UNDERSTANDING INTERVENTIONS

that Broaden Participation in Research Careers

VOLUME V

INTERVENING TO CRITICAL MASS

2012

Daryl E. Chubin and Anthony L. DePass, Editors

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Intervening to Critical Mass

SUMMARY OF A CONFERENCE
BALTIMORE, MARYLAND, MAY 10–12, 2012

Daryl E. Chubin and Anthony L. DePass, Editors

Funding for this conference was made provided by:
Howard Hughes Medical Institute (HHMI)
National Science Foundation (NSF)
National Institutes of Health (NIH)

With in-kind support from:
American Association for the Advancement of Science (AAAS)
Long Island University (LIU)

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Conference Website:
http://understanding-interventions.org

Please go to http://understanding-interventions.org for information regarding earlier conferences and summary reports.

Printed in the United States of America.

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Preface

The Fifth Conference on Understanding Interventions that Broaden Participation in Research Careers was held May 10–12, 2012, in Baltimore, Maryland. The theme of the 2012 conference was "Intervening to Critical Mass," which is a critical concept on several levels. Since the first Understanding Interventions conference in 2007, the meeting has brought together individuals from different communities working on different kinds of problems. Yet they all are bound by a unity of purpose in seeking to increase the number and impact of underrepresented minorities in biomedical and behavioral research and throughout the sciences. Achieving this goal requires more than teamwork in our own spheres of activity and influence. It requires the exchange of knowledge across boundaries with full appreciation for difference in disciplines, cultures, and language.

Critical mass can be a measurable variable in a range of studies and a condition toward which to aim. But it has varying features in different settings, disciplines, and education-to-workforce pathways. Exploring and applying the concept illustrates how the interventions community in science, technology, engineering, and mathematics (STEM) is learning and applying new knowledge in real time.

The Understanding Interventions community has been making the transition from annual conference to an organization. We are working to connect our activities through personal exchanges, a newsletter, and an archive of resources. The website (*http://understanding-interventions.org*) will continue to disseminate information relevant to our efforts and offer resources as we develop a portal for use by the community. This will promote communication and grow our community, thus strengthening our own critical mass.

This has never been an easy conference for people to fit into their schedules. It brings together a rich mix of researchers, practitioners, evaluators, policy makers, and communicators, each with many disciplinary and professional responsibilities and commitments. Yet the fifth conference, like the

four before it, was well attended, and the enthusiasm of the attendees was palpable and infectious. The conferences have recognized a need among its disparate attendees and have acted to meet that need.

Each of the conference proceedings has been captured in a reported volume—all of which are available on the Understanding Interventions website. Together they form a valuable body of information and insights into the overlapping concerns and interests of this heterogeneous community.

A prominent feature of each of the conferences has been a concluding "talk-back" session, and the 2012 session was as lively as past sessions. One suggestion was to work on ways to disseminate the approach captured by the conference to many more institutions and to more parts of those institutions. The conference has demonstrated its value to its attendees and to those with whom its attendees work. Many more could benefit, particularly if financial supports were available to subsidize their attendance.

The 2012 meeting, like previous meetings, focused on undergraduate and graduate students and on the transitions to careers in biomedical research. But conference participants recognize, of course, that the roots of underrepresentation originate not just in K–12 education but even before that. Because the conference is so flexible, it has included sessions on K–12 issues in the past and could heighten its activities in this area, particularly in the context of partnerships among institutions. One interesting suggestion was to track the success of students from different high schools and feed that information back to the schools to help optimize the preparation of their students.

The conference is about research and about practice, but it is also about the translation of research into practice, which sometimes is done by researchers, sometimes by practitioners, and sometimes by other individuals entirely. This translation process is facilitated by publications such as the ones that have emerged from each conference, but it also is facilitated by the conversations that start at the conferences and continue once the conferences are over. Many of these conversations take place informally, but they could, with sufficient support, move into a more formal venue, such as an ongoing electronic discussion that is archived along with various kinds of resources that researchers and practitioners can use. The ultimate goal would be to extend the vibrancy of the conference throughout the rest of the year and to a much larger community.

Interdisciplinary and inter-institutional meetings are inherently messy, creative, and productive. The Understanding Interventions community is diverse, and everyone in it faces challenges that are both deep and compelling. Yet when they have opportunities to interact, they immediately find both common ground and common cause. The two of us are honored to be members of this community and to participate in the process of supporting and building it.

Daryl Chubin, co-chair
American Association for the
Advancement of Science

Anthony L. DePass, co-chair
Long Island University–Brooklyn

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The Challenge and Promise of Diversity

Over the course of the 5th Conference on Understanding Interventions that Broaden Participation in Research Careers, presenters at the plenary sessions described many of the broad challenges the United States faces in increasing the diversity of the biomedical workforce. This chapter summarizes those challenges, and their corresponding opportunities, as an introduction to the topics discussed at the conference, while subsequent chapters look in more detail at undergraduate education (Chapter 2), graduate education and the transition to careers (Chapter 3), mentoring and coaching (Chapter 4), medical education (Chapter 5), data issues (Chapter 6), and interventions research (Chapter 7).

DIVERSITY AND THE ECONOMY

When the first joint replacements were made, their proportions were suited more for men than for women, observed Donna Ginther, professor of economics and director of the Center for Science, Technology, and Economic Policy at the University of Kansas. Only when women became involved was an accurate fit for women achieved. "That's just one example of how a different perspective can affect how science is done," she said.

Science is the bedrock of future economic development and growth, and greater diversity among those who do science leads to more innovation. Thus, diversity leads to economic growth, Ginther observed. As Hsieh, Hurst, Jones, and Klenow have shown, improvements in education and the diversity of occupations for white women and underrepresented minorities between 1960 and the present have increased economic growth by 15 to 20 percent.[1] "It

[1]Chang-Tai Hsieh, Erik Hurst, Charles I. Jones, and Peter J. Klenow. 2013. The Allocation of Talent and U.S. Economic Growth. NBER Working Paper No. w18693. Available at SSRN: http://ssrn.com/abstract=2199769.

should make sense to every policy maker that having a diverse, well-trained workforce can only improve things," said Ginther.

The U.S. population is becoming increasingly diverse, with a high growth rate among Black, Asian, and Hispanic or Latino populations. Whites accounted for 72.4 percent of the U.S. population in 2010, representing a 5.7 percent increase in this group over the previous decade. Blacks, representing 12.6 percent of the population in 2010, increased 12 percent over that period; Hispanics or Latinos, at 16.3 percent of the population, increased 43 percent; and Asians, at 4.8 percent of the population, also increased 43 percent.

However, the diversity of the population is not reflected in the scientific workforce. Though women have made significant gains in the life sciences and the social and behavioral sciences, underrepresented minorities continue to be underrepresented at all levels of science. Underrepresented minorities represented 18 percent of the U.S. high school population in 1994, 13 percent of life science bachelor's degree recipients in 1998, and 7 percent of the life science PhDs in 2004. "Diversity is our future, but diversity in science lags well behind the population," Ginther said.

"Diversity is our future, but diversity in science lags well behind the population."

—Donna Ginther, University of Kansas

Representation at medical schools is slightly better, she noted. Underrepresented minorities were 14 percent of the 2002 recipients of MD degrees and 9 percent of the 2011 medical school faculty. But these numbers still lag far behind their representation in the population.

Representation also varies by discipline. For example, women earn the majority of PhDs in psychology and sociology but are underrepresented in chemistry. Blacks earn proportionately more chemistry doctorates and proportionately less behavioral and social science doctorates.

In all fields, however, underrepresented minorities make up less than 10 percent of tenure track faculty. Underrepresentation is also severe in medical school faculty appointments, with non-tenure track appointments being somewhat more diverse than tenure-track appointments.

Pipeline and Career Transitions

Ginther's research examines the education pipeline and career transitions among underrepresented minorities in the sciences. Using data from a variety of sources, she has been looking at such issues as getting tenure track jobs, achieving tenure, and receiving funding from the National Institutes of Health (NIH).

Women are now more likely to go to college than men and receive bachelor's degrees. But they do not go on to graduate school in the same numbers. For those who do go on to graduate school, they are more likely to transition

from graduate school into an assistant professor position. However, they are less likely to transition from graduate school into a medical school assistant professor position.

Blacks, Hispanics, and Native Americans are less likely than whites to go to college, receive biomedical PhDs, and become assistant professors. College is the key transition for underrepresented minorities, Ginther pointed out. Blacks, Hispanics, and Native Americans are also similar to women in that they are less likely to have appointments in medical schools. Using the NSF Survey of Doctoral Recipients to study career transitions among PhDs in the biomedical sciences, Ginther examined the effects of such covariates as age, marital status, and PhD field on whether those surveyed had a tenure track job at a four-year institution within seven years of their PhD, whether they had tenure within ten years, and whether they had NIH funding within ten years. She found that women, Blacks, and Hispanics were equally likely to get a tenure track position when compared with white men, while Asians are less likely. Once on a tenure track, Blacks are more likely than whites to get tenure and women are more likely to get NIH funding. Blacks and women are more likely to be at liberal arts institutions, while men, whites, and Asians are more likely to be at Research 1 schools.

In a paper on whether science promotes women, Ginther and Kahn found that women with children are less likely to take tenure track jobs than all men and single women.[2] Ginther and Kahn also have found that single women are 13 percent more likely than single men to get tenure track jobs in life science fields, and that married women with children are 5 percent less likely to get tenure track jobs in the life sciences than married men with young children.

A research job in biomedicine is a difficult career track, Ginther observed. It requires seven years of PhD work and six to seven years of postdoctoral fellowships, so most graduates do not get their first RO1 until the age of 41 or 42. "That's a long time to wait ahead of a career if you're a woman and you want to have a family," Ginther pointed out."When you think about the diversity of the scientific labor force, you can't ignore work–life balance and the need to have supportive institutions." Relying on campus day care makes a huge difference for women with children, she said.

She also pointed out the need to improve the attractiveness of careers in biomedicine. "If you're in your mid-40s before you're an independent researcher, the opportunity cost is very high," she said. An assistant professor in biochemistry is paid in the $70,000s, while a junior economist makes over $100,000 without any postdoctoral work. "I do think that money matters, and the availability of jobs matters, so you're not going to diversify the biomedical workforce unless the career path becomes more attractive," she said.

With regard to race and ethnicity, the underrepresentation problem emerges much earlier than college, Ginther observed. Minority students come to kindergarten with learning gaps compared to white children, and the gap

[2]Donna Ginther and Shulamit Kahn. 2009. "Does Science Promote Women? Evidence from Academia 1973–2001" in *Science and Engineering Careers in the United States*, Richard Freeman and Daniel Goroff, eds. Chicago: University of Chicago Press.

gets wider as they go through the education system. On the other end of K–12 education, higher education is unaffordable for many students. And half of college graduates between 2006 and 2011 do not have jobs, partly due to more young people entering the labor market and partly because of a weak labor market overall.

From one end of the career pipeline to the other, transitions display strong differences according to race, ethnicity, and gender, Ginther observed. The transitions from high school to college and from the PhD to the professoriate are key policy points. (Aspects of these transitions are discussed in Chapters 2 and 3, respectively, in this volume.) In particular, Ginther emphasized the need to focus on growing the base of students who are eligible for graduate school.

Race, Ethnicity, and Research Funding

In 2011, Ginther and her colleagues published a widely noted paper on disparities in NIH funding.[3] They found a significant difference in the probability of receiving an RO1 award by race and ethnicity. Asians are five percentage points less likely to be funded than whites, Blacks are 13 points less likely, and Hispanics are 3 points less likely. However, the researchers could not explain the Black–white funding difference after controlling for a number of variables, including whether the research involved human subjects and whether the applicant had programs or review committee experience. The researchers controlled for nearly every variable on the biographical sketches provided with research application and were able to explain only three percentage points for Blacks and one percentage point for Asians. However, they did find that Hispanics, Asians, and Blacks are significantly less likely to resubmit grants compared with whites. "Success begets success," Ginther explained. "If you get the first RO1 you are more likely to get another."

While NIH spends considerable amounts of money on training, Ginther said, only U.S. citizens or permanent residents are eligible for these training programs, and of the research sample, only 10 percent of Asians and one-third of Hispanics fall into that category. Training improves outcomes for all applicants, but within the cohort of those with training, Blacks are still less likely to be funded compared to whites. Those coming from a top organization were 10 percentage points more likely to get funded, and applicants had an advantage even at the second-tier rank. However, the effects of publications and citations were not nearly as significant as expected.

The triage process at NIH means that some grant proposals are set aside without being reviewed by the full panel. Ginther found that 40 percent of proposals from whites and 60 percent of proposals from Blacks were not scored, and removing all unscored applications narrowed but did not elimi-

[3]Donna K. Ginther, Walter T. Schaffer, Joshua Schnell, Beth Masimore, Faye Liu, Laurel L. Haak, and Raynard Kington. 2011. "Race, Ethnicity, and NIH Research Awards," *Science* 333:1015–9.

nate the difference in awards. Only citations and prior review committee experience were significant for Blacks.

Ginther was testing a hypothesis on access to research networks. "Who you know—the tested advice that you get from colleagues, friends, and mentors—has mattered quite a lot in my career, and I can't help but believe it matters in everyone's career," she said. "I think this has a lot of promise." Ginther suggested that improvements in mentoring could help with the discrepancies in NIH funding. Her research team is also gathering information that will help determine variability in postdoctoral training among research award applicants.

THE INTERSECTION OF RACE AND GENDER AMONG WOMEN IN ACADEMIA

In their plenary presentation, Lydia Villa-Komaroff, Chief Scientific Officer of Cytonome ST, and Mahlet Mesfin, who was a National Academy of Sciences Christine Mirzayan Science and Technology Policy Graduate Fellow at the time of the conference, elaborated on the intersection of race and gender among minority women in academia and on work conducted by a subcommittee of the National Academies of Science and the Institute of Medicine on this topic. They represented the Committee on Advancing Institutional Transformation for Minority Women in Academia, which was constituted under the auspices of the Committee on Women in Science, Engineering and Medicine, a standing committee of the National Academy of Science and the Institute of Medicine. As Mesfin said, "It's easy to find information about women and science and engineering and about underrepresented minorities in science and engineering, but it's very difficult to find information about the intersection of the two."

> ***"It's easy to find information about women and science and engineering and about underrepresented minorities in science and engineering, but it's very difficult to find information about the intersection of the two."***
>
> *—Mahlet Mesfin, National Academy of Sciences*

Women, minorities, and women of color have received an increasing number of doctoral degrees in science and engineering, but the increase has not translated to more women in academic positions. Less than 1 percent of faculty are women of color, said Mesfin. Latinos represent the highest percentage, but there were only 33 Latino assistant professors and 10 full professors in the physical sciences in 2002 (the year for which Mesfin had data). Native Americans held only one assistant professorship and no tenured faculty posi-

tions at the top 50 research institutions. "These numbers are extremely small. That's why this issue is so important," Mesfin said.

Women face many subtle and not so subtle challenges. When an implicit association test was given to scientists and the general population in 30 countries, 70 percent of people had implicit stereotypes that science equals male, not female, Mesfin noted. When identical CVs with different names were shown to pre-college students, African American professors were ranked as less competent, as were women. And "the ideas that these students have actually translate very well into the experiences that some professors have had in terms of their classroom interactions with their students," Mesfin said.

Biases also arise in recruiting. Women have shorter letters of recommendation, and many have nontraditional career paths that are less well regarded by the research community. Mentoring is another challenge. Women professors without mentors have a 67 percent chance of getting grant funding, versus 93 percent if they have mentorship. Mentoring occurs more often with same-gender and same-race mentor pairs, "but if you're the one Native American professor in the country, who's going to match up with you?" Mesfin said.

Villa-Komaroff noted that women and minorities both have made progress in science and engineering, but minority women in academia have made less progress than in other areas. Diverse solutions are required to address the problem of diversity, she said. "One of the lessons we've learned over time is that as we go deeper and deeper into figuring out how it is that we bring talented people in this country into the academic world and other positions of influence and power, that what works in a particular case at a particular institution for a particular population may or may not be scalable to include other populations in other institutions."

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—Lydia Villa-Komaroff, Cytonome ST

The United States is undergoing rapid demographic shifts and economic dislocations, she noted. These create disruption and can hamper efforts to foster diversity. "People tend to get protective of their turf and worried about their position in the society," she explained. "At times like that there can be less room for people who are perceived as different."

MINORITY MALES IN STEM DISCIPLINES

Between 2000 and 2009, enrollment at the undergraduate level increased by 7.5 million, and the number of bachelor's degrees awarded rose 26 percent

at four-year public institutions. Yet this increase was primarily among whites, despite a significant increase in minority populations at four-year institutions, noted Lorenzo Esters, who at the time of the conference was vice president in the Office for Access and the Advancement of Public Black Universities at the Association of Public and Land-grant Universities (APLU), and Patrick Valdez, who was APLU's director of college access and success initiatives in the Office for Access and the Advancement of Public Black Universities. Furthermore, the number of degrees awarded to minorities rose more among women than men, and many more women than men who are underrepresented minorities now receive STEM bachelor's degrees. "This is not about pitting men against women or vice versa," Esters emphasized. "This is about ensuring that we address issues faced by all populations."

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—Lorenzo Esters, Association of Public and Land-grant Universities

More African American, Latino, and Native American females 25 or older have completed high school, obtained a GED, or completed college compared to their male counterparts, Esters noted, though among Asians/Asian Americans the reverse is true. African American males outnumbered females in only five disciplines: engineering, mathematics and computer sciences, geosciences, architecture and environmental design, and religion and theology. Latino males outnumbered females in the same five disciplines. Native American males outnumbered females only in engineering and physical sciences, and Asian/Asian American males outnumbered females in engineering and mathematics.

Analyzing data from a survey of 60,000 students in STEM fields done by the Higher Education Research Institute, Esters and his colleagues found that five-year completion rates for students in STEM at public institutions were higher for females across all races. Furthermore, the gap in enrollment by gender is only projected to widen, with male enrollment declining in absolute terms.

A Focus on Minority Males

Not many people are focused on minority males, Esters explained, so they felt the area was ripe for research. The project he described began with a planning grant supporting the APLU Minority Male STEM Initiative, which was designed to identify practices and activities that support enrollment, retention, and graduation of minority males in STEM at the undergraduate level. "The goals were to understand the factors that limit their success in higher education and prescribe some systemic remedies based on what we were told," Esters said. Their eventual goal was to work with federal agencies and develop a national agenda.

The researchers used a theoretical framework based on Bandura's social cognitive theory, which hypothesizes that particular segments of an individual's knowledge base are obtained through actual and imagined experiences. They also drew from Alexander Astin's theory of student involvement, which says that the amount of student learning and personal development associated with any educational program is directly proportional to the quality and quantity of student involvement in that program. From that framework, the researchers developed their methodology, including a survey that asked about the demographic traits of the students, what caused them to seek out STEM fields, their average household income, whether they attended public school, the characteristics of their institutions, and their activities inside and outside the classroom.

Fourteen institutions participated. Three were predominantly white, three historically Black, two with significant enrollment of Native American students, three with high enrollments of Asian/Pacific Islander students, and three Hispanic-serving institutions. All were involved in the Louis Stokes Alliance for Minority Participation program.

The researchers chose a liaison on each campus to help accomplish the goal of surveying all STEM undergraduate students of color. They also surveyed faculty in STEM disciplines. The survey contained three types of questions: demographic background information, questions about perceptions of the classroom and university, and questions about participation in programs and academic support opportunities.

The researchers surveyed 563 minority males and 441 females in STEM, as well as 137 faculty and 71 administrators. Of the male students, 93 percent were full-time students and 62 percent were juniors and seniors. The typical GPA was 3.0 to 3.49, and 55 percent were receiving Pell grants. A little less than half the sample had student loans, 45 percent had a parent with a bachelor's degree or higher, and 51 percent wanted to go on to a doctoral degree.

Survey Results

Of the students surveyed, 71 percent agreed or strongly agreed that they felt a need to prove themselves, and 71 percent also agreed that faculty were approachable and available, said Valdez, who discussed the survey responses. When asked if their professors perceived them differently than other STEM students, the largest proportion answered neither agree nor disagree. A large percentage of students did not use career and counseling services provided by the school. Students at historically Black universities, tribal colleges or universities, and Hispanic-serving institutions felt more supported by their peers than did students at other institutions, and enjoyment of STEM courses was also higher for these colleges and universities. Students at minority-serving institutions generally felt that their professors were sensitive to their cultural background and were available and approachable.

In response to a question about how much time they spent working on research with students, faculty members said that they spent an average of 15 percent of their time on research activities with freshmen and sophomores,

28 percent with juniors and seniors, and 51 percent with graduate students. When asked how their institutions tracked retention, recruitment, and graduation of males of color in STEM, many said they did not track those statistics or that tracking was up to individual programs.

When asked how much time they spent working for pay, 48 percent of students said 16 to 20 hours per week. "Many students of color will work themselves out of college," Valdez said. Support grants are crucial, he said, because students feel pressure from their family to work and contribute.

The survey findings suggest that few institutions have formal programs to recruit minority males in STEM, Valdez said. Only about 10 percent of the faculty and administrators they surveyed were able to identify specific outreach programs. Although most university administrators understand the importance of achieving racial and gender diversity on campus and understand that segments of society lack adequate representation, a majority of institutions have few mechanisms to evaluate their success in this area.

When it comes to the policy environment, Valdez said, it is necessary to prioritize STEM education interventions for underrepresented groups through the competitive grant programs and to spearhead new STEM initiatives with the business community. Working with industry, he said, can help institute programs that will get them the graduates they need.

"We cannot underestimate the role that our minority-serving institutions are playing when it comes to educating students of color," Valdez pointed out. Over 50 percent of the Hispanic-serving institutions in the United States are two-year schools, he said, and building sustainable relationships between those schools and four-year universities is an important step toward helping minority students navigate the STEM career path. It also is important to support K–12 initiatives. Quality counseling and advising in elementary and secondary schools and college preparatory courses in high school are important components of preparing students for a STEM track. In particular, students of color often do not have access to AP classes, Valdez explained. First-generation and low-income college applicants need targeted attention, and their parents need support in sending them to college.

When it comes to retention, Valdez said, protecting and expanding Pell grants and need-based scholarships and taking steps to reduce feelings of isolation among minority males on college campuses could go a long way. Universities need to help foster more meaningful and personal relationships between students and faculty and use data to track success and ensure accountability.

Valdez encouraged universities to track graduation outcomes by race, gender, and academic discipline, work toward a good fit between students and the academic process, and encourage students to participate in research and internships as undergraduates. The takeaway message from their study, he said, is to prioritize evidence-based decisions around programs and interventions, and think about how to best align core structures around students in STEM.

"We are educating students to be the next innovators of our country," Valdez said, "To do that, our programs also need to be innovative."

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—Patrick Valdez, Association of Public and Land-grant Universities

THE CHALLENGE OF PHYSICAL DISABILITIES

Accommodations for persons with disabilities can help everyone, said Brad Duerstock, director of the Institute for Accessible Science (IAS) at Purdue University. Physical accommodations such as curb cuts and automatic door openers make life easier for the elderly and people with strollers or who are carrying large loads. The value of public access typically extends well beyond its initial scope. "To me, that's the real value of diversity."

Individuals with disabilities are underrepresented both in the STEM workforce and in overall employment. In science and engineering fields, they are more than twice as likely to be unemployed as a scientist or engineer without a disability, which makes them more likely to seek out more inclusive occupations. The problems begin early. Although steps have been taken toward greater inclusion in K–12 classrooms and mainstreaming of students with disabilities, the physical tasks necessary to participate in laboratory classes can be daunting. In higher education, the changes have occurred mainly at public institutions. His own spinal cord injury occurred in high school, Duerstock said, and at the time many private colleges did not even have dorm facilities that were accessible.

High school students with disabilities are as interested in science as their able-bodied classmates, Duerstock noted, with about 18 percent of both groups expressing a desire to study a STEM field. However, as students progress through post-secondary education, attrition is substantial, resulting in proportionally far fewer students with disabilities enrolling in graduate school in STEM areas and only about 1 percent of all PhDs in STEM fields going to people with disabilities. Duerstock suggested that many high school students have not thought ahead to college, because they and their parents are preoccupied with the challenge of getting them through high school. Many go to community colleges because they can live at home and continue receiving assistance from their parents.

Both attitudinal and physical barriers prevent students with disabilities from succeeding in STEM fields. Institutional support is spotty. Even in public institutions with assistive technology centers, students often cannot actively participate in classroom activities. They may be relegated to passively recording data and watching experiments without engaging in them.

The next frontier for advancing the inclusion of students with disabilities in STEM disciplines is to provide them the hands-on experience they need to do well in those fields. Learning science is very dependent upon being able to

perform scientific activities. "Any person with a disability can pursue a career in science, that's what I truly believe," Duerstock said.

> ***"Any person with a disability can pursue a career in science, that's what I truly believe."***
> *—Brad Duerstock, Purdue University*

Toward Accessibility in STEM

The goal of the Institute for Accessible Science is to give students the tools they need, but it is up to them to become as independent as possible. Having the ability to conduct graduate research to some degree independently, whether during data collection or data analysis, is critically important to empower individuals with disabilities to pursue careers in STEM. Duerstock's objective at the Institute for Accessible Science is to give students the tools, the practical learning experiences, and the professional development that will help them succeed.

The IAS has two major initiatives. One is an online hub, IAShub.org, where students can participate in discussion groups and find resources. The hub is also working on providing accessible laboratory tools online. In addition, the IAS is working on developing special tools and computerized technology to assist students with disabilities in performing common laboratory techniques. In particular, pipetting and microscope use are two of the more challenging tasks, Duerstock said. One of his first grants was to develop a microscope for individuals with upper limb mobility and visual impairments. The use of alternate user interfaces, including gesture and speech recognition technologies, can enable students with disabilities independent operation of scientific instruments and robotic assistants.

The second major initiative is the Accessible Biomedical Immersion Laboratory (ABIL), which encompasses both a physical laboratory space and a 3-D virtual simulation for users to access through IAS hub. The physical wet laboratory developed as part of IAS has a work triangle, which includes an accessible fume hood, laboratory sink, and laboratory bench, that fosters a more effective work flow, Duerstock said. The arrangement is based on ergonomic testing, and aspects of the space also can relieve work-related stress injuries for able-bodied students. In addition, safety is an important consideration for persons with disabilities. Modifications are necessary to ensure that the emergency shower and eyewash are accessible to wheelchair users and that students who do not have sensation or strong eyesight are adequately protected from spills and fires. Robotics are becoming a more affordable choice and can be incredibly helpful in the laboratory. Three-dimensional computer visualizations are helpful in creating standards for best practices.

A group that raises interesting challenges is students with disabilities who want to be physicians, Duerstock said. Although the technical standards for medical school are changing, it can be tricky to ensure that graduates can meet the core competency requirements established by certifying bodies.

Promoting Accessibility

Recruiting students to use the IAS hub has been a challenge, Duerstock said. One way to overcome this challenge has been through the role model series, which highlights someone in the online community on the site. Another popular option has been summer research fellowships, which at the time of the workshop were being initiated to put candidates in laboratories of their choice with necessary support to be part of an established program. Additional plans were to publish weekly or monthly stories as part of the hub in which students are interviewed and the use of assistive technology in the laboratory is described.

In the long term, offering graduate fellowships to students with disabilities would be an especially promising approach, Duerstock said. A small survey of interdisciplinary life sciences programs revealed that at most 20 percent of the faculty had experience with a student with a disability, and most of those were with students who had some type of learning disability. However, most of the researchers surveyed were favorable to the idea of working with students with disabilities, although they did not know exactly how they would adapt for a particular student. The most receptive faculty were those with tenure and established laboratories with staff and students, since they tended to have greater ability to support a student with a disability.

Junior faculty may be constrained by limited funding, he said. Most faculty do not know how to get financial support and accessible equipment. Supplements exist for NIH and NSF grants, but that information is not always widely available. "We just don't know how to fund students with disabilities," Duerstock himself benefitted as a postdoctoral fellow from supplemental NIH support. "It makes a big difference, but your advisor must have an active NIH or NSF grant," he said.

A long-term perspective is essential, Duerstock concluded. Support for researchers and teachers is an important part of accommodating students with disabilities. Accessibility specialists should be involved in new construction projects on campuses. Accessibility is important not just for individual students today but for future generations.

2

Undergraduate STEM Education

As at previous Understanding Interventions conferences, a major focus of the presentations was interventions at the undergraduate level that can increase the number of underrepresented minorities who choose to pursue graduate school and careers in science. In all seven of the presentations summarized in this chapter, the theoretical frameworks and designs of the interventions were emphasized, reflecting the conference's overlapping interests in research and practice.

ATTITUDES AMONG AFRICAN AMERICANS TOWARD STEM COLLEGE MAJORS AND CAREERS IN ARIZONA

By 2018 the state of Arizona will have 68,000 computer and mathematics positions, 35,000 engineering positions, and 26,000 positions in the life sciences, physical sciences and other sciences that are currently filled or available. It is critical that the talent pool filling those jobs comes from within the state, said Jerlando F. L. Jackson, Vilas Distinguished Professor of Higher Education and director of Wisconsin's Equity and Inclusion Laboratory (Wei LAB) at the University of Wisconsin at Madison, and LaVar J. Charleston, assistant director and senior research associate at Wei LAB. The workforce should be culturally and ethnically diverse and representative especially of the state's African American population.

But the number of African Americans earning degrees relating to STEM occupations has not kept up with Arizona's STEM economy, explained Charleston. This lack of a viable STEM workforce, not only in Arizona but through the United States, increasingly threatens the economic and global competitiveness of states and the nation as a whole. "These challenges not only affect the viability of the United States as a global leader and competitor with regards to science and technology, but they also affect the social well-being of citizens within the United States," Charleston said.

Theoretical Framework

Charleston and his colleagues conducted a study based on Banduras's theory of self-efficacy, which posits that behavior is predicated on outcome expectations, efficacy expectations, and past learning experiences. "Outcome expectations embody the idea that an individual's confidence dictates behavior that will lead to a positive outcome," Charleston said. "When you look at behaviors, choices, and decision making with regard to education and occupational attainment, the consequences of performance, as well as some incentives and some justification of those incentives, will dictate what individuals choose or how individuals choose to pursue their educational and occupational career paths."

A body of literature has been growing around self-efficacy theory and occupational choice, particularly in STEM fields. Self-efficacy indices are strong predictors of career behavior, Charleston said, and studies have determined that self-efficacy decreases as a result of failure, particularly among students of color in science and math. The researchers therefore looked at the alignment among attitudes, confidence, and STEM decision making among African Americans in the state of Arizona, asking if their attitudes toward STEM fields influenced their decisions to pursue college degrees and careers in STEM and what other factors were significant in leading students to pursue STEM degrees and careers.

Jackson explained that their study was part of a larger initiative funded through the State of Black Arizona, an ongoing project that looks at issues and challenges for the state and that has recently been emphasizing STEM fields. Drawn from networks and collaborations that were already in place, the researchers worked collaboratively with State of Black Arizona project leaders to build a dataset on STEM attitudes and survey data. "The data collection process used some traditional and some very creative spaces to try to get those voices," Jackson said. It drew on churches, community events, and community listservs to gather responses, eventually surveying 634 people. About 61 percent of respondents were female, and the sample had an average age of 48.

Whether respondents pursued a STEM major in college and whether they worked in a STEM field were considered dependent variables. Independent variables included a set of background variables and variables around attitudes, such as whether participants believed society valued the work of STEM professionals, whether they felt STEM jobs were high paying, and whether they perceived that their family would provide support if they went into a STEM field.

Major Findings

Jackson discussed the five most interesting findings that resulted from the survey.

First, being female had a significant positive relationship with pursuing a STEM career. In 2007, women earned the majority of degrees in biology,

agriculture, and chemistry, and since 2002 women have earned about half of all science and engineering degrees.

Second, age showed a significant positive relationship with pursuing a STEM career. Jackson pointed out that the age variable was likely related to the skills, abilities, and temperaments of the participants. Being older increases the likelihood that cognitive demands match the skills, abilities, interests, and goals necessary to pursue a STEM career.

Third, African Americans who seriously considered selecting a major in STEM were more likely to pursue STEM majors and careers. "What we found was that it wasn't just the cursory exposure of African Americans to these particular fields of interest; it was rather a sustained and important type of engagement that allowed these interested students to see that they could build a career in this space and that they wouldn't be completely alone," Jackson said. The findings tie in well to what researchers know about the role social networks play in shaping career desires and aspirations.

"It wasn't just the cursory exposure of African Americans to these particular fields of interest; it was rather a sustained and important type of engagement that allowed these interested students to see that they could build a career in this space and that they wouldn't be completely alone."

—Jerlando F. L. Jackson, University of Wisconsin at Madison

Fourth, African Americans who believed they had the ability to obtain a degree in a STEM field were more likely to pursue STEM majors and careers. This finding is linked to self-efficacy, Jackson pointed out.

Finally, participants whose family supported their efforts to pursue a STEM degree were more likely to pursue STEM majors and careers. Family support remains a critical aspect of college and degree selection for African American students, and moving into academic fields viewed as "new" is difficult without a strong support network.

CREATING INNOVATORS THROUGH FRESHMAN RESEARCH AT THE UNIVERSITY OF TEXAS AT AUSTIN

"What we're seeing in Texas as we become a majority-minority state is something that many states are facing or will face soon," said Sarah Simmons, assistant dean for honors, research, and international studies in the College of Natural Sciences at the University of Texas at Austin. The Texas population, particularly the Hispanic population, is growing much faster than the national population. But bachelor's degree attainment for Hispanic Texans is only 11 percent historically, and 42 percent have less than a high school

degree. "We're going to be dealing at our institutions with an abundance of potential talent," Simmons said, "but we have yet to demonstrate that we can handle that."

The University of Texas, Austin, has developed a program that significantly increases the number of science, technology, and mathematics graduates—the Freshman Research Initiative (FRI). This program has significantly improved recruitment, retention, and success in STEM for groups traditionally underrepresented in the sciences. "We've learned important lessons about what you can do when you look at the institution's needs, resources, and the particular barriers you face as an institution to involving more students in science," said Simmons.

Undergraduate research programs have existed for decades and have strong data showing that involvement and engagement can change the trajectory for students, allowing them to persist and succeed in STEM fields. But such programs have capacity maximums in the University of Texas schools, Simmons said. With 10,000 undergraduate science majors and 400 faculty, the ratios do not add up, given the time it takes time for faculty to develop projects that are appropriate for undergraduates. "The traditional approach favors students who already understand the process and understand academia," Simmons said, "and this is disproportionately affecting our students who are underrepresented in the sciences."

The University of Texas has had financial support for undergraduate research for a long time, she explained, but they were mostly recruiting students in their junior and senior year. By that point, many students had already lost interest in science. Moreover, the faculty who were supporting students in undergraduate research were doing so without recognition, and undergraduate research did not feed into any kind of traditional reward structure.

A Focus on Faculty Member Research

With support from NSF, the faculty developed a program to tap research resources for students and improve retention and training by taking the freshman laboratory experience and changing it to focus on faculty member research. The program is six years old and has had over 2,100 students participate. In spring of 2012, 687 students were placed in research experiences as freshmen—25 to 30 percent of the incoming natural sciences class.

The FRI teaches the same core competencies as a traditional freshman laboratory, Simmons said, but in the context of existing research at the university. Often the piece that becomes part of a class is something a faculty member did not have time for or found too risky for a graduate student. Freshmen have the time to spend on such research, and their graduation does not hinge on getting results. If they decide they like research, there is time to provide them with further training and mentorship. By looking for that passion and engagement right away, instead of waiting until junior or senior year, student success has been greatly increased.

The program also allows any student who meets the mathematics requirement to participate. Class rank, SAT scores, and AP scores are irrelevant,

and participants are randomly selected from the pool of qualified applicants. The success of the program has demonstrated to faculty that these statistics do not really matter to student success, Simmons said.

The program makes it easy for program directors and students to say yes to by keeping the costs down and by helping students translate what they are doing into something they can explain to their parents. The program is also made easier on faculty by hiring research educators—postdoctoral level scientists trained in the faculty members' area of research who take on responsibility for supervising the student research groups.

Results

Recruitment has been successful at representing the diversity of the college, she said, with an eventual goal of representing the diversity of the state. Retention in STEM and graduation rates have dramatically increased, with 35 percent more students graduating with science or mathematics degrees. A quarter of the students entering the program are first-generation college students, a quarter are Hispanic, and the program has contributed to a doubling of the graduation rate for Hispanic students.

"Experience has shown that students learn science by doing science, and we think this kind of training is the way we should be doing introductory science at our institution," Simmons said. "We have looked at our issues and our resources and come up with a strategy that has changed everything for us."

> ***"Students learn science by doing science, and we think this kind of training is the way we should be doing introductory science at our institution."***
>
> *—Sarah Simmons, University of Texas at Austin*

In the question and answer session after her presentation, Simmons addressed the issue of cost. The school found that when the program was broken down by cost, credit, and semester hours per student, it was no more expensive than the traditional laboratory or lecture series. She added that it is important for programs to have information about costs and benefits available to industry and voters to boost investment in successful models.

DEVELOPMENT AND IMPLEMENTATION OF DISCOVERY-BASED MODULES AT AN UNDERGRADUATE CELL BIOLOGY TEACHING LABORATORY

"I think we have, as a community of intervention researchers, a great opportunity," said Franklin Carrero-Martinez, associate professor in the department of biology at the University of Puerto Rico, Mayaguez. Carrero-Martinez started doing outreach in his own laboratory by allowing a group of under-

graduate students to be a professor for a day and practice their mentoring skills. It was going very well, he explained, but he could accommodate only about ten students at a time.

Funding from NSF and the Howard Hughes Medical Institute allowed Carrero-Martinez to begin offering students opportunities in the teaching laboratory. Most teaching laboratories are recipe based, he explained, and students know the answer before they start. For this program, he increased the matrix of potential answers so that it was impossible for the students to figure out the solution ahead of time.

Carrero-Martinez initially implemented this module four times in two different classes, and through the funding from HHMI he was able to do the same in ten other courses. Rather than taking on only small, specialized courses, he decided to work with larger classes and engage other professors. One example was the plant biology module, where the large botany group on campus was able to provide expertise and technical knowledge. Carrero-Martinez sat through the teaching laboratory at the beginning of his project and realized how bored students get. "That's key," he explained. "If you are trying to change something that you don't understand, your effectiveness is going to be limited."

"If you are trying to change something that you don't understand, your effectiveness is going to be limited."

—Franklin Carrero-Martinez, University of Puerto Rico, Mayaguez

Building Investment in Science

Putting a compelling story behind laboratory work helps students feel invested in science. "If you want this to be successful, you have to engage them," Carrero-Martinez said. "If they have an open-ended experiment and they have to prepare 20 buffers, it's not going to work." Access to equipment and tools is also important, since cost is a consideration. In his laboratory modules, students have certain freedoms, but there are restraints on the experiments, which makes life easier for the technicians and coordinators.

The project took place in different cycles, Carrero-Martinez explained. The first was a development round with local experts, where he talked to professors teaching other sections, engaged laboratory coordinators, and spoke with technicians and teaching assistants. Next was a low-scale implementation where one teaching assistant had a control section and an experimental section. Assessment data from that comparison then informed a large-scale implementation.

One of the most important things learned from the study is that there has to be a manual for implementation, Carrero-Martinez said, one for the students, and one for the teaching assistants. "It is really important that you provide them with the tools to do it well, otherwise the whole thing

fails," he said. Giving the teaching assistants a sit-down session for training is invaluable in helping them implement the framework correctly. An undergraduate from the teaching lab also helped modify the protocols, which Carrero-Martinez pointed out must fit the time constraints of the teaching laboratory. Start from the basics and watch out for simple things that can go wrong, he concluded. But for him, "things are working out great."

OVERCOMING ENVIRONMENTAL BARRIERS TO STUDENT SUCCESS THROUGH UNDERGRADUATE RESEARCH

Jeffrey Xavier, senior consultant at SageFox Consulting Group, described a project that he said represented the meeting of two worlds. SageFox, an evaluation firm that also receives funding and resources to do more basic types of research, set out to evaluate programs that are part of the NIH-funded Minority Opportunities in Research Experience (MORE) project. Their results, Xavier said, "really drive home the point that well-funded intervention programs can make a difference and can help students overcome real barriers in their lives."

"Well-funded intervention programs can make a difference and can help students overcome real barriers in their lives."

—Jeffrey Xavier, SageFox Consulting Group

The evaluation focused on the Minority Access to Research Careers (MARC) and Research Initiative for Scientific Enhancement (RISE) programs, which are designed to get undergraduate underrepresented students into PhD programs and assist them in becoming independent researchers. There are four key supports that the programs provide for students: laboratory research experiences, mentoring and advisement, academic support, and financial support.

Between 2004 and 2011, SageFox studied the programs at California State University, Los Angeles; San Francisco State University; and New Mexico State University. "What made these schools so interesting was their demonstrated success as a result of having the programs in place," Xavier explained. Research began with the cohort of students between fall of 2005 and spring 2007. The researchers collected data through large-scale surveys of program participants, asking them about their background and the impact of the program and the research experience. They also collected information such as high school GPA and standardized test scores through institutional records.

In 2010 the researchers followed up with students to see if they were on track for a PhD. Since not enough time had passed for many from the initial cohort to have completed a PhD program, proxy measures were used for success and student outcomes were categorized. Students who earned a bachelor's and went on to a master's program, or received a master's and

entered a PhD program, were considered successfully "on track" for a PhD. While admission to medical school or other professional schools is an accomplishment, Xavier pointed out, it was not the aim of the program, and so those students were considered unsuccessful.

While their original sample was 185 students, only 48 responded to the follow-up survey. The researchers found a significantly lower response rate when students had English as a second language. However, other predictor variables did not show significant differences, so the researchers felt comfortable saying that the respondents were representative of the cohort as a whole. The low response rate demonstrates the importance of laying a firm groundwork that allows the tracking of students over the years, Xavier pointed out.

Results of the Survey

About 70 percent of respondents were on track for a PhD, Xavier explained. Those who reported speaking English as a second language were significantly more likely to be on track for a PhD than those for whom English was their first native language. Those coming from an area where fewer than 20 percent of the population in their zip code had a bachelor's degree were also significantly more likely to be on track for a PhD than those coming from areas with higher rates of bachelor's receipt. Respondents coming from areas considered to be high poverty were no less likely to be on track than respondents coming from more affluent areas.

When the researchers looked at the different tracks students took through school, they found that having a parent who attended college did not significantly influence their success, but studying at a community college did. Students who went to community college were more likely to be on track than those who started at a four-year institution. None of the measures of academic preparedness, such as high school GPA, test scores, or university GPA, had a significant impact on whether or not a student was on track for a PhD.

"We believe that this study supports a notion that the NIH MORE programs are capable of helping students overcome significant barriers in their lives in three key areas," Xavier said. The programs can help students overcome obstacles when approaching the PhD track in a nontraditional way, overcome environmental barriers such as coming from poor or less educated areas, and overcome weak academic preparation. The study is an important first step in demonstrating the importance of programs like MORE and the ability of students who may not look good on paper to exceed expectations, Xavier concluded.

CHARTING UNDERREPRESENTED STUDENT INTEGRATION INTO THE SCIENTIFIC COMMUNITY

Mica Estrada, a research faculty member at California State University, San Marcos, discussed a longitudinal study that began in 2005. The study draws from over 50 campuses nationwide, 25 with RISE minority training programs and 25 without, and there are 1,420 students in the panel, recruited

because they were highly interested in being in the sciences. Data are collected twice a year through an online portal, and the study just completed its seventh year, with 13 waves of data and at least a 70 percent response rate for each.

The panel is about 72 percent female, Estrada said. Half the panel is African American, close to 40 percent is Hispanic or Latino, and 1 percent is Native American. When the study began, 63 percent of the students had declared a biological sciences major, 21 percent natural sciences, 12 percent behavioral and social sciences and 4 percent mathematics and engineering. "This was representative of the demographics of the RISE program at the time," Estrada pointed out. Most of the panel had graduated, and students were moving into careers.

The researchers used the Tripartite Integration Model of Social Influence, which Estrada called simple but useful. The model, which comes from research in the 1950s and 1960s on social influence, looks at what variables predict whether someone will integrate into a community. For the scientific community, the most important variables are self-efficacy, scientific identity, and the values of the community. Looking at wave four of the initial data set, researchers found that all three variables were positively related to integration. "When people feel they can do the work of a scientist, they feel they are a scientist and they endorse the values of that community," she said. "They are more likely to state that they are going to stay in the sciences."

"When people feel they can do the work of a scientist, they feel they are a scientist and they endorse the values of that community."

—Mica Estrada, California State University, San Marcos

Study Results

The research team published an article in 2011 in the *Journal of Educational Psychology* examining what happens when all three variables are considered simultaneously.[1] What they found, Estrada explained, is that when all three variables are used, there is not a significant relationship between self-efficacy and integration. Instead, what drives the relationship is scientific identity. "Those who have and build a sense of scientific identity are the people who are most likely to continue and to feel integrated into the scientific community," she said.

[1]Estrada, M., Woodcock, A., Hernandez, P., & Schultz, P. W. (2011). Toward a social influence model that explains minority student integration into the scientific community. *Journal of Educational Psychology*, *103*, 206-222.

To see what happens as students move through the pipeline, the researchers divided the study group into three sections: those employed in a scientific career field, those who have left the sciences, and those who are employed in medicine or attending medical school. The researchers asked the study participants if they felt they were able to use scientific language and terminology, analyze data and report research results. For those who stayed in the sciences, self-efficacy remained fairly consistent throughout the time of data gathering. For those who dropped out and those pursuing medical careers, self-efficacy declined.

To test scientific identity, the researchers asked students for their level of agreement with statements such as: "in general, being a scientist is an important part of my self image," "I am a scientist," and "I have a strong sense of belonging to the community of scientists." The identities of people still in the sciences did not decline or increase. For those who left the sciences, there was a decline, and the researchers also saw a significant downward trend among those pursuing medical careers.

For scientific values, the last measure, the researchers asked participants how they related to statements about thinking research is valuable, building scientific knowledge, and thinking it is important to identify truths about the scientific method. Their results mirrored those for identity. Students that remained in science had high endorsement of the values, which remained high for the duration of the study. For those in medicine and those who left the sciences, belief in those values declined.

Recommendations for Programs

Estrada gave several recommendations for programs, including incorporating activities that sustain efficacy, providing students with the opportunities to practice scientific skills, and consciously building a sustained identity for students. The context needs to support the maintenance of a scientific identity and sense of belonging, she said.

"There is not a lot of active conscious intention to endorse and show why it's important to believe in the values of the scientific community," she said. "Communicating the values of the discipline and why it is important to continue to embrace them might be a good thing to do within an intervention program."

UNDERSTANDING THE EFFICACY OF EXEMPLARY STEM PIPELINE INTERVENTIONS

A growing literature on role strain and adaptation suggests that the efficacy of exemplary pipeline interventions to broaden participation in STEM research careers may be both impeded by multilevel social psychological risks facing underrepresented students and enhanced by a strong intervention support system and multilevel social psychological strengths. Phillip Bowman, director of the National Center for Institutional Diversity (NCID) at the University of Michigan, described a project that used this framework to study two established and respected research career pipeline interventions. Though

he did not describe the findings from ongoing data analysis at the conference, the theoretical framework he used could be applied elsewhere with other pipeline interventions for underrepresented students.

The CIC-Summer Research Opportunities Program (CIC-SROP) is a nationally recognized pipeline intervention for talented undergraduate students from underrepresented groups. It was developed in 1986 by the Committee for Institutional Cooperation (CIC), an academic consortium of 12 major research universities. These universities produce 15 percent of all U.S. PhDs and 20 percent in some fields, including chemistry. The program recruits students from historically Black colleges, Hispanic-serving institutions, tribal colleges, and others for an eight-week summer program. Over 11,819 students have participated in the SROP, and over 3,000 of these students have pursued graduate studies.

In addition to CIC-SROP, the Undergraduate Research Opportunity Program (UROP) at the University of Michigan takes place during the academic year and also has received widespread recognition for its success. While CIC-SROP gives intensive activities to advanced undergraduates during the summer, UM-UROP gives first-year students research experience during the school year. Both CIC-SROP and UM-UROP are "strong" pipeline interventions that provide students with a faculty-mentored research-related experience and multiple support components. Students have faculty mentors, staff support, and supervised research projects, including reports and presentations. These strong pipeline interventions also provide enrichment activities, graduate study planning, and faculty research career socialization. Bowman focused on the CIC-SROP program during his presentation.

Effects on Outcomes

The study design was a quasi-experimental survey, with data collected once before students started the program and three times after program completion. Researchers considered three groups of participants: CIC-SROP participants, applicants who did other summer research, and those without a summer research experience. They were particularly interested in the combined effects of intervention participation, objective and subjective risk factors, and multilevel social-psychological strengths on STEM outcomes among UR students. The first question addressed by the study was whether CIC-SROP has significant positive effects on participants' STEM research career plans, undergraduate major plans, PhD plans, and longer-term outcomes. Several research team members are also investigating other strengths-based questions, including whether the effects of strong multi-component pipeline interventions may be moderated by both risk and protective mechanisms. Preliminary findings from ongoing data analysis are presented in the 2013 doctoral dissertation by K. Williams at the University of Michigan entitled "Financial Impediments, Academic Challenges and Pipeline Intervention Efficacy: A Role Strain and Adaptation Approach to Successful STEM Outcomes for Underrepresented Students," doctoral research by T. Bailey entitled "Organizational Support, Program Satisfaction and STEM Research Career Plans in Pipeline Interventions: A Strengths-Based Approach among Underrepre-

sented Students," and the 2014 article by Bowman and A Ebreo "Rethinking STEM Pipeline Interventions: A Strengths-Based Approach for the 21st Century" (to be published in volume 28 of the Readings in Equal Education Series published by AMS Press).

This strengths-based approach is based on the social-psychological formula that personal and environmental characteristics interact to influence behavioral outcomes. Social cognitions are a major focus, which Bowman described as perceptions that link the person and environment or how people perceive their experiences or make meaning of their environment. Self-efficacy, perceived barriers, and perceived social support both within and outside the intervention setting fall into this category. "These subjective factors tend to be powerful predictors of outcomes," he explained. "Successful STEM outcomes not only depend on the objective impact of interventions, but also on how underrepresented students subjectively react to risk factors and subjectively connect to supportive resources."

The ongoing dissertation analysis by Williams will further clarify how both objective and subjective risk factors impede successful outcomes in pipeline interventions, which could be financial barriers, academic barriers, and related distress. Bowman pointed out that the comprehensive strengths-based approach also considers how successful STEM outcomes may be enhanced by both strong program organizational support and the unique cultural strengths that underrepresented students bring to pipeline intervention settings. The dissertation analysis by Bailey will explore how formal and informal organizational support within strong pipeline programs with multiple components may be linked to successful STEM outcomes among underrepresented students. Outcomes are often reduced to just what happens in the summer, Bowman explained, but extended family support systems and other factors outside the intervention setting influence outcomes in ways that deserve examination.

One of the reasons Bowman and his NCID-Diversity Research and Policy Program team did the study was to look systematically at risk and protective processes that are modifiable. "These are things that the program can become more aware of and use to invoke formal and informal changes in the way in which the program operates that could enhance the intervention's outcomes." In this way, emerging strengths-based findings can provide policy-relevant information for program directors to "rethink" traditional deficit assumptions and better understand modifiable factors that impede and promote intervention efficacy. The translation of such strengths-based findings to guide innovative support strategies can, in turn, enhance the efficacy of pipeline interventions by increasing the number of underrepresented participants who benefit.

MECHANISMS TO ENHANCE PSYCHOLOGICAL SAFETY IN STEM RESEARCH TEAMS

Adelita Cantu, assistant professor in the School of Nursing at the University of Texas Health Science Center at San Antonio, described several valuable lessons that she and her colleagues learned from the review of a proposed project. They submitted an RO1 application called Demonstrating Effective

Cohort Learning and Research Enhancement (DECLARE), which was designed to understand and inform interventions that promote the research careers of undergraduate students in the biomedical and behavioral sciences. Partner organizations were the University of Texas Health Science Center at San Antonio and the University of Texas, San Antonio (UTSA).

Their proposal was a randomized controlled prospective cohort longitudinal study designed to increase understanding of mechanisms that contribute to the transition of a diverse group of undergraduate students, particularly students who have not yet decided on a major when they enter school, to planned pursuit of majors, research training, and careers in the behavioral and biomedical sciences. At UTSA, Cantu explained, surveys revealed that over 50 percent of freshmen were undeclared, and statistics show that over 50 percent of that group drop out of the system.

In the original grant, the researchers used a social cognitive learning theory base to design their interventions. They designed an integrated series of interventions meant to build interdisciplinary research teams. Level one interventions were directed at undeclared students, while level two interventions involved students within the level one cohort who declared a biomedical or behavioral sciences major.

Their hypothesis, Cantu explained, was that students who engage in goal setting and envisioning a future where research can improve the well-being of vulnerable populations are more likely to move into a science field. Goal setting and envisioning activities will help students feel that they are giving back to their community. The model, which is called Mechanisms for Enhancing Scholarly Achievements (MESA), has a social cognitive base that looks at moderators and mediations that promote research careers. One of the variables is team psychological safety, meaning the degree to which the team work environment provides a context for collaborative engagement and open competition. Psychological safety allows members to feel that they can take risks, Cantu said, and have confidence that if they do take risks, they will be safe.

Their hypothesis was that students who engage in goal setting and envisioning a future where research can improve the well-being of vulnerable populations are more likely to move into a science field.

—Adelita Cantu, University of Texas Health Science Center at San Antonio

Reaction to the Proposal

On first submission of the research proposal, a reviewer commented that the intervention plan could use more attention to the expectations and support of the team. Interventions dosages were expected to trump individual or

team characteristics, but little was known about the mentors of the teams, so the reviewers suggested a survey of some potential mentors.

In response, the team from UTSA asked 33 mentors to answer questions about team psychological safety. They asked questions about variables for a successful mentor–mentee match and their impact on psychological safety. Three variables were significant on the survey. The first, Cantu said, was the possibility of accommodating different working styles between mentor and mentee. The second was participation with collaborators from outside the research team. The third was multidisciplinary representation of participants on the research team.

This was a survey at a large university where many disciplines are represented, she said, which may have influenced respondent perspectives. The narrative results from mentors identified common intellectual interests, open communications, and respect as qualities facilitating a good match in a mentor–mentee relationship.

Barriers to a good relationship, according to the survey respondents, were time constraints, lack of communication, inflexibility, and low confidence on the part of the mentee. Positive qualities for a mentor were passion for learning, patience, honesty, willingness to share time, enthusiasm, and experience being mentored.

The researchers submitted their proposal for a second review, and the reviewers in the second round felt that they had answered the first reviewer's concerns. At the time of the conference, Cantu said, the research team had a better idea of what builds team dynamics in a mentor–mentee relationship and how better to support the interventions of faculty members.

3

Graduate Education and the Transition to Careers

Students attending graduate school have made a commitment to pursuing careers in their chosen field. But for underrepresented minorities, attrition continues to occur throughout graduate school and during critical career transitions. The six presentations summarized in this chapter examine interventions designed to reduce attrition and position young scientists to have productive and rewarding careers.

DREAMS OF BALANCE: THE INTERSECTION OF EXPECTATIONS, BALANCE, ISOLATION, AND CONNECTIONS EARLY IN PHD TRAINING

Lynn Gazley, a medical sociologist at Northwestern University at the time of the conference, discussed a study done by the Scientific Careers Research and Development Group at Northwestern focused on work–life balance. Women in sciences are much less likely to get tenure at top institutions, she said, and that statistic is often attributed to issues of balance. However, another line of research says that both women and men have an increasing desire for work–life balance. "We know that career trajectories toward academic science begin a long time before you submit the tenure file," Gazley pointed out. "What we need to know is how these issues of balance play into decisions that are being made at each stage along the way."

The research team did a sub-study of 54 PhD students in their first year of graduate school, pulled from the National Longitudinal Study of Young Life Scientists, a longitudinal quantitative study that conducts annual interviews with graduate students. This sub-study analyzed interviews with students at the beginning of their first year and another set of interviews when students reached the end of their first year, focusing on questions about career

track, factors influencing career choice, and how those factors varied among different groups and changed over the first year. In the larger study, Gazley said, researchers had recruited 533 students, 320 of whom were going on to graduate school. Of those, 98 were recruited as undergraduates, 31 as post-baccalaureate students, and 167 as they were entering graduate school. The group had 204 women and 116 men, with 198 students identifying as white, 55 as African American, 29 as Asian/Asian American, 63 as Hispanic, and 6 as Native American.

The sub-sample is less diverse than the overall cohort, Gazley explained, which was partly a timing issue. Of the 54-student sub-sample, there were 28 women and 26 men. Nine came to school either married or in a committed partnership. A quarter said they wanted to become principal investigators, another quarter wanted a teaching-focused career at a smaller institution, 15 wanted to go into academia, and another quarter indicated a desire for a career in industry.

Themes of the Responses

The researchers began by reading interview transcripts and pulling out recurring themes. Balance was a major concern among the sub-sample population. Researchers have argued that women are looking for flexibility, Gazley said, that there is a glass ceiling or a maternal wall creating barriers to women's advancement, and that contemporary family forms are leading to a more general concern about balance. Some also posit that norms about family balance are set against norms of long hours and putting science first.

"These students are already taking their future families into account," Gazley explained. Of the sample, 36 said they definitely planned to have children, and a partly overlapping group of 36 said they were considering their future family when making decisions. Students also were thinking about time, flexibility, money, and location. However, they were mostly concerned with their day-to-day responsibilities. "For these students," Gazley said, "long-term notions about family and flexibility are very important in their long-term career planning, but in their day-to-day right-now first year of graduate school, what they are really looking for is how to manage their discretionary time."

The researchers asked students about particularly challenging or stressful times. One student's response was "Besides all the time?" One of the reasons the first year of graduate school is so stressful, Gazley explained, is the three-pronged nature of juggling coursework, rotations, and a personal life. Of the sample, 19 students said they felt pretty balanced within the first six weeks of graduate school. Ten of those students maintained their balance, three started confident but felt less balanced by the end of the year, and six students did not talk about balance at the end of the year. Of the 22 students that began out of balance, 7 reported being able to find balance, 10 still felt out of balance, and 5 did not say. Three students left graduate school. One thing the research found, Gazley said, was that the students who talked about balance were not as focused on individual tasks as on how they categorized tasks.

The study focused on choosing a dissertation laboratory as a pivotal career point. Students were concerned with scientific interest but also ideas about fit. Three areas mattered in laboratory choice: their sense of social integration, expectations for work style, and a feeling of social support. Social integration meant having a network of peers who felt like family, while social support was more related to finding encouragement and career support in the laboratory. Students who found a social home with their graduate school community were able to get work done and feel connected. "It's a complicated navigation that these students are doing to be able to find the right place for them," Gazley said. Balance was tightly connected to social support, access to networks, and career expectations, as well as how students thought their scientific interests might change and develop. Many students took up teaching assistant responsibilities, and encountering teaching for the first time played into their decision making.

To determine how to use the study to improve programs in the future, the researchers asked students what they wished for in terms of preparation. Students answered that undergraduate programs should facilitate strong time management skills and help students create strategies for balance and identify their needs. Graduate programs then should help students integrate socially, make time expectations clear, and improve time management and prioritization skills. "Students need to know things like when is course work important, when is lab work more important, and when is taking care of me more important," Gazley pointed out. To avoid built-up stress, students also need to be able to identify issues early.

"Students need to know things like when is course work important, when is lab work more important, and when is taking care of me more important."

—Lynn Gazley, Northwestern University

The study supported the hypothesis that balance matters for women, but they also found that balance was a consideration for men. In addition, balance is both a future concern and a day-to-day concern for students. Undergraduate programs can provide models of working scientists, but students also need a model of what a balanced graduate student looks like. Although students are entering school with a pretty firm idea of where they want to go, their choices are malleable, Gazley pointed out. "It is really critical that we provide meaningful support around these questions for all our students' trajectories, and not just the PI-bound students," she said.

STRUCTURED INTERVENTIONS FOR UNDERREPRESENTED STUDENTS AND FACULTY MEMBERS IN STEM

Before PROMISE, which is Maryland's Alliance for Graduate Education and the Professoriate (AGEP) program led by the University of Maryland, Bal-

timore County (UMBC), was instituted in 2003, the alliance, which includes the University of Maryland, College Park and the University of Maryland, Baltimore, had 81 underrepresented STEM PhD graduates. Between 2007 and 2009, 127 underrepresented students graduated with PhDs, said Renetta Tull, associate vice provost for graduate student development and postdoctoral affairs at the University of Maryland, Baltimore County (UMBC).

Tull also briefly described how the PROMISE AGEP has learned from the ADVANCE Program at UMBC, which had the goal of enhancing the recruitment, selection, promotion, and transition of women faculty in STEM fields. The initial ADVANCE project has ended, but its goals have been institutionalized at the university. "We've learned that having a good fit is critically important," Tull said. "Women need to have an opportunity for collaboration and connection." Fit is related to a woman's career goals and research, she emphasized, not race. When women came in knowing what they wanted to do, and when all parties were receptive to mentoring, women faculty members had a better experience. The school works to make sure there are seminars on faculty diversity, and Tull pointed out that faculty education is ongoing. "It can take time for department culture to change," she pointed out.

"Having a good fit is critically important. Women need to have an opportunity for collaboration and connection."

—Renetta Tull, University of Maryland

The four points Tull tries to emphasize are interest in academia, career-life balance, intrusive mentoring, and the role of men in women's career decisions. When it comes to changing the perception of academia, the university works with female students to give them images of what is possible. For example, the university brings in faculty members from other institutions who represent a diverse perspective.

The Pathway to the Professoriate

Maryland's PROMISE AGEP chapter recently highlighted 15 Black women who received their STEM PhDs and participated in the program. Although they were proud of their publications and professional recognition, the women said their biggest sources of pride were their families, faith, and resilience. The PROMISE AGEP now has workshops that feature relaxation techniques and healthy eating, and people can bring their families with them to any event, Tull said. The PROMISE AGEP tries to gauge the responsibilities of participants and help them meet their needs outside of academic requirements.

Intrusive mentoring, which is a term borrowed from the Meyerhoff Scholars program at UMBC, is a strategy used to help students make wise choices, Tull explained. The mentoring approach is proactive rather than reactive and

is designed to catch people while they are making decisions rather than after the results of those decisions become apparent.

Finally, Tull noted that the branch of PROMISE at UMBC is working to address a new trend where women contemplating their next career step are concerned about access or availability of opportunities for their husband or fiancée. "When a man is now the trailing spouse, opportunities may depend on his educational opportunities and background," she explained. "It's a role reversal."

Social Media Interventions

At another point in the conference, Tull discussed how PROMISE has been using social media to engage students and help them develop professionally. The main PROMISE website used to be a static website, she explained, but was changed to a blog-like format to offer a more dynamic experience. The site includes discussion pages and media links and uses RSS feeds liberally to share information. The website has a combination of regularly updated events and articles and has become one of the most popular sites at UMBC.

Students use different kinds of social media, Tull said, depending on personal preferences. Thus, the program has a Facebook page, a Twitter profile, and a LinkedIn page. Seminar and workshop pages are maintained in a newsletter format, giving updates about campus events.

The PROMISE Dissertation House site has had the most interaction of all the pages on the main PROMISE AGEP site. Dissertation House is a four-day writing conference with coaching and mini-lectures, Tull explained, held twice a year in the summer and winter. Between 2006 and 2011, 125 program participants graduated. The Dissertation House also hosts an online challenge, instituted and moderated by PROMISE Dissertation House Coach Wendy Carter-Veale, so that those who are not physically at the conference still can participate.

Bridging the Digital Divide

Before 2000, minority students had more limited access to computers, Tull explained. But now that smartphones are more available, minorities have many more opportunities to access the Internet and social media. A 2010 study done by the Pew Research Center found that minority social web use was very high and that minority adults outpaced whites in their use of social technologies.

Social media has ushered in the idea of hybrid learning, Tull said, where students are working with a professor in person but also are part of an online community. Students write from the airport and from the gym. Many students began spin-off blogs, building their own sites to track their learning. As they do this, they become more tech savvy, essentially creating a new form of professional development.

At the UMBC Discovery Center, which is part of the Department of Chemistry and Biochemistry, students go to lectures and get together in

groups of four, with a group leader, a scribe, and a blogger. The group learning environment has increased retention in chemistry and decreased the dropout rate, Tull said. Carter-Veale brought the hybrid learning structure to PROMISE. At the Dissertation House, the blogger network includes students from other schools around the state of Maryland who participated in Dissertation House events and continue to be part of the online community. The blogger community is 45 percent Black, 26 percent white, 16 percent Asian/Asian American, 12 percent Hispanic, and 1 percent Pacific Islander. Black females and white females are overwhelmingly the majority users, at 37 percent and 17 percent. There are 61 females and 22 males who have been blogging regularly since 2010, and Black females have the highest number of authored posts, followed by white females, Hispanic males and Hispanic females.

Personal blogs are often an empowering experience for students, Tull said. For example, one student created a hashtag for twitter that acted as a unifying force for the Dissertation House.

Prominent themes observed in student blog posts include follow-up and accountability, Tull said. Students communicate with mentors, call someone if he or she has been absent from the blog for a while, and receive encouragement from peers. Students go through a goal posting exercise as part of the Dissertation House, and the blog is a way for them to stay on track. Tull said that 80 percent of the top posters within the last five months successfully defended their dissertations in the spring semester. They also have observed continued interaction from Dissertation House participants on the Facebook site as well as the blog. Many students talk about balance and offer each other advice and support.

"We're encouraging the use of social media within a structure," Tull explained. The various sites maintained by the PROMISE program can be monitored, with interaction from coaches and mentors such as Carter-Veale so students are not on their own. The goal is to capitalize on social networks and hybrid learning opportunities to facilitate retention, Tull concluded.

POLICIES TO ENHANCE THE RETENTION OF MINORITY WOMEN FACULTY MEMBERS

Social science theories can shed light on faculty careers and professional growth, said KerryAnn O'Meara, co-director of the University of Maryland ADVANCE Program for Inclusive Excellence and associate professor in higher education at the University of Maryland, College Park (UMCP). Her own work looks specifically at agency and at the ways in which women faculty assume perspectives and take actions to advance their career despite inhospitable work environments.

When the University of Maryland, College Park was applying for an ADVANCE grant, it examined the status of women and underrepresented minorities on campus. According to data collected at the university, the university was competitive with national peers in terms of recruitment, but it was losing women and faculty of color in the transition from assistant to associate professor and from associate to full professor. Also, women were underrep-

resented in faculty positions and were taking longer to advance than men. There also were few women in executive leadership positions—for example, only 20 percent of the deans were women over almost two decades, and only a very small percentage of women faculty were department chairs.

The conceptual framework for the University of Maryland ADVANCE grant draws on O'Meara's 2008 work with Anna Neumann of Teachers College and Aimee Terosky of St. Josephs University to focus on faculty professional growth. Here, professional growth is understood as opportunities for scholarly learning, agency, professional networks, and recognition of commitments. The goal of the ADVANCE project at the University of Maryland is to change academic cultures at the department, college, and university level to better invest in equal opportunities for professional growth for all faculty. The project also has a number of social science studies under way to track and study the effect of these changes on faculty satisfaction, retention, and advancement.

New Policies and Programs

The university has instituted several new policies and programs to support women and minority faculty. Each college has an ADVANCE Professor who serves as a role model and mentor to women and minority faculty. The university also gives out seed grants of $20,000 to teams of faculty, including women as head principal investigators, for interdisciplinary and engaged research. The campus hosts seminars with distinguished women scholars, provides support for learning communities, and offers faculty parental leave. A dashboard project that is college specific gives all faculty members access to information about demographics, time to promotion, and salary. A leadership development program and a program for faculty of color assistant and associate professors called "Advancing Faculty Diversity" support the professional growth (via networks, information, and agency) of scholars from underrepresented groups on campus.

One issue with which the university has struggled is how to support the distinct issues that STEM women faculty of color face without creating structures that unduly separate this group from efforts to address issues that are common to all faculty. On the one hand, issues faced by STEM women of color are similar to issues faced by other women faculty on campus; on the other hand, these issues encompass distinct experiences of isolation, microaggression, and feelings of being undervalued. "What we need to do is figure out, on the one hand, how to create these safe spaces where issues arise based on trust and common experience, but, on the other hand, not replicate and bring together groups that can help each other figure out items that are in areas of their careers that are common," O'Meara explained. Minority women should not be set apart from the conversations happening that involve all women on campus, she said. However, the issues that arise from intersections with identities of race, sexual orientation, and discipline need to be understood more broadly.

"What we need to do is figure out, on the one hand, how to create these safe spaces where issues arise based on trust and common experience, but, on the other hand, not replicate and bring together groups that can help each other figure out items that are in areas of their careers that are common."

—KerryAnn O'Meara, University of Maryland

Another issue has to do with defining success. Although the university is collecting benchmark data through annual statistics on retention and advancement, qualitative interviews, focus groups, and workshops, defining success in terms of retention is difficult. O'Meara said that one approach is to measure whether faculty are participating in supportive activities in representative numbers. Only 2 to 3 percent of faculty actually resign each year (excluding retirement), O'Meara added, but they are disproportionately women and faculty of color. The institutional script about why people leave is that either they found a better position that they cannot turn down or they have decided against the academic life and plan to pursue a different path, she explained, but the true answer is usually more complicated and often involves a sense of disconnection, isolation, or a feeling of not fitting inside departments.

ADVANCE efforts at the University of Maryland, supported by robust social science research, have been a game changer at the university in many ways. For example, the faculty work environment survey has caused colleges to discuss challenges in their work environments and design solutions. Participation in learning communities and networks has increased faculty members' sense of what is possible. When faculty members know they can ask the department chair for changes that would improve their success, such as a different schedule, they are more likely to feel that they can improve their situation. The seed grants have helped to create visibility and recognition for faculty work, helping faculty members feel successful and valued within the academic community. Finally, the dashboard project, by making people aware of information that allows them to ask questions and advocate for themselves, has provided data used in salary negotiations and discussions of equity. The program is now beginning to discuss ways to institutionalize these efforts in the Office of Faculty Affairs and Office of Diversity and Inclusion.

BRIDGE TO THE DOCTORATE: STUDENT PERCEPTIONS OF SUPPORTS AND BARRIERS

The Bridge to the Doctorate is a fellowship offered to graduate students pursuing advanced STEM degrees, particularly students who are underrepresented in STEM fields. It supports students individually but also offers support at a departmental level. Students receive stipends of up to $30,000

per year, with tuition and fee supplements of up to $10,500 per year. They are given opportunities for faculty mentoring and advising, support to participate in research internships and conferences at the national and local level, and enriched academic services and support.

Kenneth Maton and his research team, all from University of Maryland, Baltimore County (UMBC), performed a qualitative process evaluation of the program that examined how students perceive barriers and supports associated with the program at the University of Maryland, College Park (UMCP). Their evaluation was the second process evaluation of the program, based on the structure and theoretical framework of the original evaluation by Sharon Fries-Britt, Jennifer Johnson, and Kimberly Holmes. The theoretical model, named "the local model of minority student retention," is a model of student retention that provides a culturally sensitive lens for understanding minority students' experience in higher education. Anna Westin and Shauna Pollard, two doctoral students at UMBC, assisted with data collection and analysis and presented findings from the evaluation.

The model identifies four barriers: discontinuity, lack of nurturing, lack of presence, and resource barriers. Discontinuity is seen in differing departmental norms and differing academic expectations. Lack of nurturing refers to the campus climate and specifically to the support available for minority students. Lack of presence is the absence of diversity among faculty and the lack of structural diversity at the institution. Resource barriers are financial challenges students might face between high school and college. The model was developed for the transition between high school and college, but some of the same barriers and experiences apply between undergraduate and graduate school, and research on graduate minority STEM students supports the use of the model for the transition to graduate school.

Study Results

The research team conducted hour-long interviews at the UMCP campus in February and March of 2012 and administered a demographic questionnaire that asked students about background characteristics, including race, gender, educational history, and parents' level of education. The interview protocol was based on the theoretical model and the previous evaluation, which took place in 2010. Some terms were changed to avoid negative connotations, Westin said. For example, the team labeled "discontinuity" as "points of transition" and used "support" instead of "lack of nurturing."

The study had sixteen participants—seven master's level students and nine doctoral students. The average age was 25 years, and the sample was evenly divided between men and women. The majority of students interviewed identified as Black or African American.

Family income of the students surveyed varied from less than $20,000 to $150,000 annually. About half of the students had been undergraduates at UMCP, and one quarter came from a historically Black college or university. They were primarily studying in engineering graduate programs, but several students were in applied mathematics and technology departments.

When they were asked about points of transition, Pollard said, the group was divided. About half the students described their movement between undergraduate and graduate work as a smooth transition, while the other half felt it had been difficult. Students mentioned learning to balance a variety of tasks, working on more challenging and long-term tasks, more independent work apart from classes, and having increased expectations from faculty as some of the obstacles they faced in graduate school.

When asked about departmental support and mentoring, students reported receiving extra funding through teaching assistantships and noted that the departments allowed them to participate in research teams and networking. "Student feedback about the quantity and quality of department support varied greatly," Pollard explained. "Students who seemed most satisfied with their departments noted support across a variety of domains. However, there were some students who did not feel supported by their departments." Students who did not feel supported reported that they felt isolated, lacked funding, and felt that faculty members were too busy to offer support or simply did not care. However, the majority of students surveyed were satisfied with their advisors and other faculty. They described faculty as helpful and accessible, approachable, passionate about their subjects, and interested in helping students learn.

"Students who seemed most satisfied with their departments noted support across a variety of domains."

—Shauna Pollard and Anna Westin, University of Maryland

Many students talked about being the only minority student at some point in their academic career. Many also observed that they had not encountered many minority faculty, particularly women faculty. A number of students said their departments were diverse, but that the diversity came from international students. Some said the lack of diversity served as a motivator, since they felt that they were challenging stereotypes.

All of the Bridge to the Doctorate fellows reported that financial resources were critical to their success. Without fellowships, Pollard said, several students reported that they would not have been able to attend graduate school. Other resources from the fellowship program were helpful as well, such as information about professional opportunities, the chance to network with other professionals, and opportunities to attend conferences.

Students identified additional elements that they would have been beneficial. Many said a technical writing course would have been helpful. Some believed they could have had more information about the range of career and job opportunities available to them after graduating. Several commented that there should have been less emphasis on conferences earlier in their careers, with more emphasis in later years. Funding for more comprehensive health insurance also was mentioned.

Recommendations

Based on these findings, Pollard and Westin described several recommendations that may benefit programs focused on student retention. The first is to work with students and make sure they are informed about departmental norms before they come. Pollard said that institutions also should help students be more aware of barriers they might encounter as graduate students and some of the strategies they can use to overcome those barriers. Efforts to help students develop better time management and study skills would be helpful. Pollard also encouraged program directors to try to identify students who lack good relationships with their mentors early on in the process, in order to make changes that can help the student get the most out of their educational experiences.

Based on the evaluation, Pollard and Westin concluded, the program was a very supportive experience for students and played an important role in their academic success at the graduate level. Mentoring helped them understand administrative policies and available resources, while the social opportunities allowed them to network and explore their career choices. In the future, the Bridge to the Doctorate fellowship program should continue administering evaluations with both qualitative and quantitative components, the researchers said, and consider including a comparison sample for stronger outcome analysis.

OBSERVATIONS FROM A NATIONAL SURVEY OF DIVERSE POSTDOCTORAL FELLOWS

The postdoctoral period is a largely invisible career stage, explained Alberto Roca, executive director of the nonprofit organization DiverseScholar. Postdocs are an engine of research productivity, but not much attention has been paid to their career needs or progress. "The postdoc experience is critical for becoming a professional," Roca pointed out, "especially a tenure track investigator at the top research institutions. That career stage now needs to be studied."

> ***"The postdoc experience is critical for becoming a professional, especially a tenure track investigator at the top research institutions."***
>
> *—Alberto Roca, DiverseScholar*

Estimates put the number of postdocs in the U.S. between 50,000 and 100,000, but it is unclear what fraction are underrepresented minorities. Surveys suggest that the U.S. population of postdocs is 3 or 3.5 percent African American, 4 percent Hispanic, and 0.5 percent Native American. What is unique about the postdoctoral stage, Roca said, is that foreign students, such as those from China and India, could make up as many as 70 percent of post-

docs, whereas in graduate school the number of foreign students is closer to 30 percent. Combining these numbers, there may be about 2,300 underrepresented minority postdocs in the United States. But the error bars are large and the value changes from year to year, Roca pointed out.

The Sigma Xi Postdoctoral Survey project run by Geoff Davis has estimated that the total U.S. postdoc population is about 50/50 male to female, but among minority postdocs the male-to-female ratio is probably closer to 1 to 2, said Roca. However, these statistics are even more uncertain. For example, the University of California's institutional survey of 2,500 postdocs found almost twice as many males than females.

These statistics are important, Roca said, because they impact the talent pool for diversification efforts and have policy implications.

A New National Database

Roca has been developing an email database of diverse postdocs since 2003, which had about 1,600 individuals. Around 1,000 of those were still in the postdoc phase.

Over 15 months, Roca said, his surveys of this database had 210 replies. Of those, 182 were postdocs, with some also in soft money research positions. Eight who were postdocs at the beginning of the survey period found jobs as assistant professors. Almost 90 percent were U.S. citizens.

The vast majority of postdocs responding to the survey were in biology, Roca said, although he was trying to expand the database to the social sciences and the humanities. The average age was 33, and they had been in the postdoc stage for two and half years on average. The female to male ratio was 2 to 1. In his sample, 42 percent of the students were Hispanic, 31 percent were African American, and some identified with multiple ethnicities. Some were Caucasian, Roca explained, because he includes people in his email list who came from interventions with a diversity mission but that do not exclude any ethnicities (such as postdoctoral programs under the Institutional Research and Academic Career Development Awards). Five percent identified as LGBT, 4 percent as coming from low socioeconomic backgrounds, and 2 percent were parents. Some were also disabled veterans. The Hispanic population was almost evenly divided between men and women, but there are many more female than male African American postdocs.

Most of the survey respondents wanted an academic career that combined research and teaching roles. Some were thinking of careers in academia where they only do research, and some wanted to work in industry or alternative careers.

Using Carnegie classifications, Roca looked at the research competitiveness of schools where the survey respondents were doing their work. He found that 48 African American and 58 Hispanic postdocs were training at research-intensive research universities (those with a Carnegie classification of RUH/RUVH).

His is probably the only national postdoc database of diverse candidates, Roca said. He was seeking collaborators to do more rigorous social science

studies, both qualitative and quantitative. The database also could be used for recruiting, and he encouraged institutions to contact him for that purpose.

ACCESS, TRANSITIONS, AND PROGRESS IN STEM DOCTORAL PROGRAMS

Fellowships can provide critical assistance to minority students in reaching their academic goals, explained Margaret Mwenda, instructor and associate department chair in the Marketing Department at Davenport University who wrote a dissertation on minority students in PhD programs after spending time working as an evaluator of an undergraduate initiative at the University of Iowa.

While the number of bachelor's degrees given to underrepresented minorities has increased in STEM over the last 20 years, doctoral degree representation remains very low. In the biomedical and biological sciences, African Americans received only 3.5 percent of the doctoral degrees conferred in 2007–08, and Hispanic representation was similar. An interesting comparison is the number of degrees given to non-resident aliens—approximately 60 percent of doctoral degrees in engineering and in computer and information sciences in 2007–08. "That brings in the issue of global economic competitiveness, which has been repeated in different reports as one of the issues that we are facing," Mwenda said.

Two theories guided her study. The first, Tinto's longitudinal model of doctoral persistence, posits three doctoral stages: the transition stage, the candidacy stage, and completion.[1] During each of these stages, the role of faculty, peers, and financial support changes in importance. The second, Weidman, Twale, and Stein's graduate student socialization theoretical framework, considers graduate school socialization, viewing graduate school as a socializing agent that gives students important tools for their future success.[2] In this model, the anticipatory stage is the first, whereby students become aware of behaviors, attitudes, and cognitive expectations of their disciplines, followed by the formal stage, when students learn as apprentices, and the informal stage, which is focused on peer interactions and influence. The personal stage is the final transition from student to scientist.

Research Questions

Mwenda focused on several questions in her research. She investigated what forms of funding students were receiving, and how that funding influenced their enrollment, transition, and progress. She also looked at the experience of minority students with mentoring and how they were influenced by peers.

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[1]Vincent Tinto. 1993. *Leaving college: Rethinking the causes and cures of student attrition.* Chicago, IL: University of Chicago Press.

[2]John C. Weidman, Darla J. Twale, and Elizabeth L Stein. 2001. *Socialization of graduate and professional students in higher education: A perilous passage?* San Francisco, CA: Jossey-Bass.

She performed in-depth interviews with eight underrepresented students in math and engineering, using a snowball sampling method. All of the students had fellowships, and most had Graduate Assistance in Areas of National Need (GAANN) fellowships, Mwenda said. Other sources of financial aid were the U.S. Department of Education, AGEP, the Vertical Integration of Research and Education in the Mathematical Sciences program, and institutional fellowships. Most of the fellowships provided four to five years of funding, and all of the students said that they might not have made it without the fellowship funding. Mwenda added that fellowships helped students transition to the PhD candidacy stage, which one student called "the weeding years." In addition, the freedom to not work while taking qualifying exams allowed students to focus on studying, and the lack of assistantship required by the fellowships in their final year made it easier for them to write a dissertation. However, assistantships were valuable in other years, as students learned job skills, how to manage their time, and how to prepare for their dissertations.

When Mwenda asked students about their experience with advising, they said that faculty helped them with academics, with managing their course load, and with navigating the academic terrain. Advisors also helped by listening to students and providing a sounding board for issues or frustrations. They prepared students to transition into the workplace and introduced them to networks and collaborators. Students valued faculty who were approachable, honest, and good at communicating. She also found that peers played a crucial role in supporting students academically and socially.

Mwenda concluded that not all financial aid is created equal. Assistantships are valuable for training and socializing students, she said, as is mentoring by faculty and peers. Her findings could help provide doctoral programs with tools to begin a dialogue about how best to enrich the experience of doctoral students and facilitate their trajectory through school and their transition to the workplace.

"Not all financial aid is created equal."

—Margaret Mwenda, Davenport University

4

Mentoring and Coaching

Mentoring and coaching can be pivotal interactions at all stages of a person's education and career, but these interventions are particularly difficult to study, understand, and shape. Six presentations at the conference looked at mentoring and coaching from a variety of perspectives.

MENTORING THROUGH INTERACTIVE EXPERIENCES IN RESEARCH SETTINGS

Science identity formation plays a clear role in the mentoring process and career trajectories of STEM students, explained Gilda Barabino, a professor at the Georgia Institute of Technology at the time of the conference. In particular, interrelationships among mentoring, research experiences, and identity have a significant effect on students' persistence, particularly for students of color. "We know that we can promote student learning through identity development," she said.

Consider the research laboratory as a "place of enactment," Barabino continued. A laboratory setting is a site for socialization and development of a scientific identity, but many structured activities in laboratories act to exclude women, and underrepresented minority women in particular. "What we wanted to focus on was these day-to-day interactions that you may not notice, but they can rise to the level of playing an important role in someone's career path."

The culture and norms of a research laboratory and norms related to race, ethnicity, and gender are often marked by a dissonance, Barabino pointed out. Certain traits that are less culturally acceptable, such as bragging or aggression, might be useful in a research environment. The research environment

also affects opportunities for mentoring, which is important to help students progress. "There are clearly differential experiences based on whether or not you're a minority or a woman, and these kinds of interactions play a critical role in knowledge creation and transmission."

"There are clearly differential experiences based on whether or not you're a minority or a woman, and these kinds of interactions play a critical role in knowledge creation and transmission."

—Gilda Barabino, Georgia Institute of Technology

In the relationship between a mentor and protégé, the mentor is typically seen as the more knowledgeable, Barabino said. Mentors take on the role of counseling, guiding, instructing, and sponsoring the protégé. How mentors interact with students in a research setting impacts how the students see themselves as part of the research community. The relationship is an important opportunity for identity transformation, which happens over a period of time and is a mechanism for socialization, development, and persistence.

Barabino described a conceptual framework for science identity from the science literature where researchers studied a group of graduate student women of color and examined their experiences in research settings.[1] The study found that the components of science identity include performance, confidence, and recognition. "These interrelated factors play a role in how people see themselves as a scientist or engineer, and that is impacted or overlaid by racial ethnic and gender identities," Barabino explained. The recognition piece is important, she added, because it is not just how people view themselves but how they are viewed by others.

Results

In the Georgia Tech study, the researchers found volunteer participants among students and faculty and conducted interviews and focus groups. They then asked for feedback on emerging themes identified in the discussions. Using discursive analysis, they evaluated this feedback through speech patterns, combinations of words, and positioning of speakers.

Barabino provided some context for their study by talking about a previous research project, in which a common theme among minority women was that they all wanted to give back to their communities, which was a major reason for going into a PhD program. The participants were not convinced that their faculty advisors viewed mentoring as a priority, and they felt a

[1]Heidi B. Carlone and Angela Johnson. 2007. "Understanding the science experiences of successful women of color: Science identity as an analytic lens." *Journal of Research in Science Teaching* 44(8):1187-1218.

sense of not belonging in their groups, not being valued, and having to prove themselves constantly. Many sought support from external networks, such as families, communities, and churches, and many said they felt invisible in their scientific communities.

Barabino's study found a disconnect between how students viewed the mentoring process and what they saw as issues that impacted their career advancement. Students felt that their minority status impacted mentor relationships—usually with their faculty advisor, but also with other faculty whom they saw as mentors. Students believed that stereotypes caused them to be under-evaluated, and they had the sense of carrying a burden and extra responsibilities because of their race. They also felt invisible and underrecognized, as in the previous study, and felt outside the loop in a research setting. They reported going to other communities often for support. In this study, the students were all minorities and the faculty members were majorities, but as Barabino pointed out, that represents a typical experience at a majority institution.

The researchers asked faculty participants leading questions about how they saw the mentoring process and their role in it and how they looked at mentoring and managing diversity. The faculty members saw a difference in diversity as something problematic, Barabino said, but in their view, it was an issue belonging to the individual, as opposed to a faculty responsibility. The faculty felt that the best advice they could give to students was to figure out problems on their own and to assimilate. Some faculty members believed in color blindness and said they treated all of their mentees the same. They demonstrated no willingness to recognize differences that might arise because of race and ethnicity or gender, and they had a tendency to believe that gender is more of an issue than race.

The finding of a disconnect between how students view their experiences and how faculty interpret issues around mentoring is troubling, said Barabino, since faculty–student interactions can predict student success in a research environment. "In research settings in particular, if we better understood those day-to-day interactions, which in some cases may seem small but are magnified for students, that can make a big difference," she said. She encouraged schools and faculty to focus on collaborative efforts, working toward inclusion rather than focusing on the individual. Such an approach could generate more innovation and help the career trajectories of students in underrepresented groups, she said.

Barabino concluded that the most important message is that faculty and other important administrators have considerable influence. She added that much of the blindness about race that they observed in the study is unintentional, which makes it even more worthwhile to bring to people's attention.

INTEGRATING COACHING AND SOCIAL SCIENCE THEORIES INTO BIOMEDICAL PHD TRAINING

The Academy for Future Science Faculty is an intervention to increase graduate students' awareness of access to relevant cultural capital and implicit social knowledge that they can use to navigate through the PhD experience

and beyond, explained Simon Williams, research fellow at the Northwestern University Feinberg School of Medicine. It uses social and career development theories, cultural capital theories, and communities of practice theories to support minority students subject to marginalization and exclusion. "What we're trying to do is apply these outside theories to our own understanding of how we might design, evaluate, and implement interventions," Williams explained.

> ***"What we're trying to do is apply these outside theories to our own understanding of how we might design, evaluate, and implement interventions."***
>
> *—Simon Williams, Northwestern University Feinberg School of Medicine*

Mentoring is the central dogma of PhD training, he said, and there is a widespread assumption that the mentorship model is the most efficacious way to train professional scientists. This belief rests on the premise that within the first few years of the PhD, learning shifts from structured to unstructured forms. But mentoring is a highly variable and idiosyncratic process, Williams said, and an informal learning environment is more difficult for an outsider to negotiate. In addition, individual mentors can be good or bad, so the value of mentoring is not necessarily a constant.

The Academy program is designed to systematize accountability and critically scrutinize mentoring. The goal is not to remove mentoring as part of the learning process but to provide a supplement to mentoring. It relies on multiple social science theories to explain the career decisions of young scientists, with the goal of translating theories into practical strategies.

Testing the Strategy

The Academy strategy has been assessed using a randomized controlled trial of two groups of students from higher education institutions in the United States. Group 1 consisted of beginning PhD students and Group 2 of latter stage PhD students roughly a year away from their dissertation defense. The intervention involves annual in-person summer Academy meetings where students and coaches meet and participate in a three-day intensive workshop. An online social networking element and ongoing remote engagement, including webinars and web conferences, are also part of the intervention

The social science theories the researchers are using vary in their approach to how students learn to be scientists. Identity theory focuses on the development of a scientist identity and whether that identity competes with or complements other identities a student might have. Social cognitive career theory focuses on how experiences translate into career choices, self-efficacy, and outcome expectations. The theory of cultural capital posits that a young scientist needs certain attitudes and values to fit within the science culture,

examining how gender, race, and ethnicity can contribute to or conflict with the accumulation of cultural capital.

Some of the subjects discussed in the summer meetings include choosing laboratory rotations, scientific presentation skills, and networking skills. The playing field for students is not level, Williams explained. Differences in how students perceive their capabilities and how others perceive them can help or hurt their ability to achieve their goals.

The researchers are investigating several questions, Williams said, including whether it is possible to prospectively coach individuals or groups of individuals toward a successful academic career and whether coaching can positively impact minority students' ability to navigate a PhD program. The researchers also will be looking at how the Academy affects students' cultural capital, sense of self-efficacy, and commitment to an academic career.

Williams said they will be analyzing baseline surveys and entry interviews as well as academic history and demographic variables, as well as asking students about their graduate school preparedness, perceptions of graduate school, and experiences with mentors and role models. Experimental students will receive a self-assessment exercise and individual development plan. The researchers expect to see that Academy participants will strengthen their communities of practice, increase cultural capital, and increase their self-efficacy and sense of identity as a scientist.

ACADEMIC CAREER COACHING AS A SUPPLEMENT TO THE TRADITIONAL TRAINING OF BIOMEDICAL PHD STUDENTS

Continuing the discussion of the Academy for Future Science Faculty, Michelle Naffziger, who was a researcher at the Northwestern University Feinberg School of Medicine at the time of the conference, observed that if underrepresented graduate students and postdoctoral fellows are less likely to become fully accepted and have equal access to professional development in the laboratory and in scientific communities, then one way to increase the number of such students choosing and achieving academic careers would be to teach them about the unconscious processes that may impede acceptance, help them develop skills to mitigate the negative impact of those processes, and provide coaching to complement mentoring they already receive at their institutions, said Naffziger. The method adopted by the Academy builds on this premise.

Coaches at the Academy work with groups of 10 students, with each group having equal numbers of men and women and different racial and ethnic compositions. The major focus of the program is an intensive three-day meeting in July, but a professional development webinar series and a virtual online community help coaches and students maintain a connection throughout the year. The frequency of group meetings is based on student interest and need, and Naffziger pointed out that the researchers did not instruct coaches on how often to meet, hoping that they would learn something from how frequently the coaches and students chose to make contact.

As part of the intervention, the researchers provided training to the coaches, bringing them to Chicago for a two-day meeting and helping them

learn about social science theories, the experiences of beginning PhD students, and how the theories can apply to those experiences. They also met with coaches right before the Academy and conducted conference calls throughout the year. "We see our coaching model as being a very proactive model," Naffziger said.

"We see our coaching model as being a very proactive model."

—Northwestern University Feinberg School of Medicine

From a pool of 26 applicants recruited by emails, the program selected 10 coaches and one alternate. The coaching pool was demographically diverse, including six women, four men, six white coaches, two Asian/Asian-American coaches, and two Hispanic coaches. The coaches came from a variety of medical schools around the country and were chosen for their knowledge of diversity issues and talent in guiding students. Some ran active labs and had been associate or full deans within their schools.

Naffziger gave a snapshot of one coaching group, which included four men, six women, three African-American students, two Latino students, two Asian students, and three white students. The students came from a variety of disciplines and different locations around the country, and all ten from that group participated in at least one conference call following the summer academy.

One of the innovations in this project, Naffziger said, is that the use of social science theories allows identification of some of the limitations of mentoring. There are often conflicts of interest between what students and principal investigators need, and the idiosyncratic nature of mentoring can interfere with students getting the specialized knowledge, access to resources, work connections, and support that they need to move through a PhD program. Furthermore, underrepresented minority students in particular can have additional obstacles. It can be more difficult for an outsider to navigate the informal architecture of a research setting, and there are certain challenges associated with being the minority in a program, laboratory group, or building.

A theoretically grounded approach helps address the limitations of mentoring. The coaches are all external to students' laboratories and institutions, which allows them to offer a perspective that is not necessarily available otherwise. Some of the coaching is one on one, but much of it is based on group activities and processes, so that students can learn from each other as well as the coach. "In the process of learning from one another, they can connect to one another and form bonds with their future colleagues," Naffziger said. The coaching groups and Academy are designed to be a safe space where students can have an open dialogue.

Preliminary Findings

Naffziger shared some preliminary findings drawn from the individual development plans students completed after doing self-assessments, evalua-

tions gathered for both students and coaches, and ethnographic observations. The researchers found a strong rapport between coaches and students. All of the student respondents felt comfortable asking their coaches professional questions, and 70 percent felt comfortable asking personal questions and appreciated that any topic was available for discussion. The majority of respondents also felt comfortable with their peers and valued the opportunity to learn from others.

In the individual development plans, students listed expectations for their coaches, including trusted contact, socio-emotional support, help with goal setting, and skill development. In the ethnographic study, researchers observed that students talked with their coaches about conflicts with faculty members, feelings of doubt in their career choice, goal setting and accountability, and plans and strategies for managing stress.

The initial findings also indicated that the academy had a positive impact on coaches. Coaches reported finding value in using the social science theories and said that the model is changing the way they work with students. The theories are also binding coaches together in a community of practice, where they can talk about their work and have discussions about how best to help the students.

The coaches experienced different degrees of success in how well their groups came together, but successful strategies included eating meals together and talking about common experiences. Some frustrations for coaches included withdrawals from the program and students not needing them as much as they expected. Naffziger pointed out that they may see changes as students move into the second year of their PhD.

One attendee at the conference expressed concern that the coaching relationship removed value from potential relationships students could build with principal investigators, but Naffziger said they see the coaching relationship as adding and not detracting from that relationship. The coach helps give students the tools and confidence to talk to their principal investigators or peers, she pointed out, and to feel comfortable asking questions.

Future Analysis

The researchers planned to complete three levels of analysis. The first was to identify important outcomes at the end of year one and year two and compare outcomes for the experimental groups and the control groups. The second was to consider how coaches are affecting their groups differently or affecting different types of students and investigate engagement and student outcomes. The third was to analyze the impact of training on coaches and on the practice of coaching, including how the program changed coaches' strategies, and what could be replicated in other contexts.

An overall conclusion is that theory is essential to understanding what challenges students face, Naffziger said. Social science theory makes challenges explicit and provides strategies to address those challenges. In addition, the expertise of coaches can be leveraged to supplement system-wide changes. Finally, the Academy program shows evidence of increasing the commitment of students to an academic career.

UNDERREPRESENTED MINORITY STUDENTS' SELF-EFFICACY FOR RESEARCH

Bandura has identified the sources of self-efficacy as mastery experiences or goal attainment, vicarious experience, verbal persuasion, and physiological states. Based on this theoretical framework, Elise Lev, professor in the College of Nursing at Rutgers University, and her colleagues evaluated a theory-based intervention delivered to mentors and protégés that was intended to increase the protégés' ability to perform tasks and activities in research. The study attempted to assess group differences in perceived self-efficacy for participants from underrepresented groups and evaluate the importance attached to attributes of research mentors.

The researchers collected data from faculty members doing research in a university setting and working with undergraduates or first-year graduate students on a research project. They also collected data from the student protégés, including biographical data.

These dyads were randomized into three groups. The control group received a booklet on ethics and research; one intervention group participated in online workshops; and one group met for a face-to-face workshop. Data were collected once before the intervention, once three months after baseline, and once six months after baseline. The researchers then analyzed the sample to find differences among groups and performed a regression analysis to find predictors of successful mentoring. Their predictor variables were biographical data and mentor attributes.

The study recruited participants from the natural sciences, mathematics, engineering, health sciences, and social sciences departments at schools throughout the country. The mentor sample included 152 males and 109 females. Of the sample, 25 participants identified as Hispanic or Latino, 3 as American Indian or Alaskan Native, 29 as Asian, 217 as white, and 7 as Black (with some identifying as more than one category). "It was a struggle the whole time to have as many underrepresented participants as we wanted," Lev noted. The group included 72 assistant professors, 49 associate professors, 15 instructors, and 48 full professors (the remaining 77 faculty had no rank).

> ***"It was a struggle the whole time to have as many underrepresented participants as we wanted."***
>
> *—Elise Lev, Rutgers University*

The protégé sample included 156 females and 109 males. In this group 49 participants identified as Hispanic or Latino, 2 as American Indian or Alaskan Native, 34 as Asian, 28 as African American, 17 as mixed race, 4 as Hawaiian or Pacific Islander, and 180 as white.

Results

Three months after beginning the study, the scores on the Clinical Research Appraisal Inventory for underrepresented groups were variable, Lev

said. As a result, it was difficult at that point to get a sense of what was going on. However, six months after beginning the study, the scores of underrepresented protégés in all study groups showed higher self-efficacy for research than mentored students who were not part of underrepresented groups.

In every study group, protégés from underrepresented groups made more progress in their research self-efficacy working in a mentored relationship than students from non-underrepresented groups. In fact, progress scores for protégés in non-underrepresented groups decreased from baseline, meaning their confidence in their research skills went down over the course of the intervention.

The attributes of mentors were significant at predicting results in the study, Lev said. Thirteen percent of the subscale for conceptualizing a study at three months was predicted by the mentor having strong academic skills. Thirteen percent was predicted by the negative statement that the student rarely saw the mentor. For predictors of designing a study, problem solving skills and resourcefulness were significant mentor attributes at six months.

Having a supportive mentor was predictive for writing study results, as was having a mentor who did not report critical incidents. NIH grants, a national reputation, and excellent teaching abilities were all predictive for supporting protégés' self-efficacy.

The multiple testing of subscales on the Clinical Research Appraisal Inventory can lead to type one errors, Lev noted. Attrition also limited their study. Nevertheless, the findings showed that mentoring students from underrepresented groups led to increased scores in research self-efficacy. Future research could focus on actual competence, increases in skills, and publications.

AN EMERGING PROFESSIONAL DEVELOPMENT INTERVENTION FOR PEER MENTORS AND THEIR MENTEES

The How to Fund Your Graduate Education workshop series began as a professional development intervention serving students at the University of Maryland, Baltimore County (UMBC), explained Frances Carter, a research associate at Westat from 2011 to 2012. UMBC created a suite of graduate student support and professional development seminars, known as Success Seminars, and other interventions. The seminars, which included the annual graduate funding workshops, are largely funded by a National Science Foundation (NSF) Alliance for Graduate Education and the Professoriate (AGEP) grant, which is named PROMISE at the university. Carter and her colleague, Patti Ordonez, were NSF Graduate Research Fellowship (GRFP) recipients and PROMISE peer mentors while pursuing their doctorates. Carter and Ordonez were mentored by the PROMISE director Renetta Tull to co-develop and facilitate the funding workshops. The workshop provided professional development for presenters, facilitators, and mentees, particularly in relation to the importance of graduate funding for success and PhD completion. The workshop takes place in early fall of each academic year.

Mentoring in graduate school is usually seen as a faculty–student relationship, Carter pointed out, but many universities are beginning to use peer mentoring as a tool for encouraging students to complete their PhDs. The

idea behind the graduate funding workshop, said Carter, was "let's take this ability, this skill that we see among graduate students who have won fellowships, and spread it to the rest of our graduate students."

> ***"Let's take this ability, this skill that we see among graduate students who have won fellowships, and spread it to the rest of our graduate students."***
>
> *—Frances Carter, Westat*

Carter, who won an NSF fellowship as a graduate student at Mississippi State University, used a previous mentor's presentation as a guide for the early workshops but also drew on the experiences that she and Ordonez have had. The presentation teaches organization, helping students understand how to set up a calendar three months ahead of the fellowship deadline, get recommendations, and maintain records for each application. The program teaches students to send their CVs and proposals to anyone writing a recommendation letter and to provide a list of facts about themselves that relate to their interest in science. "We encourage students to request strong faculty recommendations," Carter said.

The personal statement is the best chance to stand out in a graduate funding application, Carter said. She advises students to find unique scientific and personal stories to set their applications apart from others. "For some of them, it's the first time learning about applying broader impact, intellectual merit, and similar application criteria, which they will use when applying for funding for the rest of their scientific careers," she pointed out.

Demonstrated Success

The workshops, which began as a two-hour seminar conducted on one day in the fall semester, have expanded to include a range of formats: a three-day (two hours per day) workshop series, a one-day (three to five hours) workshop, and short panel presentations with other participants who provide financial information from their particular departments or organizations. The PROMISE program also began requiring Bridge to the Doctorate fellows and other graduate students to apply for graduate research NSF fellowships.

In fall 2011 the researchers started compiling feedback on the program and did semi-structured interviews with fellowship winners. "We saw that their testimonials and the data that they gave us aligned with the workshop components of organization, reflection, intellectual merit, and research," Carter said.

For the last three years, Carter and her colleagues have organized similar workshops at MIT's Summer Research Program, the University of Houston, and NSF's HBCU-UP conference. More than 200 students have attended over five years, and Carter said that the number is probably underreported.

Six people from UMBC and four from MIT have received fellowships, and a minimum of five students have received honorable mentions.

Carter posted a quote from a participant that illustrated the impact of the program: "I worked on it almost every day. . . . I thought about everything that I was involved in and considered how I could represent that experience in a unique way that showed broader impact." Students who participated in the Graduate Funding Workshop and those who mentored others also increased their preparation for careers as faculty and researchers. "Even the feedback that you get from applying to this fellowship is valuable and essential," Carter said.

Next steps, Carter said, include continuing to replicate the funding workshops locally and nationally.

PREPARING DIVERSE TRAINEES IN SCIENTIFIC COMMUNICATION SKILLS

"The reason why we focus on scientific communication is because it's such a critical skill for launching your career," explained Shine Chang, professor at the University of Texas MD Anderson Cancer Center. Scientific communication goes beyond writing to rehearsed presentations and spontaneous speaking. People are vulnerable to negative perceptions of skill, she added, and they can be ashamed about not being able to write and talk about their work well.

At the graduate school and postdoctoral levels, she said, most faculty members expect students to know how to communicate, and they do not consider it their responsibility to teach these skills. But communication can be an Achilles heel, Chang said, because the most highly trained scientists with fantastic technique can hit roadblocks to progress without the ability to talk about their work and publish.

Mentoring is an important factor, she said. "Are mentors able to correctly diagnose what the challenges might be? Do they even know that you're struggling with these kinds of issues? If they know and can diagnose a problem correctly, can they actually help?"

Part of the problem is the inability of mentors to teach writing and communication skills, Chang said. "Even people who write and communicate well can struggle to teach their own trainees." Language issues are another barrier.

Research Approach and Results

Chang and several colleagues, including Carrie Cameron, associate director in the program at the cancer center, conducted a study focused on the attitudes and needs of trainees, particularly self-efficacy around scientific communication skills. The researchers also wanted to know how mentors work with their trainees, gauge how confident they are in helping their trainees, and address their weaknesses. "Ultimately our goal is to develop

linguistically and culturally appropriate tools and curricula to address these needs both for the trainees and for their mentors," Chang said.

> ***"Our goal is to develop linguistically and culturally appropriate tools and curricula to address these needs both for the trainees and for their mentors."***
>
> *—Shine Chang, University of Texas MD Anderson Cancer Center*

The project took place in two phases. The first was based on focus groups and interviews; the second involved administering surveys and analyzing data. Researchers recruited doctoral students, postdoctoral fellows, and faculty members. In forming focus groups, they included all demographics but stratified their sample by gender and language, feeling that those traits would create differences in how people interacted in their mentoring relationships. Variables of interest for the study, Chang said, were trainee confidence and self-assessment, mentor confidence and self-assessment, the role of gender, the role of native language or dialect, and background experiences.

Four major themes emerged from the focus groups, Chang said. In general, the sense was that trainees had low self-efficacy in their scientific communications skills. Men who spoke English as their first language ranked highest. Native English-speaking women ranked lower than non-native English speaking women, while non-native English speaking men were also low. A tentative conclusion, she noted, is that neither language status nor gender appears to be a major factor in terms of self-efficacy with regard to scientific communication skills.

The second theme dealt with different perceptions of the mentoring relationship. Trainees felt that they understood the importance of communication skills, but they wanted mentors to be responsible for educating them. Mentors felt that trainees were not responsive to their efforts and were not working to acquire skills on their own. "You're already starting to see the divergence of expectations," Chang said. "What's also interesting is that the mentors felt that the trainees didn't really grasp the importance of the productivity and quality of the work that was expected." The trainees placed the burden on the mentors, while the mentors were frustrated about the trainees not working hard to improve their skills.

The third theme involved the extent to which mentors taught skills effectively. Trainee responses varied by language status. Native English speakers felt supported, but all trainees said that mentors tended to focus on content rather than form. "Perhaps it's an indirect way of saying that the mentors are not really comfortable with teaching the nuts and bolts of what needs to be learned," Chang said. Mentors felt they were deeply involved, to the point that it was taking away from their other responsibilities. Some of the responses were very passionate. The mentors reported feeling burdened and

tired of negative attitudes from trainees, and some reported taking over a project if something was not going quickly enough with the trainee.

The fourth theme was trainee response to mentor feedback. Trainees felt that feedback was painful and that mentors used a negative reinforcement style. Mentors said they could tell their trainees were uncomfortable, but they also complained that the trainees ignored feedback and did not pursue recommended resources to improve their skills.

Chang said recruiting faculty members to the focus groups was not a problem, and faculty were interested in the questions. However, she said it was problematic recruiting enough underrepresented participants, and the researchers were not able to record who said what in focus groups. To compensate, researchers conducted some key informant interviews. One interviewee with plenty of experience and a supportive mentor said she was reconsidering academia based on her thoughts about her own writing abilities, and an African-American female mentor said that questions about dialect might be offensive.

Based on their focus groups and interviews, Chang concluded, researchers are beginning to realize that communication issues can be a problem. But these issues are not a problem for all underrepresented minorities, and it can be dangerous to assume that because someone fits into a category that he or she will have a certain constellation of problems. "Our challenge is in trying to understand the prevalence of the problems and who actually struggles," she said. She also observed that the issue of how to examine the influence of dialect and accent on academic writing and speaking deserved further discussion.

5

Medicine and Diversity

Students who are interested in medicine as a career and students who are interested in pursuing science form a large, heterogeneous, and overlapping group. Programs designed to benefit any members of this group often can be beneficial to all. Three presentations at the conference described interventions that originated in a medical school or were aimed at medical students, but the lessons derived from these interventions can be applied much more widely.

RESEARCH SELF-EFFICACY IN UNDERGRADUATE UNDERREPRESENTED MINORITY STUDENTS

About 80 percent of underrepresented minorities who demonstrate intent to complete a STEM undergraduate degree fail to reach their goal, noted Marino De Leon, professor in the School of Medicine at Loma Linda University. Since 1998, De Leon and his research team have been studying different groups of students every year, trying to identify a component that can make a difference in attrition for students attending college. At Loma Linda, they have developed several programs: the High School Apprenticeship Bridge to College (ABC), the Undergraduate Research Health Disparities program (UTP), Medical Research Training Health Disparities (MTP), and the Initiative for Maximizing Student Diversity (IMSD). "The question we are addressing is how to improve the success of students into STEM careers along the academic continuum," he explained.

Between 50 and 60 students participate in summer programs at Loma Linda every year, with older students serving as peer mentors for younger cohorts. Each group participates in a different level, but "the important thing is that we have these students interacting with each other," De Leon said. For

high school students and undergraduates, the main component of the program is research, with supplementary seminars and workshops each week. The goal is to increase research self-efficacy and support cross-generational peer mentoring.

Nominations for high school participants come from their teachers and school district, generally because they have shown interest in a science career. The program does have a minimum GPA requirement, and every high school student who applies is interviewed. Undergraduates are recruited nationally, and the program provides financial support.

Sources of Self-Efficacy

Self-perceived self-efficacy consists of four main sources of influence, explained De Leon: mastery experiences, social modeling, social persuasion, and psychological responses.

Mastery experiences are the most effective way to create a strong sense of self-efficacy. Success builds belief in oneself, and failure can undermine it, but setbacks are useful in teaching persistence and resilience. Although it is easier to undermine someone's self-efficacy than build it, those who are told verbally that they have the necessary skills are more likely to succeed, De Leon said. "Successful efficacy builders do more than convey positive appraisals. They structure situations for people in ways that bring success and avoid placing people in situations prematurely where they are likely to fail."

> ***"Successful efficacy builders do more than convey positive appraisals. They structure situations for people in ways that bring success and avoid placing people in situations prematurely where they are likely to fail."***
>
> *—Marino De Leon, Loma Linda University*

Social modeling is about seeing people similar to you succeed through sustained effort, with the impact of a model on self-efficacy being influenced by perceived similarity to the model.

Reducing stress reactions and tension is the psychological component of success, he explained, adding that the way emotional and physical reactions are perceived and interpreted is more important than their intensity. "People who have a high sense of self-efficacy are likely to view their state of affective arousal as an energizing facilitator of performance," he said, "whereas those with self-doubts would see it as a debilitating factor."

Student Outcomes

As of 2011, about 119 high school students and 125 undergraduates had participated in the ABC and UTP programs respectively, with some students participating more than once. About 73 percent of high school participants came from disadvantaged backgrounds, and 71 percent of the undergraduates attended minority-serving institutions. Over 90 percent of the high school participants wanted to major in a STEM discipline, and 91 percent of the undergraduates had declared a STEM major. About 83 percent of the high school participants were underrepresented minorities, along with 96 percent of undergraduates.

About 71 percent of the high school program participants eventually finished college in a STEM discipline, and 90 percent of undergraduate participants did so. Of the high school students, 60 percent had gone to graduate school, and almost 80 percent of undergraduates had continued with a graduate degree, either an MD or a PhD. About 25 percent of high school participants went on to research-intensive doctorates, 50 percent to biomedical clinical doctorates, and 20 percent to a master's in a STEM field. Among undergraduate participants, 19 percent went to research doctorates, 56 percent to clinical doctorates, and 16 percent to STEM master's degree.

These and other data clearly show that the program is accomplishing what it set out to do, De Leon said. Mastery experiences, particularly hands-on research, were important to the students, as were mentoring relationships and the affirmation provided by the program that students could achieve their goals. The researchers concluded that experiencing well-organized research increases self-efficacy, which in turn heightens commitment to STEM disciplines and success in biomedical research careers.

ATTRITION FROM MD-PHD PROGRAMS: IMPLICATIONS FOR THE DIVERSITY OF THE PHYSICIAN-SCIENTIST WORKFORCE[1]

Although an MD-PhD program is not a destination for large numbers of students, it is a pathway for a research career, and many students enrolled in MD-PhD programs have benefited from undergraduate or high school level research programs, explained Dorothy Andriole, assistant dean for medical education at the Washington University School of Medicine. "MD-PhDs are a successful group of researchers, both in terms of their academic career pathways and in terms of the extent of funded research they do," she said.

Joint MD-PhD programs are offered at almost every medical school in the United States. Some are supported by institutional training grants from the National Institute of General Medical Sciences (NIGMS) called Medical Scientist Training Program (MSTP) awards. However, not all MD-PhD programs are MSTP funded, and not all MSTP programs are MD-PhD programs.

[1]A full description of this study appears in the following publication: Donna B. Jeffe, Dorothy A. Andriole, Heather D. Wathington, and Robert H. Tai. 2014. Educational outcomes for MD-PhD program matriculants: a national cohort study. *Academic Medicine* 89:84–93.

For example, at least one combined veterinary PhD program is supported by MSTP funding.

The MSTP program began in 1964 with three schools. Since then the number has grown more than tenfold to over 40 schools. The number of medical schools also has increased, from less than 90 to almost 140. "Even though the number of institutional MSTP awards has grown a lot, most medical schools are not getting MSTP funding for their MD-PhD programs," Andriole said.

Andriole noted that, for MD-PhD programs, "Attrition analysis can inform the selection process. . . . Perhaps even more importantly, it can inform the design of interventions to promote the success of the students involved in these programs."

Attrition analysis . . . can inform the design of interventions to promote the success of the students involved in these programs."

—Dorothy A. Andriole, Washington University School of Medicine

With funding from the NIGMS, the researchers created a database of individualized records for nearly 130,000 students enrolled in medical schools nationwide. When students enter medical school in the United States, they have the option to answer an array of questions on the Association of American Medical Colleges (AAMC) Matriculating Student Questionnaire, Andriole explained. Additional data collected from and about these students as they progress through medical school, residency training, the board certification process, and into academic-faculty positions are included in this unique, extensive database.

The researchers tracked the 3 percent of students in that database who were enrolled in MD-PhD programs at the time of medical-school matriculation, with follow-up data obtained at least 10 years after matriculation for all students. Using de-identified data, they examined nine predictor variables in association with the following three educational outcomes: MD-PhD graduation, graduation with only an MD, and withdrawal/dismissal from medical school; students still enrolled in medical school at follow-up were not included in the study. Demographic variables examined included gender, race/ethnicity, age at matriculation, and total premedical debt, all self-reported by the students. The AAMC provided information for matriculation year and composite Medical College Admission Test (MCAT) scores. Based on MSTP-funding records from 1995 to 2000, the researchers created a variable defining the institutional MSTP funding status of each medical school to which students had matriculated; the AAMC then created a variable for the 39 medical schools that had received MSTP funding for at least some of the years between 1995 and 2000 ("MSTP-funded" schools); the remaining 90 schools that had not received any MSTP funding during this time period were categorized as "non-MSTP-funded" schools. Students also reported,

at the time of matriculation, their career plans for involvement in research and their intended career setting. The researchers included all nine predictor variables in each of two multivariable logistic regression models to identify independent predictors of (1) MD-only graduation versus MD-PhD graduation (reference group) and (2) medical school withdrawal/dismissal versus MD-PhD graduation (reference group).

The final study sample of 2,582 MD-PhD program enrollees included all students in the database who had entered medical school from 1995 to 2000, reported MD-PhD program enrollment at the time of matriculation on the MSQ, had complete data for all other variables of interest, and were no longer in medical school as of July 2011 (students still in medical school at follow-up were not eligible for inclusion in the study). Of these 2,582 MD-PhD program enrollees, 73 percent were MD-PhD graduates, 23 percent were MD-only graduates, and 4 percent had withdrawn/were dismissed from medical school. Most of the sample (67 percent) was men, but gender was not independently associated with either MD-only graduation or medical school withdrawal/dismissal. About 64 percent of the sample population was white, 24 percent Asian/Pacific Islander, 10 percent from groups historically underrepresented in medicine, and one percent of other/unknown race/ethnicity. Race/ethnicity was not independently associated with MD-only graduation but was independently associated with medical school withdrawal/dismissal: compared to white enrollees, enrollees from groups historically underrepresented in medicine were more likely to have withdrawn/been dismissed from medical school. Andriole said. "For physician-scientist workforce diversity, I think it's very important for us to realize that women are not significantly more likely to drop out of MD-PhD programs, when other factors are also considered in the analysis. As long as we increase women's enrollment in MD-PhD programs," she explained, "we're going to see a concomitant increase in the number of women MD-PhD program graduates." However, the data suggest that the same may not be true for underrepresented minority groups.

Compared to enrollees younger than 23 years old at matriculation (59 percent of the sample), enrollees who were 23 or older at matriculation (41 percent of the sample) were more likely to be MD-only graduates; and enrollees over 28 years old at matriculation (3 percent of the sample) were also more likely to have withdrawn/been dismissed from medical school. The proportion of those MD-PhD program enrollees who were MD-only graduates declined sharply in the more recent years of matriculation during the study period, Andriole said, which indicates a decline in PhD program attrition over these years. Indeed, more recent matriculation year was independently associated with a lower likelihood of MD-only graduation. The proportion by year of enrollees who had withdrawn/were dismissed from medical school remained fairly consistent over the study period, and the researchers did not observe an independent association between matriculation year and medical school withdrawal/dismissal. Premedical debt also was not independently associated with either MD-only graduation or medical school withdrawal/dismissal. However, compared to MCAT scores ≥ 36, MCAT scores < 34 were associated with a greater likelihood of MD-only graduation.

About two-thirds (67 percent) of all MD-PhD enrollees had matriculated at one of the 39 MSTP-funded medical schools; the remaining 33 percent of MD-PhD enrollees had matriculated at one of the 90 non-MSTP funded medical schools. Matriculation at non-MSTP-funded medical schools was associated with an increased likelihood of MD-only graduation and also with an increased likelihood of withdrawal or dismissal from medical school. Eighty-three percent of all MD-PhD program enrollees indicated career intentions to enter academic or non-university research scientist positions, 8 percent were undecided, 4 percent indicated full-time clinical practice intentions, 4 percent indicated other career intentions, and 2 percent did not indicate any career intentions. Compared with career intention to enter academic or non-university research scientist positions, full-time clinical practice intention was associated with an increased likelihood of MD-only graduation. In addition, greater planned extent of career involvement at research at matriculation was associated with a lower likelihood of MD-only graduation. Neither career intention at matriculation nor planned extent of career involvement in research at matriculation independently predicted medical school withdrawal/dismissal.

The number of years that MD-PhD program enrollees remained in medical school was not considered as a predictor variable, Andriole explained. Most students take eight or more years to finish the dual MD-PhD program requirements. The researchers did observe that many MD-only graduates were in school for nearly six years, which suggests that they had spent at least two or three years in the laboratory before they decided to discontinue their PhD program enrollment. In closing, Andriole noted that among all MD-PhD program enrollees, 73 percent completed the PhD-degree program requirements, and 96 percent completed medical school. The numbers compare favorably to National Research Council data for biomedical science PhD completion rates and to AAMC data for medical school graduation rates, respectively.

RETHINKING THE WORK–LIFE INTEGRATION PROBLEM IN ACADEMIC MEDICINE

"I really resonate with the comments that have been made today about all the different interventions you need to implement in an organization to move the needle on diversity," said Caroline Simard, associate director of the Office of Diversity and Leadership at Stanford University. "You can't just focus on recruitment, just focus on retention, just focus on advancement—you need an arsenal of interventions."

"You can't just focus on recruitment, just focus on retention, just focus on advancement—you need an arsenal of interventions."

—Caroline Simard, Stanford University

Simard and her colleagues are using a multifaceted approach to define a new framework for developing faculty careers. Some of the variables affecting women, particularly underrepresented women, have to do with work–life balance. The United States has a physician shortage, Simard pointed out, and an aging faculty workforce, with a 50 percent increase in the proportion of faculty over age 55 in the last several decades. "That means that Stanford is looking more and more at how we support faculty in ramping down their careers to make room for the next generation of physicians," she said.

The perception that faculty careers are not conducive to work–life balance is turning students away from academia, Simard said. Academic positions compete with a robust private market, and the generational shift is intensifying the conversation around work–life balance. The shift toward couples having dual careers is also challenging traditional advancement structures.

Over the past several years, Stanford has been trying harder to understand and adopt policies that reflect the importance of work–life balance issues on campus, Simard said, but work–life balance was still coming up as a critical issue for faculty. To understand the problem better, the researchers triangulated results from a university-wide quality of life survey, a survey of 74 faculty who resigned between 2005 and 2009, and the AMC Coach Faculty Forward benchmarking results from 2009. They also conducted nine focus groups with assistant professors, involving about 100 faculty participants, and conducted ethnographies of eight faculty members, following each of them through a day of work.

"Despite significant investments in flexibility policies at Stanford, work–life integration remains a critical challenge," Simard observed. The majority of faculty at Stanford report working over sixty hours a week, and the medical school faculty had the highest mean number of hours among all departments, at 65 a week. Benchmarking against other institutions reveals that Stanford is not doing well. "We heard from a lot of faculty in our focus groups and in the ethnographic study that the bar for success was always higher, and it was impossible to meet that standard," she said.

In junior faculty focus groups, work–life balance was the second most cited cause of concern after career advancement. Only 40 percent of faculty agreed that the culture at the School of Medicine is supportive of balancing work and home. The study found that pressure was especially strong for faculty who do clinical care as well as research. Among those who resigned, faculty on the clinical line were significantly less likely to report that they were satisfied with their work–life balance.

In the focus groups and ethnographic work, the researchers found an inherent difficulty in combining all the missions of the School of Medicine, including clinical care, research, teaching, and service responsibilities. "These competing demands are not appropriately recognized and acknowledged in the workload distribution and the promotion process," Simard said. Faculty overwhelmingly felt that they spent too little time on research and teaching and too much time on clinical care and other activities. The main source of dissatisfaction was not flexibility policies but how work was allocated and recognized at the university, she explained. Faculty felt that teaching, patient care, and service were undervalued. They reflect a "misalignment with the

culture of academic medicine and the perceptions of the faculty of what it takes to be successful at Stanford," she said.

The feedback they received about the core values of medical faculty revealed that many feel it is not worth the risk to stray from the established path, that success is about individual accomplishment, and that they have to keep score and always be advancing their careers. Simard said they heard from women who took only two weeks of maternity leave because they felt they could not take more or their careers would suffer.

The top two reasons for not taking advantage of flexibility policies at Stanford were worry over looking less committed and placing undue burden on colleagues. "There is a fear of using the policies" that exist, Simard said.

Recommended Interventions

To improve the situation, the researchers came up with a several interventions that seek to frame flexibility as part of the career advancement process. "We want to promote transparent conversation around allocation of work based on the talent management and organizational development and change management literature," Simard said. She referenced Deloitte's Mass Career Customization model, which successfully shifted workplace culture from a lack of work–life integration to one where that integration is part of the career planning process.

Their framework also involves career customization, where individual faculty members can talk to the chief or department chair about what they are looking for and how to achieve their goals. The discussion considers the needs of the individual as well as the needs of the department. "This is a significant shift from the way we're thinking about academic careers right now," Simard said. The school will also offer couples career coaching, advanced family benefits, and practical home rewards such as zip cars and free bicycles.

The researchers identified seven pilot teams that wanted to participate in interventions, although Simard pointed out that the experiment is really six different pilot programs, because no team is the same. "We have to translate this and work with them to co-create this in a way that's going to work for them," she said.

Their goal for the first few years is to understand whether their approach is feasible and which parts are most beneficial to faculty and departments. They will measure whether faculty satisfaction, perceived productivity, and perceived work life balance increase. "We do have a selection bias in our first round," Simard said, explaining that the teams participating in the pilot are more willing to try something new. Based on their findings, they planned to roll out new policies based on the pilot.

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Data for Interventions

Interventions research requires careful attention to data collection and analysis, given the complex social contexts in which interventions occur. Three presentations at the conference focused specifically on data issues as a guide to other researchers.

DATA BUDDIES: PARTNERING FOR COMPARISON DATA

Gathering comparison data is a major evaluation challenge for STEM diversity interventions. Kenneth Hines and Delicia Mapp, researchers at the Computing Research Association at the time of the conference, described an innovative way of overcoming this challenge: the Data Buddies project.

The Widening the Research Pipeline Alliance (the Alliance) encourages underrepresented students to go to graduate school, earn PhDs, and become researchers in the computing fields (computer science, computer engineering, and information). It is a joint project of the Computing Research Association Committee on the Status of Women in Computing (CRA-W) and the Coalition to Diversify Computing (CDC), one of 13 Alliances funded by the National Science Foundation through the Broadening Participation in Computing Program. CRA-W provides a workshops and other activities to encourage women on the path to computing research, while CDC primarily focuses on recruitment, attrition, and transitions of underrepresented minority students in computing careers.

The Alliance runs a collaborative REU (CREU) that provides research mentoring for computing students, who work in teams at their home institution, and a distributed REU (DREU) that takes place at faculty mentors' home institutions over the summer. From 1998 to 2011, 542 undergraduate underrepresented minorities and women across the United States participated in

CREU, and over 220 CREU projects were funded. There were 643 participants in DREU, and 96 different research universities hosted DREUs.

According to pre- and post-program and tracking surveys, 30 to 40 percent of DREU and CREU students later enrolled in graduate school, mainly in PhD programs. The surveys indicated that students felt more like a part of the research community as a result of the programs, that they had more knowledge about admission to graduate school, and that they had a better idea what computing research was like.

However, because there was no control group, these programs have struggled to answer the "so what" questions. Do outcomes of program participants differ from outcomes of non-participants? To establish a comparison group with the same characteristics as the REU participants, the BPC partnered with institutions across the United States They called it the Data Buddies program and sought to construct comparison groups made up of computing undergraduates at those institutions. "The focus of the Data Buddies project was to become a national resource for data on students in computing," Hines said.

"The focus of the Data Buddies project was to become a national resource for data on students in computing."

—Kenneth Hines, Computing Research Association

Before embarking on the project, researchers looked for already existing information on computing undergraduates but could not find any useful data. They then sent letters to the chairs of computing departments around the country whose students had participated in CREU, DREU, or other Alliance activities in previous years, asking for help with data collection. The researchers categorized the programs being surveyed by type: top-ranked PhD program, other PhD program, master's only, and bachelor's only. "We specifically over-sampled minority serving institutions to get more historically Black colleges and universities in the mix," Hines said. They offered a department stipend and department report for institutions going through a self-evaluation, so participating institutions could see how they compare to others involved in the survey.

Institutional Data

Mapp discussed the data the program had acquired as of 2012. The surveys asked students about their experiences in their departments, their experiences with mentors, whether they were involved in research, what kind of research it was, and the extent of their professional networks. The researchers also asked students for their highest degree intentions and post-graduation plans.

Data from students graduating in the spring of 2011 were gathered from 45 departments, and the researchers received 706 responses from undergraduate students and 555 from graduate students. In the fall of 2011, they surveyed continuing students and received information from 50 departments, 2,329 undergraduates and 1,260 graduate students.

The spring survey revealed that non-participants in CREU and DREU programs from the undergraduate cohort were less likely to have applied to graduate school in computing, to be attending graduate school in the fall, and to be enrolled in a PhD program if they were going on to graduate school. The participants in the programs were more likely to report having their research adviser as a mentor and more likely to have a mentor who discussed their graduate school options.

When the researchers looked at the data to find out how non-participants with research experience compared to REU program participants, they found that even undergraduates with some research experience did not perform as well as the program participants on the metrics used in their study. Graduate participants in the REUs appeared to have stronger professional networks than the non-participants, with 87 percent having a good amount of knowledge about developing their professional networks, and 71 percent served on departmental conference or professional society committees during their graduate career.

The researchers were able to gather information about why undergraduates might not participate in research, finding that it varied by demographic categories. All students cited time constraints as a factor, but women were more likely to say that research did not draw their interest, and underrepresented minorities were more likely to apply but be turned down from research opportunities. Non-minority students were more likely to say that research did not pay well enough.

The fall 2011 survey showed that participants in the REU programs were more likely to attend national and regional diversity conferences, while underrepresented minority students at bachelor's granting institutions who were not program participants were less likely to attend diversity conferences because they were unaware the conferences existed or unable to find information in their department. Undergraduate program participants had more contact with computing professionals, due to national conferences, networking and mentoring workshops and research experience, and graduate participants served on more departmental conference or professional society committees than did non-participants. Relative to other students within their graduate program, PhD participants report attending an above-average level of conferences, and they were also more likely than non-participants to maintain contact with people they met outside their home institutions.

"During the development stage of Data Buddies, it was always known that we would be able to produce data that will go beyond what we found when we compared participants and non-participants," Mapp said. "We knew our data had a lot of potential, but now we have great information."

IMPROVING THE EVALUATION OF BROADENING INTERVENTIONS EFFORTS

The National Science Foundation has the resources to do good evaluations of educational interventions, said Patricia Campbell, president of Campbell-Kibler Associates. However, it does not always pay enough attention to diversity within populations or to the implications of diversity for the quality of that evaluation. "Every population we work with is diverse," she said. "Some of the characteristics of diversity are very obvious, some are not. We all come from a multiple of diversities. We're not just one thing."

Based on this premise, Campbell and her colleagues set out to identify potential threats to collecting and receiving complete and accurate information from different subgroups and to define ways in which data collection efforts are more or less valid for different populations. Their goal was to provide practical advice that can help program directors and evaluators improve the evaluation process. These are important issues, Campbell said, because without having evaluation methods targeted towards the needs, issues and goals of different subgroups, the results can be incomplete and even inaccurate, which can help to explain why, in spite of our efforts, statistics show that the proportion of science and engineering undergraduate degrees awarded to women and to African-Americans and American Indian/Alaskan Natives has not grown in critical areas.

Overcoming Threats to Accurate Data

Campbell highlighted eight areas that are threats to the collection of accurate data: what demographic information is asked, when demographic information is asked, the physical environment, how data collection is introduced, the obviousness of measures used, the accessibility of measures used, what is known about the students, and the identities of the interviewer and interviewee.

Some sources of threat in demographic information, she explained, are the categories used for race and ethnicity, not asking about first-generation status, and not asking about disability status. Solutions are to listen more carefully to how group members speak of themselves and refer to others and think about open-ended questions where people describe for themselves the groups to which they belong. She advised attendees to break down racial, ethnic and disability categories as far as possible. Categories used in the Census, she felt, are probably the closest we have to standard categories.

When demographic information is asked first, she continued, it can affect how participants think they will be viewed, how they view themselves, and their performance on an academic test. By placing demographic information last and giving a rationale as to why these data are important, that threat is lessened.

The physical environment in which participants take a survey or participate in programs can affect their responses. A 2009 study showed that when students are asked about their interest in computer science, if the décor is

more neutral, and not focused on stereotypes associated with computer science like Star Trek and video games, women's interest in computer science is higher than when they are questioned in the stereotyped environment. Campbell urged evaluators to consider whether the environment for students is comfortable and neutral and whether it reinforces dominant group stereotypes. She added that evaluators need to pay attention to not reinforcing stereotypes in their oral and written introductions to evaluation measures as well. Her advice was to include an explicit statement that the measures are not biased and to avoid telling participants what the evaluation is seeking.

The obviousness of the measures used also plays a role in the response, Campbell said. Studies have shown that responses from white students to multiple-choice questions about race were very different than their answers to in-depth questions, and gender differences were more pronounced in tests where it was obvious what was being measured and what was being measured was tied to stereotypes. One way to avoid this is to use several different measures and triangulate, or to have members of the target population review questions for clarity and obviousness.

If students cannot read or understand a measure, they will not complete it accurately, so it is important to use universal design in development of measures, Campbell added. Such designs should have clearly defined constructs, accessible and non-biased items, and simple, clear instructions.

A body of research on gender and racial/ethnic biases exists in ratings of open-ended responses, research work, faculty evaluations, and résumés. "Women and men of all races tend to be biased in their ratings," said Campbell. "This is across the board." Evaluators should make their ratings as blind as possible, Campbell advised, to avoid issues with bias. In interviews, the more different the identities of interviewer and interviewee, the more likely it is that those differences will lead to nonrandom measurement error. To as great a degree as possible, she said, evaluators should have interviewers and interviewees with similar identities, work to build trust between participants, and check conclusions with the interviewee to make sure their responses are accurately interpreted.

"Women and men of all races tend to be biased in their ratings. This is across the board."

—Patricia Campbell, Campbell-Kibler Associates

Good evaluators should have strong knowledge and expertise and experience in the field(s) being evaluated and with the populations included in a project, Campbell said. They should be able to offer evidence that their evaluation plan takes into account the diversity of cultures where the evaluation will occur, and they should validate instruments and interview protocols for the different populations. Their evaluation plans should also indicate that individuals have multiple identities and reflect an understanding of the complexity of disaggregation and reaggregation.

Campbell quoted the American Evaluation Association's definition of cultural competence to conclude her presentation, saying that "culturally competent evaluators respect the cultures represented in the evaluation throughout the process," adding that there is still considerable room for learning.

EXPANDING STEM GRADUATE ADMISSIONS: A CASE STUDY

Interventions need to be continually re-evaluated and the resulting data used to improve institutional practices, said Colette Patt, diversity director in the Division of Mathematics and Physical Sciences at the University of California, Berkeley. Patt examined this approach by discussing the Berkeley Edge Conference, which was designed to introduce promising undergraduate seniors who are members of underrepresented groups to the campus and to the faculty before the students start the graduate application process. Most participants are from colleges and universities that are not Berkeley's typical feeder institutions, and most report that they would not have considered applying to Berkeley without the intervention that the conference represents.

The study of the program used a variety of data types for triangulation, including cohort analysis, archival research, informal participant observation, and comparison groups. However, the conference is just one of many diversity efforts on campus, and establishing causation remains difficult. Nevertheless, correlations can provide insights, if not proof, Patt said.

The conference is held over three days with about 50 participants. It introduces students to the academic community and to the departments on campus, as well as to graduate student organizations. The object is to provide practical advice in an encouraging context. In this spirit, two Berkeley Nobel prize winners in physics have spoken at the conference during the years in which they won the award. Conference organizers have developed about 3,000 contacts around the country who send students, and they maintain a high bar for selection, with conference applicants being reviewed by faculty who sit on admissions committees. From the outset, Patt explained, they have been searching for students who have a shot at admission.

Outcomes

Over the 11 years the conference had been running as of 2012, almost 1,800 students had applied and nearly 600 had attended. Of those attendees, 257 applied to Berkeley after attending, roughly half were admitted, and 88 students accepted admission. The conference participants represented 18 percent of Berkeley's incoming graduate students over that time period. Head counts for underrepresented minority students in STEM at Berkeley have gone up in relation to overall enrollment, she added. Somewhere between 30 and 40 percent of that increase is accounted for by the conference. "When we look at the data, we see that in fact the students that we recruit to this conference do fit a different academic profile from most of our Berkeley graduate students," Patt said. "We are able to conclude that this event helps us to extend beyond our conventional applicant pool."

"This event helps us to extend beyond our conventional applicant pool."

—Colette Patt, University of California, Berkeley

Of the 88 students who attended Berkeley after being involved in the conference, 5 had left, 17 had earned a master's degree, 24 had earned PhDs, and 41 were still at the university. Though retention studies generally require an 11-year window, Patt pointed out, these results still yield some insights. In the very early cohorts, for example, retention is fairly typical compared to retention rate in their respective departments.

Based on the results available to date, the conference has been satisfying the goals for which it was intended, said Patt. It has built community and reinforced an inclusive academic culture. It also has pointed out where the challenges are and has suggested how to leverage the approach differently at different levels. "This conference is a valuable part of our overall strategy."

Enlisting a consortium of institutions to conduct the conference, rather than having it remain an isolated event on the Berkeley campus, would be a huge benefit, Patt concluded. Some of the students who apply and are not admitted to Berkeley, or who attend but the conference but do not apply, could fit very well with other institutions and departments.

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Funding of Interventions Research

NIH and NSF funded much of the research at the conference, and in a special plenary session, representatives of each agency described their goals for this research.

NIH FUNDING OPPORTUNITIES

The National Institute of General Medical Sciences (NIGMS) has been supporting the Research to Understand and Inform Interventions that Promote the Research Careers of Students in Biomedical and Behavioral Sciences program for about a decade. As the most recent announcement states, the program "supports research that tests assumptions and hypotheses regarding social and behavioral factors that might inform and guide potential interventions intended to increase interest, motivation, and preparedness for careers in biomedical and behavioral research, with a particular interest in those interventions specifically designed to increase the number of students from underrepresented groups entering careers in these fields."

"We want this not simply to be an examination of extant programs," said Clifton Poodry, who was director of the Division of Minority Opportunities in Research at NIGMS at the time of the conference. "We wanted this to be a deeper examination, [yielding] a deeper understanding." Applications for good research have to have a sound theoretical basis and be driven by a strong hypothesis. Researchers need to pay attention to social and cultural aspects of the student populations to be studied and explicitly identify assumptions that underlie either past or proposed interventions. Good comparison and control groups, good data analysis, contemporary methodology, adequate sample size, and an understanding of anticipated outcomes or lessons learned are all important elements in interventions research, Poodry said.

Poodry's colleague Mona Trempe encouraged applicants to read the funding opportunity announcement carefully. As the organizer for the review for the program, she said, she has seen applications evolve over time. Asking good questions, finding appropriate methods, and having the right team are the three essential elements for a successful proposal.

In the early years, program applicants exhibited some confusion about the distinction between evaluation and research. The funding opportunity is not about evaluating program success, Trempe said. A good research question will test assumptions and standard practices. Applicants should know whether the question or study has the potential to lead to an increase in understanding of current practices or design of new practices. "We want to inform scholarship practice as well as policy," she said.

The Keys to Success

An analysis of the five scored criteria for RO1s at NIGMS has demonstrated that a strong approach is most highly correlated with a successful application and getting funding, Trempe observed, but different approaches are necessary for different types of research. If the proposal uses a quantitative approach, statistical power must be sufficient; if the approach is qualitative, the methodology must be appropriate to the study. "If you're doing data mining, make sure that it's clear that you have access to the databases you are talking about using," Trempe cautioned. Proposals to construct new databases, she added, must have a clear rationale and must demonstrate the need for such resources.

The research team is also an important component of a successful proposal. "An underlying theme of this entire meeting is that we are bringing together people from very disparate disciplines who not only don't normally talk to one another, but when they do they are often speaking different languages. You really need to make sure that, in your preparation of the application, all of these voices are heard and all of the different complementary expertises are represented," Trempe said.

Awareness of the audience reading an application is critical, she added. If an application proposes many different methods, the review process will bring in people familiar with those methods to read it. Proposals also need to plan for how they will generalize the results. The population of study often needs to be limited, but the results should be able to inform interventions for other populations. The application also should provide a strategy for disseminating results among a broad community, so that results are shared with all of the disciplines involved in doing the work.

The funding opportunity is announced yearly, in the NIH guide and on the NIGMS website. "One of the past deputy directors of NIH said there is no amount of grant sponsorship that will turn a bad idea into a good one, but there are many ways to disguise a good idea," Trempe concluded.

"There is no amount of grant sponsorship that will turn a bad idea into a good one, but there are many ways to disguise a good idea."

—Mona Trempe, NIGMS

NSF FUNDING OPPORTUNITIES

"Many people come up with very well intentioned programs based on instinct and intuition—and they are effective—but the bottom line is that we need to know why and we need to use that to be able to go forward," said Kellina Craig-Henderson, visiting scientist at NSF at the time of the conference. The Science of Broadening Participation (SBP) program at NSF supports empirical work that answers fundamental questions about what works and what does not work.

"What we are envisioning at NSF is a program that cuts across all levels of analysis," Craig-Henderson explained. The program can encompass many different approaches and is seen as an opportunity to encourage collaboration among researchers from different fields. Many social scientists have been working in this area for a long time, she explained, but their results have not been generalized or applied. Meanwhile, STEM professionals are creating programs without a firm understanding of social, behavioral, and economic variables.

NSF wants to take "a scientific approach to answer these questions," Craig-Henderson observed, which sometimes yields counterintuitive results. For example, entry-level salaries for women are often less than for men, and many people have drawn the conclusion that women do not negotiate well for themselves, which has led to the development of programs to help women be more assertive. But a series of studies by a former NSF researcher showed that assertiveness can detract from women's likeability, further disadvantaging them.

Research on broadening participation is inevitably interdisciplinary and informed by social and behavioral science theories. It also has the potential to be transformative, said Craig-Henderson. "This kind of work has the potential to disrupt our existing paradigms."

"This kind of work has the potential to disrupt our existing paradigms."

—Kellina Craig-Henderson, NSF

Toward a Foundation-Wide Program

Like the program at NIH, the NSF activity is not focused on program evaluation, Craig-Henderson explained. It also overlaps with many other activities at the foundation. For example, a collaboration with the directorate that funds social and behavioral sciences at NSF and with the education and human resources directorate will enable NSF to expand and energize resources and efforts in interventions research, and the mathematics and physical science directorate at NSF is very interested in providing support for this kind of initiative. The end goal, she said, is a foundation-wide program in the science of broadening participation.

Craig-Henderson did say she was disappointed with the length of time it has taken to get a program up and running. She attributed the difficulty in part to a lack of appreciation for the ways that social science can help address issues in broadening participation. She also acknowledged that applied research does not have the same cachet as basic research in the social science fields. However, NSF is considering how it can elevate researchers and encourage investigators to engage in applied research, including interventions research. "There is, however gradual, a shift in appreciation for those kinds of integrative approaches.

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