILDING CONNECTIONS TO THE RESEARCH COMMUNITY THROUGH DISCIPLINE-SPECIFIC WORKSHOPS

The Discipline-Specific Workshop (DSW) program has sponsored 30 workshops in computing fields since 2006, explained Elizabeth Bizot, the Director of Statistics and Evaluation at the Computing Research Association. The workshops are part of a portfolio of mentoring programs in computer science, computer engineering, and information jointly run by the Computing Research Association Committee on the Status of Women (CRA-W) and the Coalition to Diversify Computing (CDC). They are funded by the NSF and work to support underrepresented students as they go through graduate school and seek research careers.

The workshops vary in length from one to four days. Some are co-located with a conference, while others are held as stand-alone events. Most focus on graduate students, although some include a wider spectrum. The content focuses on a specific sub-discipline of computing and is a mix of technical information and career development.

The central group that runs the DSW program consists of two volunteer project directors, one from CRA-W and one from CDC, Bizot explained, with additional staff support from the Computing Research Association office. Together they put out a request for proposals, review the results, and select which workshops will be funded. None is fully funded, but those selected receive partial funding. The organizers then plan and conduct the workshop, while the central group deals with travel reimbursements and evaluation.

Manuel Pérez-Quiñones, co-chair of the CDC, discussed two workshops he organized with Ron Metoyer of Oregon State University as part of the DSW program, both of which dealt with human–computer interaction. Both were co-located with a major international conference, one in 2010 in Atlanta

and one in 2012 in Austin. CRA-W and the CDC provided support of about $25,000, he said, and NSF support covered travel for students. Microsoft, IBM, and Intel contributed funds and speakers to the workshops.

Holding the workshop at a conference meant that students had the opportunity to attend conference sessions; it was also cheaper to get speakers since many of them were already planning to be in the area, and the space was free as part of the conference. A disadvantage was the limited time for the workshop. Alternatives include holding workshops at local universities during the summer, when dorms are empty and space is cheap. That option allows for longer workshops, but it is challenging to get presenters from outside the university roster to attend.

In soliciting applications, he explained, knowing where to advertise is important. Universities with graduate programs in human–computer interaction will yield more applicants, but a pool of students at institutions where the sub-discipline does not exist may also be interested, and both are important demographics.

Coordinating the workshop is also a major challenge, he pointed out. It can take several months to organize hotel rooms, food, and travel plans for attendees and speakers. For their workshop, they used Google forms to collect information from students, including name, email, mailing address, name of their advisor, the sub-discipline they study, and the number of years they have been in their graduate program. Students working on a PhD have preference, although a few master's students were at the workshops. Applications asked students how they felt they could contribute to and benefit from the workshop.

From more than 70 applications, about 40 students were able to attend each workshop, he said. About 70 percent of attendees were female, and 75 percent were African-American or Hispanic. The subject matter varied, but it included a panel on human–computer interactions in academia, industry, and government, discussion of research methods, and talks on experimental research, current hot topics, and the history of the field. The organizers asked presenters to tell personal stories of how they got to where they are, so students could see that there is no one simple path to getting a PhD. The overall intent was to foster a more casual and social environment than the traditional technical conference. Activities connected people who knew each other through second- or third-hand acquaintances, which was part of an effort to show students the connections that exist throughout the research community.

The NSF was very supportive, Pérez-Quiñones said, as well as industry. If the workshops were a bigger part of the conferences, more of the workshop funding could be covered.

The evaluation process evolved over several years, explained Bizot, as desired effects of the workshops were pinpointed and a targeted logic model and survey were developed. The goals of the workshops are to increase students' technical knowledge, interest, and confidence and to help them develop a career strategy and clarify their career interests. Even if students decide against pursuing a career in the workshop sub-discipline, said Bizot, the workshop organizers consider it a positive thing if the workshop helped them

reach that conclusion. The goal is not only to influence individual students but to have an effect on the discipline as a whole by increasing the visibility of underrepresented groups and developing a sense of collective responsibility.

The three pieces of the evaluation include a post-workshop survey for students, a shorter survey for speakers and mentors, and an analysis comparing workshop attendees to non-attendees. The workshop surveys have space for both a standardized set of questions and individualized questions dealing with specific workshop sessions, so organizers can look at particular data of interest. In the early years, Bizot said, they looked for more formative feedback, but now they are beginning to look at data that can be compared across workshops. During the evaluation, they also run a quick report of responses that the organizer can send to other funders to demonstrate that the money was well spent.

People come away from the workshops on a sort of high, with a lot of good feelings, Bizot said, and follow-up surveys provide a sense of how people feel once they are back in their regular routine. Students report learning a lot from sessions at workshops co-located with a conference on how to navigate the conference and get the most out of it. They also report more interaction with peers when workshops include poster sessions. When a workshop had more career content, as opposed to technical content, participants thought it was more likely that they would stay in touch with other attendees.

A follow-up survey in 2010 asked previous workshop attendees if career or educational decisions were strongly affected by something they learned at the workshop or someone they met there. About 25 percent of those who were one year out from their workshop answered yes, and after two years the affirmative response rate was 34 percent. As examples, they cited meeting a postdoctoral advisor, getting an internship, and submitting a paper or proposal with someone they met.

Students also reported that the workshop had a substantial impact on their interest in the field and feeling part of the research community, and slightly less impact on their interest in a PhD. When compared with non-participants, the workshop attendees were more actively engaged in the research community in two ways, Bizot said. They were more likely to have served on departmental conference or professional society committees, and they were more likely to have attended the primary technical conference in their field the last time it was held.

From surveys of speakers, the workshop organizers learned that 61 percent of the people giving presentations at the workshops had not previously done anything with CRA-W or CDC. Of those speaking in that setting for the first time, 69 percent said it made them much more aware of diversity needs in their area and suggested additional ways in which they might be able to contribute. “We feel like this is one of the ways in which we could start to have an impact beyond just the students being served by the single workshop,” Bizot explained, “to start to create larger awareness and activity within the sub-disciplines.”

In 2007, she continued, the DSW program provided 68 percent of funding for workshops, with organizers getting 32 percent from other sources. In 2010

and 2012, 63 percent of the funding came from other sources, which indicates that the workshops are becoming more sustainable and gaining support across the discipline.

Helping underrepresented students build connections and feel part of the research community is one of the most important functions of the workshops, said Bizot. Those connections are more easily built in small groups with lots of interaction than they are in formal technical sessions or large auditoriums. Even big names in the disciplines are willing to speak and are supportive of the mission.

In the early years, the DSW program did give some underrepresented students funding to attend general-purpose workshops. While those opportunities are important, she said, they are not as valuable as workshops aimed more specifically at diversity.

Having a combination of technical development and career development in the workshops helps attract high-level speakers, Bizot said during the discussion period following the talk. Pérez-Quiñones pointed out that at many institutions, only one or two people are studying human–computer interactions, so the opportunity to come together with others in the community helps counter that isolation.

In response to a question about how the organizers were able to get industry support, Pérez-Quiñones said that holding the workshops with conferences was a big help since many industry representatives were already attending. Bizot added that many connections are made through the research context, and that personal connections are especially fruitful. The organizers have pulled together a list of information for workshop organizers and feel that a good community exists around the workshops themselves.

There is still progress to be made, the presenters agreed. For example, Pérez-Quiñones pointed out that they push students to pursue academic positions partly to make it easier for the next generation of underrepresented students to enter the field.

A NETWORK FOR UNDERGRADUATE RESEARCH AND CAREER DEVELOPMENT OPPORTUNITIES

Research-intensive universities have many opportunities to broaden the pipeline of students in biomedical research, including broad research opportunities, a strong research environment, peer support, role models, and career paths to emulate. However, these universities often have a small proportion of students or trainees from underrepresented minority groups, and recruitment for research experiences is often passive. Community support for underrepresented students can be lacking, with limited faculty–student interaction.

Minority-serving institutions often have a strong sense of community and a sense of mission, with great peer support and stronger student–faculty interaction. However, research opportunities may be limited, and students interested in pursuing research typically have fewer career models. Also, peers are frequently focused on medicine, not on biomedical research, as the most desirable career outcome.

To bridge the gap between both kinds of institutions and research careers, members of the Endocrine Society, a professional society devoted to endocrine research, formed a task force designed to leverage the society's strengths. One of those strengths, observed Steven Anderson of the University of Colorado School of Medicine, is that the society's members represent a broad diversity of career paths and are engaged in biomedical research, clinical research, basic research, and translational research in academia, government, and private industry. That convergence of scientific interest enhances a sense of collaboration and provides a more diverse set of role models than what exists at research intensive institutions.

The task force concluded that the society's members represented a largely untapped resource for mentorship. The Endocrine Society has a career day focused on graduate students and postdoctoral fellows, and it holds workshops for new faculty in clinical and basic science areas. In this way, the society can offer role models and coaches who go beyond those present at a single institution, Anderson said.

The task force's proposed the creation of a comprehensive multisite program for training that would enhance professional development and encourage the pursuit of biomedical research careers. Such a program "would enhance self-identification of our trainees as scientists and provide support for career progression," Anderson said. Because of the diversity of the society's membership, such a program could embrace a broader interpretation of success than is the case in institutions where biomedical research is the paradigm. For example, the society sees the decision to enter medicine as a success because many physicians are involved in clinical or collaborative research.

The Minority Access Program (MAP), which the Endocrine Society has developed, supports students for two years of summer research. The program began with four institutions and now has expanded to six. Students engage in career development and networking at the society's annual meeting, where they present their research, and they are engaged in long-term and year-round mentoring.

The target population is rising sophomores and juniors who have expressed an interest in biomedical research, have a GPA of 3.0 or higher, and are attending a minority-serving institution. They also focus on non-MARC students, Anderson explained. The program has a T36 grant from NIGMS, and it receives administrative and logistical support from staff at the Endocrine Society. An advisory board includes training partner institutions (the Baylor College of Medicine; the University of California, San Diego; the University of Colorado at Denver; the University of Virginia; the University of Wisconsin–Madison; and Emory University) and program directors.

The program recruits students in the fall and solicits applications by February 1. Students are assigned to institutions in March. Most start their research experience around June 1 and attend the Endocrine Society meeting in mid-June. Students have an introduction to what to expect at the meeting the night before the meeting starts, since few have been to that kind of event before. A career development luncheon occurs on the first day, a mentoring reception takes place on the second night, and students shadow people

throughout the meeting. Then they return to do summer research, which is broadly based on their interests.

The second year they move to a new institution. At the annual meeting in that second year, they present a poster based on their research conducted during the first summer. More importantly, they serve as peer-to-peer mentors to the first-year students.

The program continues to support students in the fall after their second summer and encourages them to apply to graduate school while continuing the mentoring process. If students began the program as rising sophomores, they can do a third year of research.

Over the last six years, program representatives have visited 22 schools, Anderson said. They usually visit 12 to 14 each fall in about six weeks of recruiting. They try as much as possible to place students in the labs of Endocrine Society members, and follow-up mentoring occurs in several different ways. Students are actively engaged in social networks and often contact program directors for advice. Mentors provide support to attend conferences and advise students on graduate schools and post-baccalaureate programs, as well as providing letters of support and reference.

Prior to this year, 57 students have entered the program. Of those, 22 did not return for a second year, and 17 have entered post-graduate studies, including medical school, PhD programs, MD-PhD programs, and post-baccalaureate programs. Of the 35 students who finished two years, 16 have entered some form of postgraduate training. Those 35 students include many who are returning for a third year of research because they are not seniors.

A qualitative analysis group led by Rick McGee is conducting a short-term evaluation of the core program components along with long-term theory-driven longitudinal research involving a matched control group. This research is looking at the impact of the program on success and persistence in science as well as psychological mediators. The qualitative analysis involves interviews before and after the annual meeting to identify what has worked well and what has not worked well during the summer program. Researchers ask students about the effectiveness of each component of the meeting, including the reception, student orientation, lunches, and poster sessions. So far, Anderson reported, students have said that they value all of these events. A difficulty, he added has been to align the expectations of trainees and mentors, some of whom want students to go to one lecture and some of whom expect their trainees to shadow them all day.

Students' interviews have revealed that second-year students in particular understand that they have to take advantage of the opportunities available at the meeting. They have to talk with other people, get over being shy, and make contacts. When students do that, the impacts are substantial, Anderson said.

When researchers have asked students about their satisfaction with their mentors, they find that in the first year most students are very happy, but by the second year, as they gain more experience, they become more demanding. Students still are not good at telling their mentors what they need from them, Anderson added.

Many students say that the program has enabled them to do research and be successful in graduate school. However, attending a small minority-serving institution and then being dropped into a big laboratory remains a struggle for many students, and some still feel there is bias against them. The program is still gathering information on how best to prepare students for this challenge and help the students adjust to the challenging environment of a research-intensive university.

The long-term evaluation involves a web-based program developed by Anna Woodcock called My Science Journey, which is part of a longitudinal study comparing the students in the program with a matched control group. The study is looking at rates of degree completion; application, acceptance, and enrollment in graduate school; intentions to pursue biomedical research; and other psychological mediators of outcome. So far, 31 MAP students and a comparison group of 53 students have participated in the evaluation. To date, communications have been personalized and the response rate among the students and comparison group has been very high, Anderson said.

Other professional societies could be engaged in this type of outreach, Anderson concluded. "We are able to bridge inter-institutional barriers largely because we are working through our membership," he said.

7

Institutional Responses: The Federal Role

In the first and fourth plenary sessions of the conference, three speakers commented on the federal government's role in broadening participation in research. This final chapter of the conference summary draws from their presentations and from the ensuing discussion sessions to revisit several of the major themes of the conference.

FEDERAL POLICY AND THE INTERVENTIONS COMMUNITY

Federal agencies understand the value of diversity in the workforce, said Kathie Olsen, founder and managing director of ScienceWorks and former deputy director and chief operating officer of NSF. In particular, NIH and NSF both have numerous programs to increase the diversity of the research workforce.

As an in-depth example of this commitment, Alison Hall, the acting director of the Division of Training, Workforce Development, and Diversity at NIGMS, described the division's "enormous, long-standing commitment to training." Research training is a shared responsibility, explained Hall, who was a professor at Case Western Reserve Medical School before becoming a Postbaccalaureate Research Education Program (PREP) director and then joining NIGMS. It is a partnership between program directors, academic institutions, faculty members, and trainees, all of whom must adhere to common values and common goals. It also focuses on student development, not just talent selection. By working with people on multiple career paths and encouraging individual development plans, institutions can broaden the groups that participate in science. "Diversity is indispensable to research excellence," Hall observed.

NIGMS sponsors programs all along the career trajectory for students going into biomedical sciences. The best known, Hall said, are the Maximizing Access to Research Careers (MARC) programs and the Initiative for Maxi-

mizing Student Development (IMSD) programs. Almost 3,000 pre-doctoral graduate students are supported on NIGMS training grants, and the institute has a vested interest in creating an outstanding biomedical research workforce through creative programs.

The National Research Service Awards, which fund both T32 grants for graduate students and T34 grants for undergraduates, are targeted to enhance student preparation for a research doctorate degree. Many strategies can help achieve that goal, Hall said, including research training, mentoring, and academic development. However, she pointed out, it is rare to see references that support the use of a given observation or strategy, or references to literature where advances have been made. "Resolving that challenge requires partnerships," she added. Data the NIH gathered two years ago from T32 PhD graduate training programs show that the PhD completion rate at 10 years for students supported on training grants and fellowships was about 80 percent, compared with the 70 percent normally achieved in PhDs across the board. In addition, the median time to degree was a year and a half shorter than the average PhD.

About 12 percent of individuals appointed to T32 grants come from underrepresented minority groups, said Hall. Studies show that students supported by training grants and fellowships are more likely to apply for and receive an NIH research grant than PhDs in the same fields without T32 support.

In the MARC program, students are identified as juniors in college and supported through training grants, giving this program a longer trajectory than the graduate awards. Some of those students choose a research career, and some do not. The program has many measures of success, but the two major ones are student achievement of a STEM baccalaureate and a biomedical PhD.

When considering the average numbers of underrepresented minority PhDs each year for 100 institutions, the top-ranking institution had about 20 PhDs per year, while the lowest had fewer than two graduates per year on average. However, institutional comparisons can be misleading, because the institutions can be very different kinds of places. The National Center for Educational Statistics looked at the estimated number of underrepresented minority students who earned baccalaureates and computed the PhD yield for each school. The data showed that some programs had great yield even without any NIGMS funding, Hall said. A historically black university with two NIGMS programs had a yield of 7.3 percent, while a Hispanic serving institution, also with two NIGMS programs, had a yield of only 1.5 percent.

Figuring out what explains that difference and what makes programs effective is a critical issue. "It is unclear to us, as we look at these sorts of data, what makes a program work well and what might be happening at institutions that are not doing so well," Hall explained. The Understanding Interventions conferences, by fostering the use of social science tools to evaluate which interventions and activities produce good results, contribute to the strengths of these programs, Hall said. The conferences also help build a common language and bibliography between social scientists and natural scientists, creating a shared resource in improving training programs.

UNDERSTANDING AND MEASURING INDICATORS OF PROGRESS

Experience has revealed areas where improvements were needed, observed Olsen. For example, when she worked at NSF, the foundation had a grant program specifically for women. The program sounded wonderful, Olsen explained, but it was underfunded, and the success rate for the women who participated ended up being much less than when they submitted to the regular research programs in their fields. In addition, some who won those highly competitive grants ended up feeling penalized because they were not taken as seriously when they received grants that were directed only at women. She emphasized the importance of anticipating unintended messages and evaluating policies and programs to make sure they are accomplishing the desired goal.

Clifton Poodry, senior fellow in science education at the Howard Hughes Medical Institute and former director of the NIGMS Division of Training, Workforce Development, and Diversity, agreed that the effectiveness of programs is the first and most important consideration. This requires learning how best to add value by taking good students and making them better.

Federal agencies are constantly evaluating various programs, he pointed out. But the line is often blurred between the broad objectives of a program at the national level and the specific activities and interventions applied at the local level. Evaluations sometime skip the important questions of how well the interventions are working, he said, and institutions need to think about the specific activities that they are undertaking and whether those activities achieve the intended outcomes. This can be accomplished only by going deeper in the evaluation, breaking down the elements of a program and deciding which ones achieve the intended effect and which ones do not. In particular, just as measuring blood pressure and cholesterol levels provides an intermediate indicator of heart health, understanding and measuring the intermediate indicators of progress is valuable in developing and evaluating potentially successful programs.

DEALING WITH BIAS

In their joint presentation, Poodry and Olsen also discussed the issue of bias (see Chapter 1). Olsen cited research from Frederick Smyth at the University of Virginia, who found that overt bias and discrimination has decreased globally but that unconscious bias is still a major challenge. "It's difficult to counteract what we don't actually know we are guilty of, and reinforcements that feed our implicit biases are all around. It's hard to filter them out," said Olsen. For example, she noted that a Google Image search for "professor," "scientist," "research," or "engineering" yields, in the first 15 to 20 images displayed, primarily white males, while a search for "research assistant" produces images of women and minorities. "It's just a machine returning results based on some algorithm involving popularity of the site and the number of occurrences of the search term. Nobody's trying to advance an agenda. But it certainly demonstrates, as well as helping to create or reinforce, our cultural implicit bias about what a professor, scientist, engineer, or assistant looks like."

"The biggest challenges deserve the biggest solutions," she said. Unconscious bias is deeply embedded in our culture, and research shows that regardless of the social groups we belong to, we treat people differently based on their social groups (Figure 7-1). Harvard's Implicit Association Test, found on their website, is highly revealing, Olsen added.

The challenge for the conference attendees, Olsen said, is to think about strategies to overcome bias, whether conscious or unconscious, and develop explicit proven criteria for implementing them. She encouraged participants to think about how the federal and institutional policies and practices could be altered or enhanced, and how to address biases in advisory committees, reviews, and funding. As an example of how such ideas could be implemented, she mentioned that the NIH Center for Scientific Review has launched two grand challenge competitions for public input on improving peer review, one calling for ideas to detect bias, and one asking for proposals to strengthen reviewer training to enhance impartiality and fairness. Both have a cash prize.

The issue of bias led to a wide-ranging discussion with the conference attendees. It is hard for people to admit they are biased, Poodry said, even when evidence of bias exists. A conference participant added that review officers often recruit from their own professional networks. A registry of possible reviewers in different locations could make it easier for them to cast a broad net, she pointed out. Olsen cited the NIH Pioneer Awards as an example, which

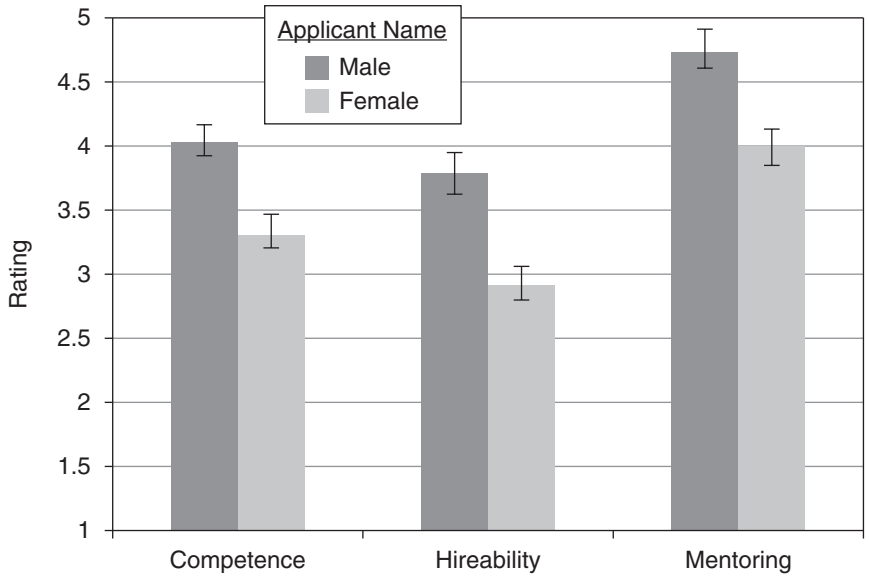

FIGURE 7-1 STEM faculty members judged fictitious male applicants higher than fictitious female applicants for a lab manager position. Source: Moss-Racusin, C. A., J. F. Dovidio, V. L. Brescoll, M. J. Graham, and J. Handelsman. 2012. Faculty's subtle gender biases favor male students. *Proceedings of the National Academy of Sciences* 109(41):16474-9.

were given almost exclusively to men in the first round, but there were only three women on the large review panel. The next year, she said, the panel was more diverse and so were the awardees.

Poodry commented on the difficulty of instructing and training the people who select review panelists to balance the bias of the panelists and extend their networks. Doing so requires reach within the agency to provide professional development.

Another speaker asked about learned helplessness and how it can be countered or deterred in peer review and selection committees. Poodry said that it has to be acknowledged but can be offset by training and heightened awareness. "We have to recognize that we have all grown up in these times, so we bring with us a lot of baggage."

Another speaker brought up the emphasis in NIH proposals on preliminary results and research environment, as well as a biographical sketch, saying that those criteria aggravate individual bias unless there is clarification of how they are factored into the review. Poodry and Olsen agreed that the NIH system has obstacles to eliminating bias. A participant mentioned that there is almost an explicit bias at NIH toward medical schools and recommended that the institution amend panels to include more faculty from non-medical schools.

Marcello Vincenzo, from Oberlin, commented that it makes sense to talk about these issues as a community of practice, and consult colleagues in the psychology and sociology departments. "Though we care deeply about the process of developing new scientists," he said, "a lot of what we are talking about is beyond our own expertise." Psychologists have good data and years of experience studying these issues. He also pointed out that the implicit bias exam can be misleading, citing research from a colleague who found that stereotype threat is in effect for white male participants.

Another speaker addressed the issue of how to respond appropriately to a lack of diversity, pointing out that the correct action is not to place the burden on the person who is being biased against but to do better training of the people in charge.

A ROLE FOR EVERYONE

In response to a final question about how individuals who are not in the minority can engage on the issues raised at the conference, Poodry observed that everyone has a role to play in broadening research participation. In particular, it is necessary to work against forces that say only one type of experience or one background is valuable. "The real objective is to ensure that everyone has a voice and an opportunity," he said.

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