UNDERSTANDING INTERVENTIONS
THAT BROADEN PARTICIPATION IN RESEARCH CAREERS

VOLUME VIII

Collaborative Interventions

SUMMARY OF A CONFERENCE
PHILADELPHIA, PENNSYLVANIA, FEBRUARY 26–28, 2016

Anthony L. DePass and Daryl E. Chubin, Editors

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

Conference Staff

CO-CHAIRS

Anthony L. DePass
Long Island University–Brooklyn
Brooklyn, New York

Daryl E. Chubin
Independent Consultant
Savannah, Georgia

PLANNING COMMITTEE MEMBERS

David Asai
Howard Hughes Medical Institute

Phillip Bowman
University of Michigan

Calvin Briggs
Lawson State University

Goldie Byrd
North Carolina A&T University

Bradley S. Duerstock
Purdue University

Luis Cubano
Universidad Central del Caribe

Angela Ebreo
University of Michigan

Portia Flowers
University of Missouri

Barry Komisaruk
Rutgers University

Kelly Mack
Project Kaleidoscope
American Association of
*   Colleges and Universities*

John Matsui
University of California, Berkeley

Richard McGee
Northwestern University
Feinberg School of Medicine

Clifton Poodry
Howard Hughes Medical Institute

Claudia Rankins
National Science Foundation

Laura Robles
California State University,
*   Dominguez Hills*

Alberto I. Roca
DiverseScholar

Yoel Rodriguez
Hostos Community College

Lydia Villa-Komaroff
Cytonome/ST, LLC

CONFERENCE PLANNING TEAM

Shanta Outlaw
Long Island University–Brooklyn

Carleta Joseph
Long Island University–Brooklyn

Anthony L. DePass
Long Island University–Brooklyn

Daryl E. Chubin
Independent Consultant,
    Savannah, Georgia

Contents

Preface

Many professionals face the challenge of finding and interacting with people who do some of the same things, but different things as well. The Understanding Interventions project was begun in 2007 partly to address that challenge. For the past decade, it has been bringing together, both at its annual meetings and online, people involved in the quest to increase the number of underrepresented minorities in science careers, including researchers in the life sciences and physical sciences, program developers and directors, social scientists, policy makers at the federal and state levels, representatives of professional societies, university administrators, and students. Of course a major goal of the project has always been to bolster the research base on which decisions are made. But the Understanding Interventions movement also was translational before translation became popular, focusing on the conversion and implementation of empirically based knowledge in real educational settings. And it has emphasized the movement of knowledge from practice to research so that the growth of understanding begets a cumulative and virtuous cycle of improvement.

The two of us had no idea, when we began the project, that it had so much potential to grow. The 2016 conference in Philadelphia was the largest yet, with more than 300 registrants. Over the course of two and a half days, participants took part in five plenary sessions, ten workshops, and eighteen symposia, six deeper dives, and 108 abstracts. Meanwhile, the Understanding Interventions website—*www.understanding-interventions.org*—has continued to expand and evolve, with the addition of new information, features, and capabilities. A thriving community has taken shape around the idea of understanding interventions to broaden participation in science careers, and the signs of progress are abundant. For the two of us, diversifying the research workforce has become a lifetime commitment.

The 2015 conference in San Diego featured the first demonstration of the Understanding Interventions Index, which continues to grow and develop as a user-friendly database of interventions articles and other resources. The UI Index includes a list of journals that publish interventions research, reports of relevance to the community, a database of research funded by the National Institutes of Health on interventions, browsable reports, and electronic versions of the reports summarizing each of the previous Understanding Interventions conferences.

At the Philadelphia conference, another extension of our work was unveiled. Since the beginning of the conference series, we have heard a familiar question from attendees: Where can I publish interventions work? Though many journals do publish such work, no one journal has been devoted to this task. As a result, the project has launched an online journal, edited by the two of us, with John Matsui from the University of California, Berkeley, and Janet Bradshaw from the University of Wisconsin-Madison serving as associate editors. The idea is not only to publish top-quality, peer-reviewed work but to make sure that people get professional credit for doing so. Initial plans are to publish a letters section, a communications section with longer contributions, and a section of full articles. Parts of the journal could appear on fixed publication dates, with other parts appearing on a rolling basis, depending on the needs of the community. Post-publication review will allow identified members of the community to comment on, augment, criticize, and otherwise respond to what has been published. The idea behind the journal is to speed and diversify dissemination, bring more people into the community, and increase collaboration. As with other aspects of participation in the Understanding Interventions community, any necessary publication fees will be kept at minimal levels to ensure the broadest possible participation.

This printed summary of the conference, which has been published after every Understanding Interventions conference, is also undergoing changes. Individual summaries of presentations are now available through the UI website. Video recordings of the plenary sessions are available online for those who want to view highlights of the meeting. While the printed reports will continue to provide a useful, stand-alone, and non-electronic summary of each meeting, they also will be available online for people who want to access the information that way.

A particularly enjoyable part of the Understanding Interventions conferences has become the recognition of prominent thinkers and doers in our field through two annual awards. At the Philadelphia conference, the Intervenor Award went to Martin Chemers, professor emeritus at the University of California, Santa Cruz, "in recognition of long-term, sustained support of research, policy, and practice that create opportunities for individuals and organizations to prepare for and ascend to careers in science." A member of the steering committee for the first Understanding Interventions conference, Chemers has been a researcher, a leader, and an educator of the next generation of interventions researchers. As Clifton Poodry said in presenting the award, Chemers created an opportunity "to bring people together to start a community or practice where they could share methodology, in a friendly

and constructive way critique each other, and train students, colleagues, and those of us in government."

The recipient of the Tol Award—named for Adolphus "Tol" Toliver, the head of the Minority Access to Research Careers program at NIH—was Wesley Schultz, professor of psychology at California State University, San Marcos, and his colleagues Anna Woodcock, Mica Estrada, and Paul Hernandez, who have spent more than ten years studying the effects of the NIH programs that support minorities in biomedical research, in the process developing tremendous stores of intellectual capital, knowledge, and expertise. (Chapter 4 of this year's conference summary includes a description of some of the research done by Schultz and his colleagues.) The Tol Award, which goes to a team of early- or mid-career investigators for work on understanding interventions, recognizes both past work and the potential of ongoing research to change lives in the future.

The Understanding Interventions movement has always been oriented toward the future. In 2016 the project made more than 40 travel grants to individuals, enabling more young people to come to the conference than in past years. In an innovation introduced at the conference, selected symposia featured "deep dives" in which attendees were invited to sit with presenters at individual tables, pursue issues in greater detail, and discuss ways to translate research into action. Our activities have always been characterized by their multidisciplinarity, which is becoming an ever more prominent part of science in general. As one conference attendee said in the final plenary session, the Understanding Interventions movement "is not only an opportunity to make change at the local level, it's an opportunity to change the world."

Anthony L. DePass
Daryl E. Chubin

1

Overcoming Bias

A fundamental issue at all of the Understanding Interventions That Broaden Participation in Science Careers conferences has been how best to overcome the biases that contribute to the underrepresentation of many minority groups in science, technology, engineering, and mathematics (STEM) fields. These biases can take many forms. They can be explicitly expressed, as when an African American woman was told in a job interview "Your résumé didn't look Black," as one speaker at the 2016 conference recounted. Or they can be implicit, reflecting broader cultural and social influences that subtly shape interpersonal interactions.

In the initial plenary session at the 2016 conference, three speakers examined the Algebra Project and a successor project based in the Civil Rights movement, the Young People's Project, as a case study of academically oriented programs that seek to counter the effects of bias on the education of minorities in STEM fields. The second plenary session turned to gender bias, which shares many characteristics of racial and ethnic bias but affects an even larger group of people (and can be cumulative, as when gender bias is directed toward minority women in STEM fields). As all of the speakers noted, the habits of mind that contribute to bias can be changed, but doing so requires awareness, effort, and practice. Several workshop and symposium speakers examined possible ways of reducing bias, ranging from the use of video games to the cultivation of critical race consciousness to social support for first-generation students.

MATHEMATICS EDUCATION AS A CIVIL RIGHT

The Algebra Project was founded in 1992 by the civil rights leader Robert Moses, who was a field secretary for the Student Non-Violent Coordinat-

ing Committee in the 1960s. In the 1980s he used fellowship funds from the MacArthur Foundation to lay the foundation for a project that would treat mathematics literacy as a critical civil right for the modern age. As Chad Milner, national director of technology, media, and communications for the Young People's Project, said in the initial plenary session of the conference, Moses came to see mathematics education, and particularly algebra, as "the key to 21st century citizenship for disenfranchised students."

The Algebra Project seeks to motivate disadvantaged students to over-come the personal challenges and institutional obstacles that stand in their way, said Milner. It engages students, parents, community members, and mathematicians to reform mathematics curriculum and pedagogy so that students can succeed. It builds on students' experiences and knowledge to develop facility with mathematical concepts and language. Students double up on mathematics classes and work with teachers who have been trained to use effective pedagogies and curriculum materials. Its goals are to increase the graduation rate for high school students and to increase their readiness for college-level mathematics.

The Young People's Project began in 1996 as an outgrowth of the Algebra Project. Its approach is similar to that of the Algebra Project, said Milner, but it focuses on out-of-school interventions and the use of trained high school and college students to teach their younger peers. Currently active in eight cities, the Young People's Project works jointly with the Algebra Project in some places and is independent in others.

One way that the Young People's Project seeks to interest students in mathematics is through the use of games and experiential learning. For ex-ample, the Flag Way game helps students in the third and fourth grades become familiar with prime factorization and other skills that will be critical when they begin to study algebra. These grades are "a key time for students in terms of their math development and their trajectory in terms of success in mathematics," said Milner. The Young People's Project "meets students where they're at and allows them to think critically about numbers in a way that maybe they're not being asked to do in the classroom."

The Algebra Project has proven to be an effective intervention, not only in terms of producing effective teaching and learning environments but in solv-ing complex and system problems in American education, said Frank Davis, who was president of the research and evaluation firm TERC from 2007 to 2014 and has been involved as an evaluator of the project for almost 25 years. In addition to its development of curriculum materials and teacher profes-sional development models, the project has organized communities and moti-vated students to serve those communities. "The Algebra Project was not just about one thing," said Davis. "It was a project with a big goal—the idea that people should come together to think about how to solve [a big] problem."

Evaluations have repeatedly demonstrated the value of the project, Davis observed. For example, from 1997 to 2001, the project attracted over 700 teach-ers into professional development institutes and workshops. Almost a third participated more than the 100 hours they were expected to put in, and 17 percent participated from 150 to 400 hours. Another evaluation found that, in an elementary school near Beaufort, South Carolina, where nearly all the

students are African American and qualify for free or reduced cost lunch, the fifth grade's state mathematics test scores rose from 20 points below the state average in 1999 to 25 points above the state average in 2004. At that point, 80 percent of fifth graders were performing at or above proficiency in mathematics, which was a higher rate than in the nearby schools of Hilton Head. In fact, the higher scores and new approach to teaching mathematics eventually became a political problem, according to Davis, and contributed to the principal of the school eventually being replaced.

The Algebra Project and Young People's Project also have been working on computing skills with students. In particular, high school students learn programming skills that they then can teach to younger students. As one high school student interviewed for an evaluation put it, "I used to think computer programming was just for people at MIT. Now I know that I can do it too."

A new innovation being used in the Young People's Project is a cohort model in which a group of students have the same teachers throughout their high school years. In four of the five cohorts studied in one evaluation, students had four-year graduation rates that were significantly higher than before the intervention.

Projects like these, along with their evaluations, often appear to have many different pieces, noted Davis. In response to this issue, the Educational Testing Service has been putting together a theory of action for the Algebra Project that encompasses teacher professional development, summer institutes, coaches, curriculum materials, experiential learning, out-of-school support, and other components. Though the model does not and cannot include all of the relevant factors, "one of the most critical things is to have a view of what the model is and what the outcome is"—which is also a critical objective of the Understanding Interventions approach.

Finally, Jay Gillen, a mathematics teacher in Baltimore City Schools and author of the book *Educating for Uncertainty: The Roles of Young People in Schools of Poverty* (Chico, CA: AK Press, 2014), provided what he called an "on-the-ground perspective of what the Algebra Project looks like." A former English teacher, Gillen embraced the Algebra Project when he switched to teaching mathematics. In a school where the graduation rate was 17 percent, 71 percent of his first cohort of students who began studying with him in ninth grade, graduated—15 of 21 students, with another student graduating after being incarcerated.

Something that Gillen often heard from his students was that they needed jobs during school and after they graduated. Therefore, with funding from the school district and foundations, students who had been through or were currently in the Algebra Project were hired to teach mathematics to middle school students. "Over the past 12 years, the students from the Algebra Project who've done afterschool math literacy work have earned over $3 million through the Baltimore Algebra Project," Gillen said. Students had "cash because of what they know about mathematics, impressing their peers with their new phone or their shoes, or taking a date to the movies because of the money that they had earned through their math knowledge."

When funding for the program was cut because of a budget crisis arising from underfunding of the Baltimore City public schools, students in the

Algebra Project, well versed in the history of Bob Moses and the civil rights movement, became politically active. They represented themselves in court, took their case to their peers and the public, and engaged in "a whole range of political activities . . . coming out of a culture of self-efficacy that was developed in their math classrooms." The students involved in the Algebra Project were from the local community, Gillen observed, so they could demonstrate "that math isn't something brought in from outside of the community; it's something that's entrenched in the community if the circumstances are nurturing."

In the end, a new principal brought into Gillen's school shut the program down. "You would think that, when we were able to demonstrate the 71 percent versus 17 percent graduation rate, the school board would have intervened. But despite a lot of pressure they said, 'No, we have to trust our principals at the building level. If they mess up, they'll be held accountable.'" However, in this case, said Gillen, the principal was actually there to close the school down, which happened two years later, further undermining "the ability of communities to organize themselves for success."

Mathematics and science "emerge naturally from any community that is supported in the ways the human beings need support," Gillen concluded. "There's nothing special about the development of math and science. It comes out of communities naturally. It comes out of families naturally. People want to be around other people doing math and science if the environment is nurturing and appropriate, and we've actually experienced that. . . . We know that young people develop a sense of themselves as complete human beings, including human beings that do math and science, through the work that Bob Moses taught us to do."

During the discussion session, several conference participants praised the Algebra Project and pointed to successes in specific locations. They also asked about the political difficulties it has engendered in some locations. One issue, said Davis, is that some people have not believed that disadvantaged students could do so well in mathematics, leading to accusations of cheating on tests. Another issue is that the pedagogy adopted by the project seeks to make mathematics culturally relevant, which means adopting the language of the community. To some observers, this language can seem foreign in mathematics classrooms, leading to concerns about whether students are learning the mathematics they need to learn. Such concerns can even lead to accreditation problems, one participant observed, which can limit the project's impact and dissemination.

In response to a question, all three presenters emphasized the importance of raising the floor as well as the ceiling of mathematics achievement. Bringing up all students, as opposed to skimming the best students off the top, is a way of getting community support. Students in the lowest quartile of mathematics achievement can tackle even sophisticated mathematical problems if given the necessary support. This approach also reinforces links with the civil rights of students, all of whom deserve an opportunity to succeed.

Gillen also emphasized the importance of preparing students to remain in and contribute to their communities. Several of the student-teachers in his program are now pursuing education degrees and plan to teach in the Balti-

more public schools in the future. "We have to figure out how we change the culture so they want to come back to it."

IMPLICIT BIAS AS A BARRIER TO WOMEN

The passage of the educational amendment of the Civil Rights Act in 1972 essentially made it illegal to discriminate against women in institutions of higher education. With this legislation in place, said Molly Carnes, professor of medicine, director of the Center for Women's Health Research, and co-director of the Women in Science and Engineering Leadership Institute at the University of Wisconsin–Madison, in the second plenary session of the conference, the widespread expectation was that the lack of women in science, technology, engineering, mathematics, and medicine (STEMM) would gradually fix itself as more women entered those fields. So long as STEMM fields were a meritocracy where women's and men's accomplishments were viewed and rewarded equally, and so long as women behaved like men, they would advance at the same rate.

Unfortunately, these expectations turned out to be incorrect, Carnes continued. Instead, unconscious gender-based assumptions and stereotypes deeply embedded in the patterns of thinking of both men and women have continued to contribute to underrepresentation. Research has repeatedly shown that women and work performed by women consistently receive lower evaluations than men, by both men and women evaluators, even if the work is identical. These and other implicit cognitive processes function as habits of mind, said Carnes. But because they are habits, they can be broken.

Despite disappointments at leadership levels, women have made tremendous advances in entering many STEMM fields at the early stages. Women represent about half of all medical students, PhD students in the biological sciences, and residents, Carnes observed. However, their numbers progressively decline at higher levels in the academic hierarchy—to 44 percent of assistant professors, 34 percent of associate professors, 21 percent of professors, 15 percent of chairs, and 16 percent of deans (Figure 1-1). Furthermore, the low numbers at the higher levels of the academic hierarchy have changed very little in recent years.

This lack of representation can have direct consequences for health. As Carnes pointed out, "almost every major advance in women's health is linked to women leaders." For example, the Women's Health Initiative, which was one of the largest multi-center clinical trial ever conducted by NIH, demonstrated that hormone replacement therapy was harming rather than improving the health of women, after which prescriptions for such therapy dropped by 70 percent.

Furthermore, researchers have shown that bringing multiple social identities to bear on a problem increases creativity, Carnes noted. For example, when Motorola wanted to understand why fewer women were buying cell phones in the early days of the technology, the company brought in women engineers to learn how to make cell phones appeal to women customers.

Finally, observed Carnes, research suggests that women are more likely to be transformational leaders, which is the leadership style that has proven
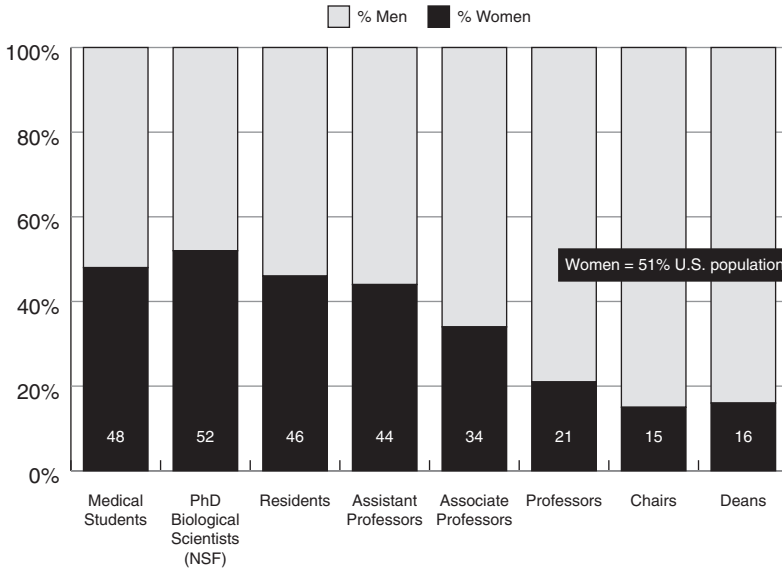
FIGURE 1-1 Women represent successively smaller percentages of academic professionals in science and medicine. SOURCES: Association of American Medical Colleges. 2014. *The State of Women in Academic Medicine*. Washington, DC: AAMC. National Science Foundation. 2010. *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2015.* Arlington, VA: NSF.

most effective in a wide range of domains. Transformational leaders are able to inspire members of an organization to invest time and energy in the organization beyond their own self-interests. "If we are systematically doing something that prevents women from having opportunities to rise toward leadership," said Carnes, "we are doing a disservice to the future of academic STEMM."

Women are entering many STEMM fields at comparable levels as men, they do not have less talent, and they do not lack interest or commitment, according to research that has been done on STEMM fields. However, culture creates and reinforces assumptions about men and women that have a strong influence on their actions and decisions, Carnes pointed out. Men tend to be seen as competitive, ambitious, independent, and willing to take risks, attributes that Carnes categorized as agentic. Women tend to be viewed as nurturing, gentle, supportive, sympathetic, dependent, and delicate, which she described as communal. These stereotypes can lead to expectancy bias and assumptions of occupational role congruity, as well as to the imposition of social penalties for violating prescriptive gender norms. "We have words to describe men or women who violate these assumptions, and none of them are flattering. For men, we have words like wimpy, feminine, or soft. For women who violate these norms, we have words like bossy or domineering or other words [that] perhaps I shouldn't say from the podium."

Inter-group bias is both explicit, as when someone answers a question about the views or attitudes on a survey, or implicit, as when behaviors or judgments are unintentionally biased by prevailing cultural stereotypes. Whereas explicit bias has been decreasing in recent decades, implicit biases are still highly prevalent and act as a strong predictor of behavior in some settings, even when they are at odds with personal beliefs. "Implicit biases can occur even in those of us who endorse egalitarianism, who want to be fair and unbiased," said Carnes. For example, the implicit association tests developed at Harvard have demonstrated that both men and women more quickly match male names with words associated with science and more quickly match female names with words linked to the humanities. Research at the University of Wisconsin has shown the same effect for words linked with leaders and supporters.

These assumptions may contribute to a wide variety of outcomes, Carnes pointed out, including differences in funding success for NIH grants, less positive letters of recommendation for women faculty, fewer opportunities for advancement for women faculty, fewer institutional resources and lower pay for women faculty, a greater likelihood for women faculty to be engaged in "institutional housekeeping" duties, and lower quality assessments of work performed by women.

Similarly, in medicine, men tend to be overrepresented in higher status, agentic fields like neurosurgery, orthopedics, and urology, while women have higher representation in communal specialties such as pediatrics, family medicine, and primary care specialties. Even in more agentic specialties, women tend to move into the more communal aspects of those fields and tend to be assigned more often to care for women than men. Partly as a consequence of these trends, women earn less than men in medicine.

Research has demonstrated that male and female students tend to be socialized toward different specialties. For example, an analysis of about 300 medical student performance evaluations found that only female students with female authors of the letters had "family medicine" correlated with standout adjectives.[1] For male students with male authors, family medicine was not mentioned, while with female authors, family medicine was negatively correlated with ability and insight word categories. Similarly, in a study of medical residents who lead cardiopulmonary resuscitation event codes, the agentic behaviors expected of leadership—including being assertive and authoritative—created stress for female residents, though male and female residents felt that both genders were equally effective in leading codes.[2] Women said "I felt bad yelling at people," "I always turn red," or "I try my best to look authoritative, but it's stressful," Carnes reported. Nevertheless, the women were largely successful in finding ways to suspend gender norms

---

[1]Isaac, C., J. Chertoff, B. Lee, and M. Carnes. 2011. Do students' and authors' genders affect evaluations? A linguistic analysis of Medical Student Performance Evaluations. *Academic Medicine* 86(1):59–66.

[2]Kolehmainen, C., M. Brennan, A. Filut, C. Isaac, and M. Carnes. 2014. Afraid of being "witchy with a 'b'": a qualitative study of how gender influences residents' experiences leading cardiopulmonary resuscitation. *Academic Medicine* 89(9):1276–81.

when leading a code, affirming their legitimate power, and adopting a "code persona" and a "code stance."

Habits can be broken, but it takes more than good intentions to do so—otherwise "no one would be smoking," Carnes observed. Breaking habits takes awareness, motivation, self-efficacy, positive outcome expectations, and deliberate practice. On this basis, Carnes and her colleagues conducted a cluster randomized controlled trial of an intervention designed to break the gender bias habit in academic science, medicine, and engineering (see the following section of this chapter). In 46 pairs of departments encompassing 2,290 faculty members, the intervention groups received a 2.5-hour workshop, followed by implicit association tests and other measures of bias. The workshop recommended the following strategies for minimizing implicit bias: stereotype replacement, counter-stereotypic imaging, individuating, perspective taking, and increased opportunities for contact. The intervention also discussed two approaches that do not work—trying to suppress stereotypes, and having too strong a belief in one's personal objectivity.

The study did not find a difference in the implicit association tests between the intervention and control groups, but it did find significant differences in all of the proximal measures of behavioral change, including personal bias awareness, motivation, self-efficacy, positive outcome expectations, and self-reported action.[3] The intervention produced significantly better climates for both men and women; for example, faculty members in the intervention departments were more likely to say that their research was valued, that they fit in their department, and that they felt comfortable raising personal and family issues even if they conflicted with departmental activities. And the percentages of women hired rose significantly in the intervention departments compared with the control departments.

In conclusion, said Carnes, gender stereotypes affect attitudes, behaviors, and judgments, even when people are unaware of them. These group stereotypes have real effects on women in traditionally male fields, especially as they rise toward leadership. But gender bias habits can be broken, and when they are, departmental climate improves and more women are hired. "This is an issue of investing in the talent in our country," she said. "If we can't figure out how to take full advantage of the rich diversity of our population, we are shooting ourselves in the foot in terms of being competitive in a global economy."

A WORKSHOP TO REDUCE IMPLICIT BIAS

During a workshop at the conference, Carnes and Eve Fine, researcher and director of curriculum development and implementation for the Women in Science and Engineering Leadership Institute at the University of Wisconsin–Madison, demonstrated how to implement an intervention aimed at

---

[3]Carnes, M., P. G. Devine, L. Baier Manwell, A. Byars-Winston, E. Fine, C. E. Ford, P. Forscher, C. Isaac, A. Kaatz, W. Magua, M. Palta, and J. Sheridan. 2015. The effect of an intervention to break the gender bias habit for faculty at one institution: a cluster randomized, controlled trial. *Academic Medicine* 90(2):221–30.

promoting racial diversity in STEMM fields. The workshop was adapted from a gender equity intervention conducted in 2010 as an experimental study. In that study, 46 of 92 STEMM departments in the university received the intervention and 46 served as controls.[4] Departments that received the intervention showed significant improvements in department climate, and a two to three year follow up on hiring data revealed that the experimental departments had significant increases in hiring female faculty and increases, though not significant, in hiring underrepresented minority faculty.

The intervention took the form of a workshop with three major objectives: (1) recognizing implicit bias as a habit, (2) identifying implicit bias (becoming "bias literate"), and (3) implementing strategies to reduce the influence of implicit bias. All three components include lectures, paired and group discussions, and evaluation. The structure focuses on three central ideas: one's mind is more important than the sum of its conscious parts, unintended thoughts can contradict one's beliefs and shape one's actions, and acting consistently with one's beliefs requires more than just good intentions.

As with any habit of mind, people must first become aware that this habit exists and when they are most likely to engage in the habit if they are to change it. People then must be motivated to change that habit and learn and practice the strategies to help them overcome it. One thing that helps to build awareness is recognizing that the ordinary mental processes that usually serve well in most circumstances can be subject to error and can fail or interfere with intentions, values, and beliefs. As an example, Carnes and Fine described a study in which undergraduate students in communication science classes listened to a 450-word recorded essay, approximately four minutes long, read aloud by a graduate instructor from Ohio who spoke excellent and clear standard American English. Students were randomly assigned to either a topic in the sciences or humanities. When students were listening, they were given a photograph depicting the instructor, either a white or Asian woman. The photographs were standardized to have the same backgrounds and same styles of clothing, and models were pre-tested to be equivalently attractive. The students who received the photo of the Asian women were more likely to perceive a foreign accent in the recording. The perception of an accent led those students to have less comprehension of the essay, and the effect was stronger if students heard a science essay rather than a humanities essay.[5]

This leads to a paradox in prejudice literature, Carnes noted. Direct measures are used to assess bias and prejudice, but these measures only tap into conscious processes. When people are asked a question like "Should women be in the workforce?" many more people respond positively than would have 30 years ago. But when indirect measures are used that bypass the conscious process, these measures reveal that bias is still very prevalent in society, even among those who renounce prejudice or bias on a conscious level. These

---

[4]Rubin, D. L. 1992. Nonlanguage factors affecting undergraduates' judgments of nonnative English-speaking teaching assistants. *Research in Higher Education* 33(4):511–531.

[5]Kang, O., and D. L. Rubin. 2009. Reverse linguistic stereotyping: Measuring the effect of listener expectations on speech evaluation. *Journal of Language and Social Psychology* 28(4):441–456.

measures can include things like how often a person blinks when talking to a person of a different race, how far a person sits from someone of a different race, or one's performance on an Implicit Association Test.

Even though implicit biases often conflict with consciously endorsed beliefs, values, and commitments to equity and fairness, they can produce consequential outcomes. Overcoming these biases requires constructing a new bias framework. The old framework mandates that if people act with prejudice, they must be bad people. The new framework recognizes that prejudice, thoughts, and actions are habits of mind that all people have learned who have grown up in the same culture. If people want to break these habits, it will require more than good intentions or a desire to be fair and equitable; it will require effort. As Michelle van Ryn has written, "The fact that automatic and frequently unconscious processes are in play reduces blame but not responsibility."[6]

The workshop described by Carnes and Fine uses six manifestations of bias to promote discussion: expectancy bias, competency bias, role congruity/incongruity, similarity bias/homophily, microaggression, and stereotype threat, although they noted that other examples can be used depending on the constituency. Expectancy bias is defined as expecting certain behaviors or characteristics in individuals based on stereotypes about the social category to which they belong. For example, in one study UCLA undergraduate students identified stereotypes like "intelligent, bad drivers, small eyes, and quiet" with Asian Americans, "poor, uneducated, day laborers, and gangsters" with Latinos, and "high status, intelligent, privileged, and racist" with whites.[7]

Expectancy bias leads to competency bias, where one feels it necessary to work harder than one's peers to gain recognition of competence. As one underrepresented medical school faculty member described it, "You feel like you are expected to do a mediocre job always. And so you strive to be a super woman to combat the expectations that you are only going to be mediocre."[8] Expectancy and competency biases can in turn influence hiring decisions. When résumés were adapted to make them appropriate for job openings advertised in newspapers in Boston and Chicago and randomly assigned white or African American sounding names, the white-sounding names received 50 percent more callbacks for interviews than the applicants with African American–sounding names.[9]

With role incongruity bias, assumptions or stereotypes about groups of people are incongruent with assumptions or stereotypes of specific occupations or roles. A person from a lower status group seeking a higher status job may be disfavored, while a person from a higher status group seeking

---

[6]van Ryn, M., et al. 2011. The impact of racism on clinician cognition, behavior, and clinical decision making. *Du Bois Review* 8(1):199–218.

[7]Ghavami, N., and L. A. Peplau. 2013. An intersectional analysis of gender and ethnic stereotypes: Testing three hypotheses. *Psychology of Women Quarterly* 37(1):113–127.

[8]Pololi, L., L. A. Cooper, and P. Carr. 2010. Race, disadvantage and faculty experiences in academic medicine. *Journal of General Internal Medicine* 25(12):1363–1369.

[9]Bertrand, M., and S. Mullainathan, S. 2004. Are Emily and Greg more employable than Lakisha and Jamal? A field experiment on labor market discrimination. *American Economic Review* 94(4):991–1013.

a higher status job might be favored regardless of qualifications. When a résumé was assigned a male name chosen to reflect either a white, Asian, Hispanic, or Black identity, competency scores assigned by white male evaluators were significantly influenced by an applicant's race or ethnicity. Asian Americans were regarded as the most competent, followed by whites, then Hispanics, then African Americans. Asian Americans and whites were regarded as the most suitable for high status positions. African Americans and Hispanics were regarded as the least suitable. When looking at low-status positions, the results were perfectly flipped.[10]

Homophily, similarity bias, or ingroup affinity refers to the fact that people categorize themselves as similar to others based on shared identities and tend to associate and bond with those they perceive as being similar to themselves. Carnes and Fine illustrated the concept through a case study where a search committee is looking to hire an associate professor in the college of arts and sciences at a large public university. One of the committee members favors an applicant who is similar to himself and the person who had previously filled the faculty role. However, looking at someone who has previously been successful does not guarantee that a similar person will create the same results. The better option is to craft a new position to get away from the replacement mindset, Carnes said.

Microaggressions are commonplace verbal, behavioral, or environmental indignities (often but not always unintended) that devalue members of a social category, which can be encountered on a daily basis.[11] Examples of microaggressions include "Where are you from?" which can send the message, "You are not American," or saying "There is only one race, the human race," which denies a person of color's racial or ethnic experiences. Microaggressions can even be disguised as compliments: "You are so articulate," meaning, "It is unusual for someone of your race to be intelligent." Microaggressions can be divided into three types: microinvalidation, microinsult, and microassault. Microinvalidation excludes or negates a person's thoughts or feelings; microinsult demeans a person's racial heritage or identity; and microassault involves purposeful discriminatory action such as verbal attack or avoidant behavior. As an example of the latter, Carnes cited a female medical school faculty member who reported "I got my RO1 very quickly and I got a very, very good score. I was really proud of that. I worked very hard on that grant. And a colleague of mine, he looked at me and said, 'I'm convinced that these things are decided based on ethnicity.'"

Finally, stereotype threat is the fear of being judged based on a group stereotype or of confirming a negative group stereotype. It is triggered when environmental cues make group membership salient, which can cause anxiety, reduced working memory, and disengagement. When Asian American women undergraduates were primed to focus on their identity as Asians, they performed better on a mathematics test than a control group of Asian

---

[10]King, E. B., et al. 2006. What's in a name? A multiracial investigation of the role of occupational stereotypes in selection decisions. *Journal of Applied Social Psychology* 36(5):1145–1159.

[11]Sue, D. W. 2010. *Microaggressions in Everyday Life: Race, Gender, and Sexual Orientation.* Hoboken, NJ: John Wiley & Sons.

women. But when primed to focus on their identity as women, Asian women undergraduates performed worse than the control group.[12]

Several strategies can reduce the influence of implicit bias, Carnes and Fine observed. In particular, they identified four—engaging perspective taking, practicing the right message, individuating, and challenging your stereotypes—which they labeled with the acronym EPIC. Challenging one's stereotypes requires recognizing and labeling stereotypic thoughts or stereotypical portrayals. Whenever someone says, "X group is good at . . ." a stereotype will follow because that person is talking about a group rather than individuals in a group. To challenge stereotypes, one has to identify precipitating factors, challenge the fairness of the portrayal, and replace the stereotype with data. For instance, studies do not find that gender is always a significant predictor of competence in STEM. Similarly, studies have shown that diverse work groups develop more creative and feasible solutions to complex problems.

Individuation can be achieved by gathering additional information. In hiring, this can be accomplished by prioritizing specific criteria for evaluations. For example, committees with more information can rely on the entire package rather than one piece of information. Another way to individuate is to imagine in detail counterstereotypical exemplars. If someone engages in a behavior that is stereotypically associated with a group, it is often judged as a reflection of themselves rather than the situation. Instead, people need to practice situational rather than dispositional attributions.

If the right behavior is practiced for long enough, it can become habitual. By practicing making situational attributions, one can prevent those automatic responses. But practicing the right message is key, said Fines. Telling people that everyone has bias actually increases bias, perhaps because it normalizes bad behavior. Acknowledging that everyone is trying to reduce bias can form a united, supportive environment for change.

Finally, the E in EPIC stands for engagement in perspective taking by actively contemplating another person's experiences and perceptions. In one study, researchers examined the effect of asking study participants to take the perspective of an African American male in several situations. Compared to control participants not asked to engage in perspective taking, the perspective takers had less pro-white bias on the Implicit Association Test, had warmer feelings for blacks, set seating distance less to meet "Tyrone" versus "Jake," had more positive rating by black interviewers of an interaction, and engaged in more positive non-verbal behaviors of coded interactions.[13]

In their original trial of 46 departments that participated in the gender workshop at the University of Wisconsin, Carnes and her colleagues found significant differences in self-efficacy, positive outcome expectation, personal bias awareness, and self-supported actions. In a separate but related study

---

[12]Shih, M., T. L. Pittinsky, and N. Ambady. 1999. Stereotype susceptibility: Identity salience and shifts in quantitative performance. *Psychological Science* 10(1):80–83.

[13]Stewart, T. L., I. M. Latu, K. Kawakami, and A. C. Myers. 2010. Consider the situation: Reducing automatic stereotyping through situational attribution training. *Journal of Experimental Social Psychology* 46(1):221–225.

done every three to five years by the Study of Faculty Work Life, the results revealed that faculty in the departments that experienced the workshop felt more valued, included, and comfortable bringing up personal issues in their department. A workshop of this nature has to be voluntary, Carnes and Fine emphasized. Coercion does not work. But if a quality workshop is offered, people will come. Positive findings within the departments occurred when a critical mass of the department participated—between 25 and 30 percent—to allow conversations and change to happen.

Carnes and Fine concluded their workshop by asking participants to write down a commitment to action that includes both individual-level and institution-level bias-reduction strategies. "If you've ever tried to break any behavioral habit, you know it's not easy," Carnes said. "But with effort, awareness, motivation, and sustained commitment, prejudice, like other habits, can be broken."

UNDERSTANDING BIAS THROUGH A VIDEO GAME

"Scientific advances don't come from people thinking the same way that everyone's always been thinking; it comes from thinking about things from new angles, different perspectives, and new ways coming together," said William T. Cox, a social scientist with a doctorate in experimental psychology from the University of Wisconsin–Madison. In that respect, he added, the failure to enhance scientific workforce diversity is a threat to the vitality of the economy because scientific advances fuel economic and technological advances, he said.

Biases are particularly problematic for underrepresented minority students who are in a leaky pipeline where few have the opportunities to succeed in STEMM careers, noted Christine Pribbenow, the Director of the LEAD Center and PI of an NIH-IPERT grant that funded the intervention/workshop given at UI and at other venues nationally. Few black and Hispanic students make it through the pipeline, and many are dissuaded from entering it in the first place. Fair Play, which was envisioned by Carnes after she received a Pathfinder Award from NIH, was designed to increase opportunities for participation and advancement of talented individuals from groups that have been underrepresented in STEMM fields.

The Fair Play intervention was designed to shift the framework around bias. Most people believe that prejudice is bad, so if a person is caught doing something biased, that makes them a bad person. This framework tends to be unproductive by quickly shutting people down. The intervention seeks to shift the conceptualization by acknowledging that bias can happen and, while that does not make it a good thing, it is an understandable reaction that is often learned from culture. Overcoming these biases takes effort, attention, and work, just like breaking other habits. "Unintended thoughts can contradict our strong personal beliefs that oppose racism, sexism, and prejudice," said Cox. "Acting consistently with our beliefs requires more than good intentions."

The video game format was chosen because of its capabilities to harness human cognitive abilities to solve complex problems, change people's habits

and ways of thinking in the moment, and change how people perceive the world. In the game, players step into the shoes of Jamal, an African American graduate student who experiences bias incidents as he interacts with faculty, staff, and students on a college campus. For example, on the first day of graduate school, the player tries to figure out how to find an advisor. Through that experience, the player encounters microaggressions and biases based on real life experiences gathered by the game developers. The goal of the game is to succeed in science, not to fight race bias, Cox noted. The game would be less effective if the players only experienced bias, since it is supposed to help players understand a different perspective on a real life situation.

The game is mouse operated and open ended. Players must complete certain objectives to reach the end of the game, but they also have the opportunity to explore the environment and encounter different types of biases. Each player has a different experience in the game, rather than just being taken through a narrated slideshow of different biases. Players not only experience but learn how to name microaggression. "If you can name it, you can tame it," Cox said. This strategy allows players to convert tacit knowledge to explicit knowledge by naming problems, which gives them a way to think about and discuss those problems.

The players have different response options in a given situation. While more confrontational responses were included in the earlier versions of the game, the final version did not include these options, since many early players responded negatively to these responses, saying that they would not act that way in real situations.

After playing the game, one player said, "The most surprising thing to me was the sort of visceral anger I felt at various interactions with people." The responsibility for solving the burden of these biases is placed on the players, not on Jamal. The game is not about Jamal's responsibility, but rather about the recognition of the biases Jamal faces and the difficulty in dealing with those biases. In one scenario, for example, Jamal gets up from his workstation at the library and the librarian follows him, demanding to know whether he is from that institution. Players can recognize this behavior as a microaggression even if they have never experienced this kind of situation themselves.

In the game, Jamal never speaks. The designers wanted the players to focus on what is being said to Jamal rather than Jamal's actions. While the game was designed to benefit people from all races, it also allow white players to experience the sort of biases that many underrepresented minorities consistently face. The game is designed to open up discussions rather than make players defensive.

Video games are expensive to develop, but if the team finds additional funding it could develop more characters and a richer world. As it is, Fair Play can summon many ingrained stereotypes with a relatively small amount of information. Fair Play is the first step in both understanding and modifying behaviors by enabling players to take another person's point of view. The game takes an average of 60 minutes to play (range of about 45–90 minutes) and is available at *www.fairplaygame.org*.

FEMALES OF COLOR AND STEM PERSISTENCE:
THE ROLE OF TALENT

Both African American women and Latinas comprise 2 percent of U.S. scientists and engineers, compared with 20 percent and 51 percent of their white female and male counterparts, respectively.[14] Thus, persistence of women of color in STEM fields is a major national challenge with important implications for both higher education policy and social science theory. While evaluation studies have demonstrated that STEM interventions can increase the success of underrepresented minorities, less is known about how race, gender, and other characteristics interact to enhance student success.

Michele Randolph, a PhD candidate at the University of Michigan, is writing her dissertation on the relationship between social-cognitive motivational factors and STEM persistence. Her theory-driven dissertation focuses on women of color within a strengths-based research framework to better understand the pivotal mechanisms that facilitate and undermine intervention efficacy.[15] Women of color bring a unique set of strengths to STEM disciplines, Randolph said. Interventions that go beyond the traditional focus of remediation and financial aid to engage with these strengths are particularly effective in promoting STEM persistence.

Studies have shown how research experiences, peer support, and support from faculty mentors can increase the persistence of underrepresented minorities, but decided to take a different approach. Her study addressed the questions: What natural talents and other social-cognitive factors do students bring to STEM interventions overall? Do women of color bring *unique perceived* natural talents to those STEM interventions? Are *perceived* natural talents and other social-cognitive factors related to STEM persistence among underrepresented women of color? How do intervention-based sources of self-efficacy impact outcomes?

Participants in the study were broken into groups based on gender and race, STEM majors, and non–STEM majors. Students were specifically asked about their perceived natural specialized talents, and these responses were coded and themed. Randolph's reformulation of social-cognitive career theory considers the operation of four major sources of self-efficacy within intervention groups and the moderating role of specialized STEM-related talent, identity, and interest in promoting STEM success.

Randolph found five themes that students identified as their perceived natural talents; STEM-related talents, arts and humanistic talents, athletic and physical talents, social and empathy talents, and conscientiousness and intellectual talents. Based on this study, it appears that women of color believe that they bring less STEM-related talents to STEM interventions over-

all. However, interestingly, women of color did report that they bring more expressive or creative talents than their non-minority male counterparts to STEM interventions.

Randolph's study has implications for the development of opportunities for women of color in STEM whose talents may lie in other, more creative areas. A pipeline STEM intervention program could reinforce the multi-dimensionality of strengths for women of color who are pursuing STEM careers. Perhaps, offering a broader range of opportunities within STEM may guide women toward specific scientific or worker domains that use their talents, Randolph said. Often, the most productive scientists are those with creative artistic talents. By incorporating natural talents into the STEM curriculum, students could have a better chance of reaching their full potential. More broadly, personal strengths could be the pivotal factor that reinforces social-cognitive motivation, buffers the impact of contextual barriers, and promotes STEM persistence for underrepresented students.

In the future, Randolph said, she would like to look at additional variables that influence success in STEM disciplines for women of color.

MALES OF COLOR AND STEM PERSISTENCE: THE ROLE OF CRITICAL RACE CONSCIOUSNESS

As with women of color, men of color have a high rate of attrition as they progress through the STEM pipeline. In 2010, African American males received 5.7 percent of bachelor's degrees but just 2.6 percent of PhDs in STEM fields. These low rates do not reflect the racial composition of the U.S. population and have led to a low level of diversity in the scientific workforce.

Gordon Palmer, a second year doctoral student in the Center for the Study of Higher and Postsecondary Education at the University of Michigan, designed a study to examine whether racial consciousness can impact student persistence. Critical consciousness addresses a person's locus of control, including the internal and external elements that factor into one's success or failure. Critical consciousness primarily deals with external factors: whether people blame themselves, their groups, or the system for their failures. People blame themselves when they lack consciousness. They only become conscious when they become aware of the external barriers and microaggressions they face. In this way, underrepresented minorities can use critical consciousness to make sense of a system that often alienates them.

Palmer's study explored several research questions: Do males of color have distinct patterns of critical racial consciousness? Are males of color who blame the system rather than group deficits for racial inequalities more or less likely to pursue STEM majors? Do other personal strengths such as STEM-related efficacy or STEM-related talent, identity, or interest moderate the relationship between critical consciousness and STEM persistence among males of color?

Palmer's study examined the idea of critical consciousness through a strengths-based framework. He situated critical consciousness within a two-part hypothesis. First, a person must recognize the injustice of the system. Second, a person must build the efficacy to overcome the barriers within

that system and determine the most efficacious actions to succeed. Coming to a consciousness of a system's barriers does not happen overnight, Palmer noted, but it leads to positive academic and vocational outcomes.

Racial consciousness includes three types of predispositions about inter-group racial inequalities of inequities: cognitive (critical system–blame beliefs), affective (feelings of discontent), and behavioral (readiness for collective resistance). Palmer identified two predominant measures of construct: moderated variables, and individual efficacy. A scale of 20 items addressed participants' sources of blame, whether of the system or of the individual, and the form of this blame.

When comparing efficacy rates among groups, underrepresented males, underrepresented females, and white and Asian women had fairly similar responses. In general, these groups had much lower self-efficacy than white and Asian men in STEM fields.

In Palmer's study, minority males had higher levels of critical consciousness. This consciousness positively correlated with student self-efficacy right after a summer academic program, but a year after the program, individual efficacy was more positively correlated with career plans. Consciousness and individual efficacy are positively correlated with persistence, Palmer noted.

More research needs to be conducted in the future, Palmer observed, with his study being merged into more intersectional approaches. Greater understanding can promote awareness of the systemic barriers that underrepresented minorities face and ways of moving around those barriers.

FIRST-GENERATION COLLEGE STUDENTS AND STEM PERSISTENCE: INFORMAL SOCIAL SUPPORT AS A MEANS OF ALLEVIATING STUDENT DISTRESS

Levels of psychological distress in the form of anxiety and depression can be especially high among first-generation students. Often these students not only come from low income families but also face financial, academic, and other sources of stress. In addition, this group can face systemic barriers involving race, gender, and socioeconomic status.

For this reason, it is especially important to better understand the patterns of informal support, psychological distress, and STEM persistence among first-generation students. Nathonael Boorsma, an undergraduate student at the University of Michigan involved in the Diversity Research and Policy Program as part of the Undergraduate Research Opportunity Program, designed a study to examine the relationship between role stress and informal support in STEM persistence for first-generation students. Informal support was measured across five dimensions: emotional support, socializing support, practical support, financial support, and advice or guidance. Role stress was measured across three areas: role overload, role conflict, and role ambiguity.

Boorsma's study aimed to address three research questions: How do students in STEM interventions experience role stress and informal social support? How do first-generation college students in STEM interventions experience role stress in informal social support? How does role stress and informal social support relate to STEM persistence for first-generation students?

Data revealed that informal support from specific sources was associated with lower levels of distress. However, STEM undergraduate majors perceived significantly less socializing support and advice and guidance from their friends than non-STEM majors. Boorsma found that the informal social support depends to some extent on the specific support sources, support functions, and STEM versus non-STEM undergraduate majors. His results also showed that first-generation students within STEM interventions experience significantly less emotional, socializing, financial, and advice/guidance support from family than second-generation college students. As STEM students perceive higher levels of role ambiguity, they are more likely to pursue a Ph.D.

"Practitioners should consider how STEM persistence is impeded by role stress and promoted by role support," Boorsma said. Specifically, for first-generation students, interventions should consider the importance of increasing socializing support from families. However, parents often can provide first-generation students with general support but not with the technical support they need. Thus, first-generation students have to rely on peers to get technical support while relying on their families for social and emotional support.

Future research should explore how peer support reduces the adverse effects of role overload and role conflict, Boorsma said, thus building on new insights into the theoretical, practical, and policy implications of how support affects first-generation students.

2

Institutional Transformation

Interventions designed to broaden participation in science careers can take place on either small scales or large scales. But the problem of underrepresentation of minorities in STEM fields is so long-standing and pervasive that small-scale programs need at least the potential to be scaled up if they are to have a significant effect on the STEM workforce. In addition, the most comprehensive approaches are those that occur not only at large scale but larger units of departments, colleges, and universities. In this respect, interventions ultimately need to create a climate of transformation rather than limited local improvements.

Two plenary speakers and several other speakers in workshops and symposia addressed the issues involved in transformative change. Different kinds of institutions have successfully embarked upon this process, and their approaches could be taken elsewhere. Moreover, the issues that arise in seeking to transform institutions can inform a much broader range of educational interventions.

TRANSFORMATIVE CHANGE AT GEORGIA STATE UNIVERSITY

Ten years ago, Georgia State University had relatively low graduation rates marked by persistent achievement gaps among student groups—31.6 percent for white students, 25.6 percent for African American students, and 22 percent for Hispanic students. Since then, both the state of Georgia and the city of Atlanta, where Georgia State is located, have undergone large demographic shifts. From 2008 to 2014, the percentage of underrepresented minorities in the student body rose from 53 percent to 63 percent, the percentage of undergraduates on Pell grants went from 32 percent to 59 percent, and the percentage of students qualifying for federal financial aid increased to 90 percent.

Over the same period, the institution lost about $40 million in state appropria-
tions because of the economic recession.

"It's not the setting where you would expect to see transformative
change," said Timothy Renick, vice president for enrollment and student suc-
cess and vice provost at the university. "Except for the fact that interventions
make a difference—they do work." Over the past eight years, Georgia State
has used data very aggressively to diagnose the problems its students face.
It has then piloted programs to solve those problems, has tracked the effects
of those programs, has modified the programs to make them more effective,
and, most important, according to Renick, has scaled up those programs to
affect large numbers of students. "It doesn't do any good if you have a really
successful program that touches 20 or 30 students—at least it doesn't do
any good for the majority of your student population. What we've done at
Georgia State is establish interventions that touch hundreds, thousands, and
in some cases tens of thousands of students every academic year."

The first intervention Renick cited is the Summer Success Academy. It
identifies more than 300 incoming freshmen most at risk, based on their
incoming grades and the institution's previous experiences with similar stu-
dents. They are invited to a summer session before the fall semester starts that
provides seven credit hours of bachelor's-level work, with intensive advise-
ment, strengthening of academic skills, training in financial literacy, and team
building. From a retention rate of 50 percent for these students in 2011, the
retention rate rose to 87 percent.

Another intervention is the enrollment of most of the freshman class into
learning communities organized around the "meta majors" of STEM, busi-
ness, arts and humanities, health, education, policy and social science, and
exploratory. Previously, many students were changing majors multiple times,
resulting in wasted credit hours, a longer time to degree, and other problems.
The meta majors feature block schedules of five to six courses, faculty lectures,
departmental mixers, and other activities. Advisers work with students so
that they pick their majors wisely and are more likely to stay in that field.
Outcomes have included increases in first-year GPA and retention.

Georgia State also has one of the largest supplemental instruction pro-
grams in the country, with about 10,000 students benefiting from this program
each year, according to Renick. The average course GPA for students receiv-
ing such instruction was 2.91, compared with 2.41 for students not receiving
supplemental instruction, and their retention rate was 91.2 percent compared
to 83.5 percent. This program has taken advantage of student work-study
programs so that students can be hired to work with other students need-
ing help. The institution also has converted the way courses are delivered,
using hybrid and flipped classes with adaptive learning. In the pre-calculus,
college algebra, and introduction to statistics classes, the rate of students
earning D's, failing, or withdrawing from the class was 43 percent prior to
the change and dropped to 19 percent afterward, resulting in an additional
1,800 students each year getting through their mathematics requirements in
their first attempt.

Besides looking at classroom pedagogies, Georgia State has redesigned
entire programs using data on such factors as what students need to succeed

in upper-level courses. For example, in the past, only 20 percent of the students who had spent two years in a pre-nursing program got into the nursing programs, and the students who did not get in had a very low subsequent success rate. "It was not their fault; it was our doing," said Renick. Low-income students spent two years taking courses for a major that they then could not pursue. Now, pre-nursing students have a one-year program that does not include specialized nursing courses. Predictive analytics determine, based on grades earned in core courses, which students will do best if they are admitted into the nursing program, while the other students are able to apply the credits earned in the pre-program to other majors.

In addition, Georgia State has used analytics to maximize its use of financial aid. For example, a sizable subset of students at Georgia State are just a semester or two away from graduating and are running out of eligibility for financial aid. As a result, hundreds were dropping out just a semester or two away from graduating. Since 2011, more than 7,000 Panther Retention grants have been provided to such students, and more than 70 percent of senior recipients of the grants have graduated within two semesters. "These are targeted interventions that work," said Renick.

He also mentioned the use of analytics-based, proactive advisement. Through a collaboration with the Education Advisory Board and four other institutions, the university has been using live nightly feeds to make daily alerts to advisers if students have missed any of their markers. The system has used records from past students to find hundreds of academic behaviors that were predictive of students either failing classes or dropping out of the university. If those behaviors are detected in a current student, the advisor assigned to the student is notified and an intervention occurs. For example, a student might sign up for a course that is not on a program map leading to a degree, resulting in a conversation with the adviser. "They can take an elective out of their program, but we want to make sure they know about it and are doing so knowingly. We began to correct those kinds of issues at scale." Similarly, students getting C's in required classes in their majors are provided with assistance rather than simply being passed on to upper-level classes.

Another component is a Major Matcher that uses predictive analytics to give individual students guidance about the majors in which they are most likely to succeed. "When we first rolled this out, the harshest criticism came from our faculty, [who thought] this would be a recipe for moving students to easier majors," said Renick. The opposite has been the case. Over four years of running these analytics every day and having tens of thousands of interventions, the two fastest growing majors at Georgia State are biology and computer science. Instead of allowing unprepared students in a major to sink under a workload they cannot handle, early interventions give them the help they need. Similarly, career analytics help freshmen think not only about majors but about future jobs. For the 25 careers most likely to result from an undergraduate major in biology, for example, students can see data about job demands, starting salaries, and other criteria.

In general, universities need to change the way they operate, said Renick. Over the past 12 months, the University Advisement Center at Georgia State has had more than 45,000 student visits. More than 2,000 preterm registra-

tion corrections have been made, with more than 7,000 recommendations being made for major changes. This advice is especially useful for part-time students, including adult learners and military learners. In addition, the time to degree has been declining, along with the number of wasted credit hours that students are amassing.

"These programs have paid for themselves," said Renick. "They generate more credit hours. They generate more revenues from tuition and fees. And every one point Georgia State goes up in its progression rates is $3 million of additional revenues per year." The programs also have gotten the university national attention, as when university representatives were invited by President Obama to the White House. "It's heady stuff to be sitting a few feet from the president talking about the kind of programs that we've put in place."

Degrees have risen 82 percent for African American students over five years, 93 percent for Pell grant students, and 123 percent for Hispanic students, and Georgia State now grants more bachelor's degrees to African Americans than any other university in the country. In fact, increases in the number of graduates have required Georgia State to move its commencement ceremony from campus to the Georgia Dome. The programs put in place did not target specific student populations, but the groups that benefited most were the ones most at risk, and today African American and Hispanic students who attended Georgia State are graduating from college at rates equal to white students (Figure 2-1). "That is the kind of transformation that we need to make nationally," Renick concluded. "We have an obligation to the students we enroll to make sure we give them every chance to succeed."
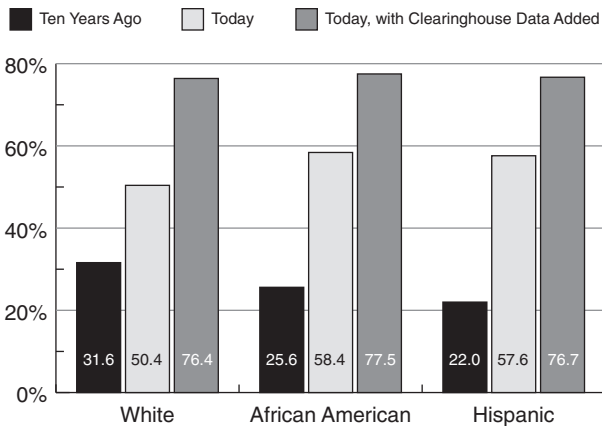
FIGURE 2-1 African American and Hispanic students at Georgia State University graduate at rates equal to white students when data from the National Student Clearinghouse Research Center are added to account for students who transfer to and graduate from other institutions. SOURCE: Georgia State University.

TRANSFORMATIVE CHANGE AT THE UNIVERSITY
OF MASSACHUSETTS, BOSTON

In 2007, six-year graduation rates at the University of Massachusetts, Boston, were 33 percent for first-time freshmen, noted Andrew Grosovsky, Dean of the College of Science and Mathematics at the university. Within the College of Science and Mathematics, less than 30 percent of first-time freshmen were earning a degree at the university, and only about 13 percent of first-time freshmen were earning a degree within the college without transferring to some other major.

More than half of the students at UMass Boston are students of color, with large numbers of low-income and first-generation students, many of whom commute from their families' homes and work substantial hours at jobs. The College of Science and Mathematics is also richly diverse—with about 58 percent students of color, compared with 46 percent in the college as a whole—and more than half of the college's students are women (Table 2-1). Also, enrollments in the college have grown dramatically in recent years, so that it now has as many freshman students as the College of Liberal Arts.

The College of Science and Mathematics has taken a comprehensive approach to transforming institutional practices and improving students' persistence, retention, and post-graduation success, Dean Grosovsky said. First, it worked to recognize and support the sequential and hierarchal nature of the science curriculum. When students enter college, they need to take a full load of credits to be on track for four-year graduation, according to Dean Grosovsky. "People used to worry that we were pushing students too hard. There was a lot of well-intentioned advice at that time to take fewer credits. . . . But the results of nine years of work have shown that our students are

TABLE 2-1 Diversity at the University of Massachusetts, Boston (UMB), in the College of Science and Mathematics (CSM), and in the Freshman Success Community (FSC) Program

Undergraduate Students	UMB	CSM	FSC
American Indian or Alaska Native	0.23 %	0.08%	0.39%
Asian	15.07%	23.33%	18.90%
Black or African American	18.08%	18.13%	19.69%
Hispanics of any race	16.59%	15.48%	19.29%
Cape Verdean	1.45%	1.48%	0.00%
Native Hawaiian or Other Pacific Islander	0.02%	0.04%	0.00%
Two or more races	3.28%	3.38%	0.00%
White	**45.28%**	38.08%	**41.73%**
U.S. Students of Color Subtotal	**54.72%**	61.92%	**58.27%**

Source: Data are derived from the UMass Boston 2015 and prior Statistical Portraits.

doing better when they take courses in the appropriate context." For example, taking a full load of courses helps prevent gaps in a student's education. "Organic Chemistry II is a hard course, and it's best if you take it immediately after Organic Chemistry I."

Correct mathematics placement was another major factor. All STEM students should be placed on the pathway to completion of the calculus requirement, Dean Grosovsky said. Mathematics is foundational to success in STEM fields, so students need to be taking the right level of mathematics right away to get to an appropriate level.

The college sought to create a greater sense of engagement and belonging with other students, faculty, advisors, and academic support staff. Students needed a better understanding of the resources, campus opportunities, and programs available to them. They needed to feel more networked and engaged. "We wanted to increase their confidence," said Dean Grosovsky. "We wanted to increase their resilience. Often students will have a problem and not know that is the type of problem that the university can support." To provide this support, the college developed a proactive outreach model for advising and academic support. This support was designed to reach students "before they even realized they needed it. We wanted to push it out to them."

The college also wanted to create impact at scale. "It wasn't going to be good enough to create a program for 50, 60, 70 students, put it on the website, and call it a success. We needed everybody to have an opportunity to maximize their opportunity for success." The resulting holistic approach included making student success the highest college priority and commitment, promoting a strongly student-centered and evidence-based culture, fostering strong faculty participation, and building collaborative relationships with institutional and individual stakeholders to enhance opportunities for student enrichment.

Dean Grosovsky focused particularly on first-year students, since their experiences are critical to later success. The centerpiece of these steps was the creation of Freshman Success Communities, which were designed to establish a small "home base" in a large and complex institution where freshmen can experience close engagement with fellow students, peer mentors, faculty, and staff. Each community included up to 24 academically similar students who were co-enrolled in relevant introductory coursework. The similarity of students made it possible to provide Freshman Success Communities with co-curricular enrichment using cost-effective programs and "off the shelf" parts. All students take a science gateway seminar, which serves as a foundation for the community program and meets UMass Boston's first-year seminar requirement. The seminar was converted from a one-semester four-credit course to a two-semester four-credit course. This has made it possible to build strong cohorts of students who can support each other during the first year and beyond. "They travel through courses together. It's one of the most popular aspects of the program," Dean Grosovsky said. Furthermore, the Freshman Success Community program has been scalable, growing from 2 communities and 46 students in 2009–10 to 17 communities and 296 students in 2015–16.

As of 2016, 1,344 students had gone through the Freshman Success Communities Program. The retention rate for those students at UMass Boston was

81 percent. On average, those students had completed 93 percent of the credits for on-track status at their level. Their average GPA is above 3.0, "which is higher than we've seen before," noted Dean Grosovsky. Their average time to degree has been reduced by a year from 5.2 to 4.2 years. Furthermore, on surveys, students express high levels of satisfaction with the program (Table 2-2).

These students are also persisting in STEM degrees to a much greater extent than for previous students in the College of Science and Mathematics. More than 60 percent of these students either have graduated or are still enrolled after six years, compared with a six-year graduation rate at UMass Boston of about 40 percent (Figure 2-2). "This is higher than national graduation rates for all disciplines, and much higher than the rest of the university. People might think our demographic [makes it] difficult to provide for success. But interventions can be identified that can make a big difference."

STRATEGIES FOR INSTITUTIONAL CHANGE

A relatively generic framework can be used to provide structure in becoming an agent of change, observed Michael Penn, vice president for diversity, outreach, and mentoring at the Gladstone Institutes. First, one must be thoughtful and analytical about the specific situation at one's institution. While it is easy to identify successful practices, those may not work in an institution's specific context. Second, partners need to align with the potential to make things happen. Every institution has different strengths and weaknesses, and systemic changes are only possible with multilevel support. Third, a sense of urgency must be identifiable to stakeholders. Lasting change requires a simple and compelling vision that inspires action. "To inspire change means that we are taking people out of their comfort zones, so there has to be something that we are aspiring to that's worth it," said Penn.

After a plan has been established, the focus should shift to action, Penn continued. The action needs to be structured in a way that success can be achieved in the short term while also thinking about a longer term plan and strategy. Ideally, action creates momentum while remaining sustainable. The culture of an institution should be considered so that action can be embedded into its very foundations. "You're asking people's brains to do something not comfortable, so the immediate response is to resist," Penn said. The brain loves simplicity, repetition, comfort, and past structures and behaviors, so change requires conscious effort and always takes longer than desired.

Meaningful change also depends on recognizing the interconnectedness of departments, systems, goals, and priorities. Each factor can be difficult to control, but everyone has the opportunity to set the example, create a vision, and communicate it to a larger audience, Penn insisted.

A SWOT analysis based on strengths, weaknesses, opportunities, and threats can break down the change process into actionable things to cultivate. Strengths and weaknesses are internal to the developer or the institution, while opportunities and threats are external factors. Systematically identifying each of these elements can help create an effective strategy that aligns with the needs and interests of all players and can be communicated effectively to the groups involved.

TABLE 2-2 Levels of Student Satisfaction with the Freshman Success Communities

	2011– 2012	2012– 2013	2013– 2014	2014– 2015	2015– 2016
How did participating in a Freshman Success Community impact your academic experience at UMass Boston?					
It deepened my interest in science	80%	90%	87%	88%	89%
It had a positive effect on my grades	82%	93%	89%	89%	89%
It kept me on track towards graduating in four years	85%	93%	87%	87%	89%
How did the FSC influence your understanding of what it takes to be successful in college?					
I have a better understanding of my major requirements	91%	91%	89%	90%	87%
It encouraged me to feel more comfortable asking for help	84%	92%	86%	87%	87%
Seeking out services on campus is less intimidating because of my FSC participation	83%	86%	81%	84%	87%
How did the Freshman Success Community affect your freshman year overall?					
I felt like UMass Boston was the right place for me	81%	86%	87%	82%	81%
I felt like I was part of a close-knit community	83%	86%	87%	81%	85%
I was better able to balance my school, work and family responsibilities	73%	85%	84%	85%	84%
Overall Satisfaction Questions					
If you had to do it over again, would you choose to join a Freshman Success Community?	93%	100%	99%	89%	98%
Are you satisfied with your Freshman Success Community placing?	94%	100%	100%	87%	98%
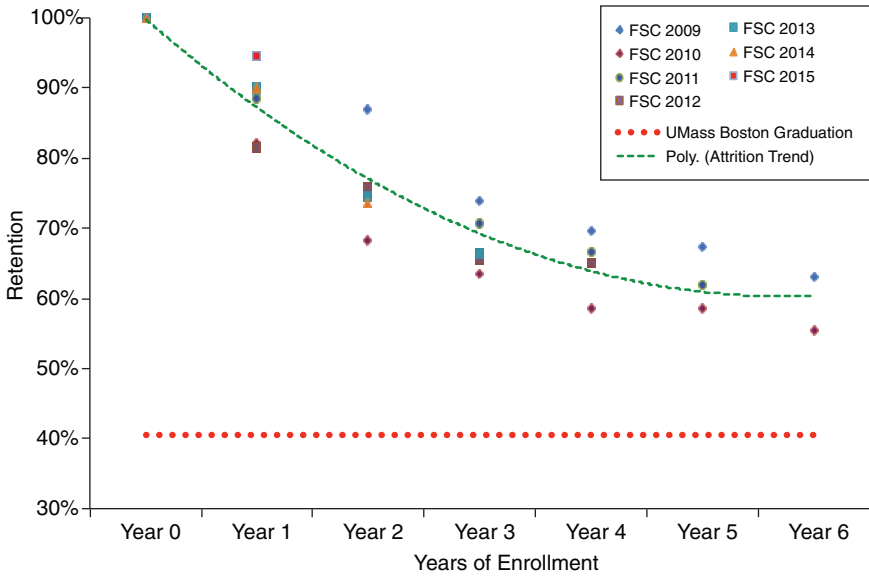
FIGURE 2-2 The six-year retention of students who took part in the Freshman Success Communities (FSC) greatly exceeded the graduate rate for UMass Boston as a whole. SOURCE: University of Massachusetts, Boston.

Effective communication is based on relationships based in trust and credibility, Penn concluded. Leadership does not take place in a vacuum. Leaders at all levels must broadly communicate impact, accomplishments, vision, and ideas to get the resources necessary for efficient and lasting change. Even incremental steps can encourage institution-wide steps toward ambitious, holistic, maintainable goals.

FINDING OPPORTUNITY IN CRISIS AT THE UNIVERSITY OF CALIFORNIA, SAN DIEGO

One way to inspire change is to find opportunity in crisis, said Terrance Mayes, associate dean for graduate education and the director of the Graduate Programs and Diversity Office at Stanford University. Before working at Stanford, Mays attended graduate school and taught at the University of California, San Diego (UCSD). Historically, UCSD is a predominantly white and Asian institution that is well known for its exemplary science and engineering programs. When Mays taught there, the campus's conservative, peaceful atmosphere was not conducive to social activism or a social work environment. However, beneath the veneer of tranquility brewed an undercurrent of racism and microaggression that came to a head in 2010.

That year a white fraternity threw an on-campus party with the theme "the Compton cookout." Supposedly, the event was thrown in honor of Black

history month, but attendees were encouraged to come dressed in baggy clothes with drawn gold teeth. At the party, students ate watermelon, fried chicken, and other foods based on African American stereotypes. Later that year, UCSD students used racial epithets on a campus television station to denounce black students. Then, students arrived on campus to find a noose hanging in the Geisel Library. Outrage and protests ensued, but Mayes said he was less surprised that these incidents occurred than he was at how un-prepared the institution was to deal with these critical issues.

Racist actions at the university garnered national attention. Students courageously demanded change, particularly students of color. The campus responded by radically redesigning its institutional structure. It created cul-tural community centers for African American students, Hispanic/Latino students, and Native American students. The campus hired a chief diversity officer, a cabinet-level position in charge of diversity issues for the whole uni-versity. The campus developed an aggressive diversity recruitment strategy. A center for inclusion, diversity, excellence, and advancement was developed at the school of engineering. Students now are required to take a cultural competency curriculum that is integrated into the existing undergraduate curriculum, with diversity training required within undergraduates' first two years of school.

By working with diversity officers who serve as critical liaisons between the senior administrators and the students, the campus was able to execute a broad vision that addressed diversity at all levels. A coalition of likeminded individuals collectively created and executed a vision based on the window of opportunity created by institutional crisis. "Diversity is not asking you to do something you wouldn't normally do," said Mayes. "It's encouraging people to commit to the very thing that the institution is founded around: excellence and diversity in an environment that encourages each person to offer their unique and valuable contributions," said Mayes.

The program has radically changed campus culture at UCSD, but some areas still need improvement, Mayes concluded. For example, training is not yet required of faculty, staff, and senior leadership, a problem that he hopes will be addressed in the future.

EQUIPPING FOLLOWERS TO LEAD[1]

Change often focuses on a top-down approach where leaders imple-ment and cause change. However, deep change also requires a bottom-up approach, observed Steve Lee, Graduate Diversity Officer for the STEM disci-plines at the University of California, Davis. The followers of a strategic plan for change need to be actively engaged if the plan is to have meaningful and lasting impact.

Mentoring-up is a concept that promotes change, Lee noted. In the 1980 paper "Managing Your Boss" in *Harvard Business Review*, John Gabarro and John Kotter found, in a corporate setting, that young managers who were

---

[1]This session at the conference was co-led by Michael Penn, Sherilynn Black, Steven Lee, Terrance Mayes, and Anthony DePass.

particularly effective at being proactive in their relationships with their super-
visors above them tended to meet with success. Training mentees to also be
proactive in mentoring relationships can have similar effects, said Lee. Men-
tees need to act with confidence, actively listen to their mentors, provide input
to goals, and be engaged yet respectful in a mentoring relationship. This fine
balance can be achieved by assessing each particular situation and designing
a strategy that specifically uses the mentee's strengths and weakness.[2]

Additionally, strengths-based leadership training has prepared graduate
students and postdoctoral fellows to lead diversity initiatives at UC Davis.
Leaders of organizations such as the Ecology Diversity Committee and the
Black Graduate and Professional Student Association met weekly over five
sessions. Team exercises in leadership and diversity helped identify their
professional strengths and enabled them to work with each others' strengths.
Their strengths were identified by using the StrengthsFinder and Myers-
Briggs Type Indicators self-assessments.

CREATING MOMENTUM AROUND
DIVERSITY AT DUKE UNIVERSITY

To broaden representation in STEM fields, many levels of coordinated ini-
tiatives, institutional support, and highly specific interventions, with clearly
defined and measurable outcomes to determine progress and success, must be
implemented, said Sherilynn Black, assistant professor in medical education
at the Duke University School of Medicine and co-principal investigator of
the Duke Initiative for Maximizing Student Development (IMSD), which is
referred to as the Duke Biosciences Collaborative for Research Engagement
(BioCore). In 2010, Duke created the Office of Biomedical Graduate Diver-
sity, with Black as founding director, to address the urgent need to diversify
biomedical graduate programs. The office's development of more than 15
coordinated interventions addressing 19 graduate departments and programs
in the School of Medicine has dramatically and significantly shifted attitudes
and engagement in all categories of diversity initiatives, Black said.

When Black started the diversity office, the administration proposed
a very traditional structure similar to that at many other institutions. The
university was willing to spend institutional dollars to create an office, but
it wanted that space to be a self-contained administrative office where all di-
versity work was confined to Black and a few staff members. "You're crazy,"
Black told them. "This is the reason why you haven't been effective."

Black offered the administration an alternative approach: to decentralize
initiatives and expand into each department. Responsibility would be placed
on the constituents being served rather than a single person. She knew that
the office needed to reach beyond the School of Medicine to affect the whole
university and other institutions. Duke responded favorably to her requests

---

[2]Lee, S. L., R. McGee, C. Pfund, and J. Branchaw. 2015. "Mentoring Up: Learning to Man-
age Your Mentoring Relationships" in The Mentoring Continuum: from Graduate School
through Tenure, G. Wright, ed. The Graduate School Press of Syracuse University.

and expanded her staff from one to six people, four of whom were covered by institutional funds.

To incentivize these efforts, Black identified the individuals that could benefit from her efforts. She determined what she needed to do to be relevant to the campus ecosystem, studied strategic plans, and identified leaders' key needs. Identifying a person's needs can help that individual feel valued and create the potential for shared interest. Partnerships with academic and institutional colleagues can go beyond the obvious diversity programs, but it is important to understand what is wanted from faculty members and hold them accountable for their actions. "I need to make sure that the people who are working with me are extensions of my message and not deterrents to my message," said Black.

Program leaders need to be better at self-promotion to best serve students, said Black. A program's success needs to be disseminated through publications, conferences, and notices. Every time a program receives a grant, institutional leaders should be notified. Deans, presidents, and provosts want to raise the caliber of their institution, and press releases documenting successful programs benefit the whole academic culture.

Ultimately, students are the linchpin of a successful program. The better students perform, the better the institution does at a national level. All programs must ensure that they raise institutional caliber to connect better and more intrinsically into the institutional community, Black concluded.

As with all interventions, data are particularly important. Especially in an environment of constrained money, where questions are asked about how effectively money is being used, programs need to back up their work with hard evidence. The types of information that are possible to collect at the institutional level are very different now than 30 years ago.

Black's current research focuses on identifying common variables associated with successful STEM student development interventions in higher education and in creating computational models that are predictive of the success of higher education intervention programs. She is responsible for bringing talented underrepresented minority graduate students to Duke to enrich their experiences of doctoral studies through a series of enrichment programs, mentoring programs, professional development opportunities, academic development, and cohort formation activities. BioCore provides extensive mentoring and scientific engagement opportunities for talented and diverse undergraduates in biomedical and behavioral sciences at Duke.

Many members of the majority community at research one institutions believe in diversity but do not see a role for themselves in the process, Black said, leading to low levels of engagement and disconnects with students. When Black was approached in 2010 to start the diversity office, only 8 percent of the student body across 19 departments and programs were underrepresented minorities. Many of these students suffered feelings of alienation and isolation that prevented them from reaching their potential. Having low levels of diversity also decreased Duke's national role in diversity measures, the success of its recruitment practices, and its chances of getting sustaining funding to address the problem.

Black wanted to find a way to engage the entire community to solve this problem. She aimed to create a system that would integrate departments and disciplines and ultimately lead to student feelings of inclusion and comfort. Black's background in biomedical science allowed her to bond with students. She was not just a bystander but was viewed as a faculty member doing rigorous work in a scientific discipline.

From day one, Black received strong institutional support, including financial and administrative support. She focused on four key areas for student success: funding and scholarship; administrative prominence in leadership; student engagement, professional development, and enhancement; and faculty engagement. She developed a strategy called the Full Community Engagement Model that focused on creating a unified diversity platform that engages the entire scientific community. She expected every member of the faculty to be involved with her office, which created accountability and contributed to feelings of ownership and inclusiveness. People avoid getting involved in diversity fields because of the stigma these initiatives are remedial, Black said, something only for minorities. Involving everyone in the process raises the caliber of the program and indicates its intention for excellence.

Funding was one of the key components to Black's success. "Everyone who knows me knows that I will relentlessly and shamelessly find funding anywhere that I can," she said. Duke has been very supportive of her programs, partially because of her aggressive grant writing. Her initiatives at Duke are being funded by NIH, the Burroughs Wellcome Fund, and the Trent Foundation. A partnership with the development office allowed for effective institutional communication. She meets regularly with the development officer, who helps to seek out funding opportunities. Partnerships with industry and other institutions have allowed synergistic funding from grants.

Black had several goals when starting the diversity office. First, she wanted to create a safe space both for students and faculty. By making constituents feel valued, she encouraged the spread of methodologies, recruitment, and retention. She started a combination administration and research postdoctoral program through the offices, so that individuals could learn how to do interventions research and be effective administrators. Specific administrative goals included aligning the office initiatives with national diversity priorities and partnering with each department in the School of Medicine on T32 grants and other administrative issues.

T32 grants fund many graduate students, but some T32 students were on probation because of the low number of diversity initiatives at the institution, and a large percentage of the students had either marginally acceptable or unacceptable diversity statements. By forming partnerships with other institutions, federal agencies, and companies with a history of strong diversity practices, Black enabled cross-institution collaborations and revamped recruitment strategies. Currently, 100 percent of T32 students have fully acceptable diversity statements.

The Institutional Partnership Program, which works to recruit students to campus through mutually beneficial relationships, incorporates Duke into the national community. All faculty get involved in the program, which has led some faculty members to form research collaborations with minority-

serving institutions. The program also has helped faculty get involved with conference travel.

The programs instituted through the Diversity Office have made a major difference in student perceptions of Duke as a supportive environment for success, Black reported. Before the diversity office was created, the School of Medicine received an average of 40 to 50 applications per year. This year, 143 students applied. The matriculation rate has increased from 8 percent to 14 percent, with a peak of 18 percent. Data from the more than 20 interventions Black has created show that students are exhibiting higher performance levels in laboratories and classes and at milestone events. The programs have spurred significant increases in students who obtained fellowships and external funding. An increased number of students seek to remain in academia and other scientific careers.

Faculty are provided with the resources and tools to be better mentors and more sensitive to students from diverse backgrounds. Black works with faculty to increase empathy by finding a common core of experience with underrepresented students. She ensures that faculty are integrated at all levels and provides professional development opportunities for enhanced mentoring confidence. Survey data indicate that students feel more comfortable, connected, and confident in their relationships with faculty, and faculty feel more comfortable with training minority students. Diversity is now a part of the scientific culture at Duke, Black concluded.

OUTCOMES AND PROCESSES OF THE MEYERHOFF SCHOLARSHIP PROGRAM

The Meyerhoff Scholarship Program was created more than 25 years ago to work with highly accomplished and motivated high school students as undergraduates at the University of Maryland, Baltimore County (UMBC). The program is a leader in sending well-prepared underrepresented minority students to advanced biomedical and engineering degrees. The Meyerhoff scholarship program provides emotional, financial, and academic support for students while establishing accountability, identity, and belonging in science and toward each other. "The magic that helps keep kids in tough science majors and keep the goal of going to a PhD program is the relationship these students develop with each other," said Kenneth Maton, professor of psychology at UMBC. More broadly, the program has transformed courses, attitudes, and perceptions at UMBC. "Having the president of UMBC support the Meyerhoff program since its creation has made a huge difference," Maton also said.

A recently completed study of the program had two goals: to examine the effect of the program on STEM PhD completion, specifically among African American students, and to explore the specific mechanisms of influence, particularly the role of perceived benefits of program components as a mediator of the relationship between sense of community, science identity, and research self-efficacy. Concerning the first goal, the study gathered data through 16 cohorts between 1989 and 2005, comparing a group of 479 African American Meyerhoff students to 249 similar students who declined the Meyerhoff scholarship offer. The Meyerhoff scholars sample included more males than

females, with a greater verbal SAT score among "declined" students. The sample was divided into two equal groups: eight cohorts from 1989 to 1996 and eight cohorts from 1997 to 2004.

Results revealed that African American Meyerhoff scholars were 4.85 times more likely to complete a STEM PhD than the "declined" students. After controlling for GPA, SAT scores, and gender, African American Meyerhoff scholars were found to be over seven times more likely to complete a STEM PhD. Students from the more recent set of cohorts were 36.5 percent more likely to complete a STEM PhD than those in the earlier set of cohorts. Of those scholars who earned PhDs, 78.4 percent received their degrees from Research 1 universities or Doctoral universities with the highest levels of research activities (using Carnegie classifications).

Concerning the second goal of the research, student science identity and research self-efficacy were examined after two years of student participation in the Meyerhoff program for students entering the program between 2010 and 2013. The study measured their sense of community, during a summer bridge program prior to freshman year, and perceptions of program benefit at the end of freshmen year. Assessments demonstrated strong reliability.

On a four-point scale, Meyerhoff scholars averaged scores of 3.4 or 3.5. On a five-point scale, they averaged around four. All students in the program reported benefits despite some variation. Sense of community and perceived program benefit were positively related to both of the outcome measures, with significant correlations in the expected direction. Sense of community during the Summer Bridge program, which is a pre-freshman six-week program designed to develop a sense of community and mutual accountability, was positively related to science identity two years later. The relationship was no longer significant when perceived program benefit was added into the equation (full mediation).

Regular focus groups and other qualitative data collection techniques supported these findings. In one interview, a summer bridge student said, "Summer Bridge is where it all begins. It's like saying that a chain is only as strong as its weakest link. That's Summer Bridge." Students also benefit from peer advising and counseling. A number of parents whose children have graduated years ago are still involved in the program, volunteering their time and efforts for fundraising and student support.

Importantly, the program provides students with the opportunity to do research. One student said, "It was my first, best science experience. I just fell in love with it. I just really loved how I had to think about everything. It was just very informing. And that had a lot to do with considering the PhD."

Meyerhoff students are similar to comparison students at college entry, Maton reported. They have similar levels of STEM interest, career aspirations, and academic backgrounds. Students who decline the Meyerhoff Scholarship offer typically attend highly selective universities. However, Meyerhoff students are more likely to earn STEM PhDs than comparison students.

Results suggest that a sense of community and research experiences are important components to student success. In the Summer Bridge program, students form support networks, a sense of culture, and a sense of academic

and social integration. Meyerhoff scholars typically identify as Meyerhoff scholars first and then as students within their specific major.

Confidence in outcomes is limited by the lack of a randomized control group, and different intervention approaches are being assessed to ensure data reliability and validity. Peer and mentor reports should also be included in future research, said Maton, not just self-reports for students. Qualitative data need to be expanded to look at all the psychosocial variables that influence students from the start of their college careers to graduation. Ideally, a comparison sample would complete the same survey measures as Meyerhoff students, and all participants would be followed through their career outcomes.

THE MEYERHOFF ADAPTATION PROJECT AT PENNSYLVANIA STATE UNIVERSITY

The Howard Hughes Medical Institute (HHMI) has been funding a multi-year experiment that has aimed to adapt the Meyerhoff Scholarship Program to two other universities, the University of North Carolina, Chapel Hill (UNC), and Pennsylvania State University (Penn State). With the help of UMBC and an advocacy group, the institutions are adapting and adopting elements of the Meyerhoff Scholarship Program, identifying barriers to success and developing strategies to overcome these barriers, and documenting efforts and effects of the experiment to help other universities use the knowledge gained from the experiment to guide institutional change on their own campus across the country.

Pennsylvania State University incorporates a similar six-week Summer Bridge program as UMBC. Students attend the program before the fall of their freshmen year and engage in different programming thereafter, including research experiences and summer internships. The evaluation plan for the program aims to examine academic, scientific, and social experiences to identify the experiences that predict short- and long-term academic success, graduate school enrollment, and completion. Implementation processes are gathered, organized, and analyzed in relation to program goals using quantitative and qualitative measures.

Since 2013, data have been collected for three cohorts at Penn State. The first cohort included 18 students, with three student leaving the program but remaining enrolled in the university; at the time of the conference, about 100 students were being interviewed for 40 spots in the fourth cohort. Summer Bridge component surveys measured scientific STEM self-efficacy at baseline, with the goal of increasing this self-efficacy over the course of the program. The adaptation particularly aimed to increase student ability to do meaningful research, their confidence in their ability to excel in research endeavors, and their perceived potential to become highly influential scientists or engineers. STEM self-confidence was assessed using 15 items, including a strong sense of belonging, personal satisfaction from working on a team doing important research, and the appeal of daily work as a scientist or engineer. STEM career expectations included eight items such as enjoyment of the work, completion of research-related tasks, and expectations for future research.

The results showed that men's STEM identity decreased and women's STEM identity increased after the Summer Bridge program. Students reported stronger STEM self-confidence, STEM self-efficacy, and research expectations after the program. A high percentage of students found advising, counseling, and mentoring to be useful resources. The majority of students also reported the benefit of peer-to-peer support. Sixty-five percent of men reported academic advising as useful or very useful versus 91 percent of women. Women reported tutorial services as 63 percent useful or very useful versus 83 percent of men. A majority of the students also found professional development and interpersonal relationships to be useful or very useful.

Qualitative work will provide insights into further processes. For example, 20 percent of students reported the opportunities for respectful exchange of ideas as poor or average. When students were asked if they considered leaving the Summer Bridge program, some considered it, but the majority did not. Students reported overall satisfaction with the Summer Bridge program, but agreement was not complete.

Next steps include linking students' academic record data to surveys and further supplementing quantitative data with findings from the qualitative data. By combining cohort data, larger numbers could produce more meaningful statistical comparisons. In addition, the study directors would like to create a matched cohort comparison sample with similar students who declined to be in the MSP program.

THE MEYERHOFF ADAPTATION PROJECT AT THE UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL

At the University of North Carolina (UNC) at Chapel Hill, research on the Meyerhoff Adaptation Project has been looking at several questions. To what extent do program participants overall, and underrepresented minorities in particular, achieve desired outcomes? Does the program have an effect beyond what would be expected for top, highly motivated students who are not in the program? How do the program's components compare to those of the Meyerhoff Scholars Program in terms of implementation of each component and component-specific student outcomes achieved? Will modeling analyses reveal relationships among background and baseline measures, component-specific and theory-based intermediate predictors, and longer term student academic outcomes?

Students are assessed throughout the first, second, third, and fourth years through surveys and interviews. During the five-week summer bridge program at UNC, students complete several assessments after the first, second, fourth, and fifth weeks. Depression is measured at multiple times, since the summer bridge program can be a very emotional experience for students. Students are analyzed for their attribution scale, mathematics and science competency, STEM identity, and STEM self-efficacy. The study aims to assess how student trajectories change from the summer bridge through their time at UNC and beyond. If students go on to graduate school, the study aims to collect both academic and social performance.

Roughly 4,000 students are admitted into each incoming class at UNC, with 1,200 to 1,400 of these students expressing an interest in STEM when they apply. From that group, admissions officers pass a list of 200 to 300 people on to the programming staff, who invite those students to attend selection weekend. For the research project, students were matched with similar students demographically and financially who declined to participate in the program. More African American, Hispanic, Native American, and multiracial students were in the control group.

In all cohorts, students in the program achieved higher GPAs at every time point than the comparison group. Students enter the program with fairly high STEM confidence, and as they progress through their majors, confidence levels decline, likely because students realize they are not as knowledgeable as they once thought. Students also experience a slight decline in STEM self-efficacy. At the end of the fall, all students who were part of the program were asked to read through the Meyerhoff program outlines and comment about how closely aligned they feel the UNC program is to each individual component. Students responded, for example, that the summer bridge is similar to UMBC's model but not identical.

At the end of the year interviews, Meyerhoff scholars complete a lengthy questionnaire that assesses their reactions to the program. In general, students appreciate mentoring, academic advising, monthly program coordinator meetings, and peer group support. Family involvement still needs to be developed, according to the research result. While students do social activities together, live together, take similar courses, and are all the same age upon entering the program, many students drift apart as they progress through their majors. Because the program has so many elements, it remains difficult to assess its full impact.

In the future, the program could determine ways to get a broader population of students, particularly by assessing which individual components of the Meyerhoff program are the most essential. New conclusions could be drawn from sub-population analysis of the cohorts rather than modeling of the entire population. As the Meyerhoff model continues to expand to other institutions, cultural, demographical, and logistical factors are also going to be important in adapting the program to its environment.

SOCIAL PSYCHOLOGICAL INNOVATIONS TO BROADENING PARTICIPATION WITHIN THE ACADEMY, ONE FACULTY MICROCLIMATE AT A TIME[3]

The metaphor of a leaky pipeline is often used to describe underrepresented minority students' pathway through STEM education and careers. Using that analogy, interventions often look at the water leaking out of the pipe when they should examine the pipe itself, said Jessi Smith, professor of psychology at Montana State University (MSU). Smith's work emphasizes

---

[3]This session at the conference was co-led by Jessi Smith, Sara Rushing, Chatanika Stoop, and Dustin Thoman.

situations and context to create change at the contextual level rather than trying to change a person to fit in with a situation.

Smith received a multi-million-dollar Institutional Transformation grant from the National Science Foundation (NSF) with the goal of changing the culture of MSU in five years, with a particular focus on women faculty in STEM. The study she described was grounded in self-determination theory, a classic motivational theory that emphasizes the support of natural and intrinsic tendencies to behave in effective and healthy ways. Based on this theory, Smith hypothesized that if women's psychological needs were supported in STEM fields at MSU, this support would be associated with positive changes in job satisfaction for everyone on campus, since an inclusive campus benefits the whole institution.

At the inception of the grant in 2012, MSU had 33 departments, 17 in STEM fields, and nine colleges, three in STEM fields. About 400 faculty were employed at that time, with 17 percent of STEM faculty women (compared with a national average of 34 percent). Three initiatives were designed to enhance work–life integration, cultural attunement, and research capacity, and opportunity for women faculty in STEM in a way that could benefit everyone. The programs aimed to create a context supportive of competence, relatedness, and autonomy to bring about positive change.

The first program revolved around search intervention. Faculty searches needed to be redesigned to illustrate how unintentional bias can undermine decision making, Smith said. When faculty members were shown research documenting the existence of implicit bias, they attempted to poke holes in the data, leading Smith to realize that evidence was not sufficient. In a modified implicit association test, participants were instructed to slap a knee for associations, and faculty were much slower when the words did not align with gender stereotypes. This activity served as a powerful experiential demonstration, given that the entire room could hear the delays caused by implicit biases.

Next, faculty were given a toolkit of concrete strategies for conducting a broad search. For example, they were provided with support for working with a family advocate, who can meet with all job applicants and play a confidential role. Because faculty often fear liability if they ask personal questions, the family advocate can safely facilitate these types of discussions.

A randomized controlled design that compared search committees that received training with those that did not found that the group with training conducted phone interviews with significantly more women, conducted on-campus interviews with significantly more women, and were 6.3 times more likely to make an offer to a woman candidate. Moreover, women candidates were 5.8 times more likely to accept offers. These results suggest that the intervention was effective in broadening the participation of women faculty.

The intervention has made a significant impact on the number of women faculty participating in STEM fields at MSU. However, hiring more women does not guarantee their success, Smith said. She also wanted to create a new microclimate setting to enhance the research capacity for women faculty. Theory again informed the intervention design with the same three components. For example, past data demonstrate that, when women apply for

funds, they do not ask for as much money, and when asked to cut their budgets they cut themselves before anything else. A grant-writing boot camp was designed to provide tools, templates, and specific concrete examples of how to navigate the grant writing process. One-year pre- and post-assessments were conducted of three boot camps, spaced six months apart over an 18-month period. Twenty-one faculty members in STEM fields, all pre-tenure, participated in the six-week intensive program. Results revealed a significant increase in the number of external grants submitted and an increase in the number of proposals with women as principal investigators.

Smith's third project involved analyzing the microclimates in faculty laboratories through the NIH Interventions Research Study in collaboration with Dustin Thoman, who was then at California State University, Long Beach. The analysis used a framework of Goal Congruency Theory and emotional contagion research, which is based on the idea that some groups, and especially underrepresented minorities, value particular cultural goals, and in particular communal goals. Students often fail to see the value of culture and community within the science curriculum. For example, when students are tasked with washing dishes in the laboratory, they tend not to understand the bigger picture. Informed by these theories, the project predicted that values and norms within a faculty member's research laboratory would be contagious among students.

The study also considered how students' performance might increase by understanding the value and relevance of research and their role as part of a larger community. The connection between research and community is important for capturing student interest, especially among underrepresented students.

The study tested whether communal values within faculty labs are contagious with 522 research assistants in 42 biomedical research labs at multiple universities. Students were measured within the first couple weeks of their laboratory experiences, at the end of the semester, and then every semester for two years. Key measures included communal utility, inspired value, how experiences might be applied to the bigger picture, and interest in being a researcher.

Using multilevel modeling, results showed that a contagious environment was produced for underrepresented as well as well-represented minority students. The environment did not seem to make a difference for white students, but no one was harmed by thinking about the laboratory as a communal space. The higher a student's lab mates' perception of communal utility value, the more that student was interested in research over the long term.

These findings set the groundwork for future theory-informed interventions that target the microclimate of faculty's research laboratories as intervention settings, said Smith. A more diverse faculty also could change the laboratory environment by helping underrepresented students get grants and by conducting research in a way that facilitates diversity, thus creating a cycle that promotes equity.

Taken together, results from the three interventions highlight how social psychological science is rapidly changing the way scientists and educators regard intervention research. "I'd like to inspire everybody here to think

about interventions and curriculum reforms that use integrated theory-driven science to account for the unique cultural setting that you're trying to study," Smith concluded. Programs should try to think of the unique aspects of a situation and apply classic and contemporary theory in the design and analysis of interventions.

INTEGRATING STUDENT SUCCESS PROGRAMS AT A LARGE DECENTRALIZED UNIVERSITY

The same processes that are often undertaken in a program of institutional transformation can occur on a small scale, perhaps in anticipation of a broader initiative. An example of this is the M-STEM program at the University of Michigan (UM), which was launched in 2008 to maximize the academic, personal, and professional success of students regardless of their demographic background. UM is a large decentralized research university with multiple academic support and student services initiatives. In an effort to use existing resources and keep M-STEM's budget low, the program partnered with a large number of offices and programs across the university. M-STEM works with programs in the Medical School, the School of Engineering, the School of Public Health, and the School of Education. Recently, the College of Literature, Science, and the Arts has joined the initiative, bringing a total of 100 science, mathematics, and engineering students annually to participate in the cross-university effort.

The science part of the program is funded by an NSF STEM Talent Extension Program (STEP) grant, with considerable cost sharing from the provost's office and the office of the vice president for research. It is a true campus-wide effort that instills a sense of ownership for the university. While the collaborative nature of M-STEM has its challenges, the rewards are significant, said Darryl Koch, the Director of Retention and Academics Support Services in the College of Engineering.

The College of Engineering has about 5,500 undergraduates on campus, but only 60 students are accepted into M-STEM each year. Koch works to identify students who may have lower ACT scores, are first-generation, or have lower family incomes. Many of these students are underrepresented minorities, but she also looks to include more women in the program. M-STEM admits 40 to 50 percent women, while the percentage of women in the College of Engineering is about 30 percent. Koch helps oversee the summer program component for engineering students, and her office supports supplemental instruction sessions, tutoring, and other academic support services.

The program begins with a six-week summer transition program where admitted students take classes taught by UM faculty and graduate students, providing students with a taste of what they will experience in the fall, said Shannon Zuniga, the director of M-STEM Academies. During the summer program, students are also exposed to many different campus resources, allowing them to become familiar with what is offered. "When they come to campus in the fall, this is their second nature and they hit the ground running," said Koch.

M-STEM runs through the first and second year at UM. During the first year, students are paired with an academic coach who is part of the university's professional staff. Unlike an academic advisor, the coach helps students navigate all aspects of university from financial aid to breaking up with a boyfriend or girlfriend. In her role as an academic coach, Koch said, "That's a very good perspective for me, because I can see a lot of the issues students face as they come through the summer program and what a lot of these transitions are as they come into the first year."

M-STEM also includes many community building programs. During monthly M-STEM family meetings, students come together to discuss relevant issues associated with that time of the academic year. Students are also required to participate in a weekly mathematics supplemental instruction session, and if they are enrolled in a science course they must participate in a peer-led study group through the Science Learning Center.

Many programs partner with the M-STEM program to create this collaborative learning environment. One of these support services is the Engineering and Learning Center (ELC), a collaborative learning space where students can go to study, use computers, and discuss their work. Students are introduced to these resources in the summer program and become accustomed to accessing and benefiting from these resources before the school year begins. The ELC provides free drop-in tutoring for mathematics, science, and engineering courses; supplemental instruction sessions; practice exams; and workshops to strengthen academic skills and learning strategies.

The program's partnership with the Undergraduate Research Opportunity Program (UROP) exposes M-STEM students to research opportunities. UROP was started 27 years ago to retain diverse students on campus and encourage them to pursue graduate and professional degrees. UM has a long tradition of undergraduate research but M-STEM takes a narrower approach, specifically targeting students during their first and second academic years and helping them get research positions in the summer. M-STEM students are introduced to UROP during the summer program through panels of current undergraduates who describe why research is so important to them and what they gained from those experiences. Students who are introduced to UROP during the summer program are much more likely to participate in it during the year than other entering students, said Koch.

Through UROP, students attend bi-weekly research seminars with 30 other students geared specifically toward their discipline. Some of these are STEM seminars, which allow students to integrate into the larger campus STEM community. Other seminars allow students to explore different disciplines and fields. Seminars teach students such things as how to read peer review literature, how to follow research ethics and integrity, and how to acquire a faculty mentor. Research field trips take students outside the university for hands-on experiences. "The advantage of this collaboration is that it enables us to provide a strong research component to the M-STEM program without creating a whole new infrastructure and additional resources," said Sandra Gregerman, the director of UROP.

During the academic year, students work 8 to 12 hours a week on a research project for either academic credit or work study support, which allows

the university to provide financial support to M-STEM students who have work study as part of their financial aid packages. Early research experiences force students to contact faculty outside of the classroom. This non-remedial approach to academic success and retention enables more M-STEM students to get involved in research from an earlier stage.

Peer advisors meet monthly with UROP students to provide additional support. Juniors and seniors who have had one to three years of research experience teach students how to interview faculty, help them find projects and research opportunities that match their academic interests, and guide them in developing résumés. Journal clubs and research building workshops provide additional academic support, and the program culminates in an annual research symposium where students share their work.

After the first year in M-STEM, students are encouraged to participate in summer research and internships. International experiences are also encouraged, and many students study abroad or gain international internships. Some students also return to work at UM over the summer while taking classes at the institution or at a community college. In the second year, many students join a hybrid program called Research Scholars, where they work with faculty to identify pieces of a large project that they have ownership of.

The second year of M-STEM involves some of the same programs as the first year. Students still have an academic coach, are still required to participate in academic support activities, and are given assistance to seek additional mathematics, science, and engineering opportunities. A student council comprised of current M-STEM students works on many of the social aspects of the program, organizing events that range from ice skating to a formal. Their functions bring all of the cohorts together to socialize.

Data gathered from the program reveal the barriers students may face, how those barriers can stymie success, and how to mitigate those factors. Data from cohorts between 2010 to 2013 have shown that underrepresented minority students' average two-year retention rate was 91 percent versus 84 percent for students not in the program, despite lower ACT mathematics scores. African American students in the intervention had an average second-year cumulative GPA of 3.01 versus 2.82 from non-intervention African American students, despite lower entering ACT mathematics scores. For M-STEM students between 2011 and 2013, when matched for mathematics ACT, high school GPA, family income, gender, and ethnic group, the retention rate of students declaring a STEM major was 90 percent versus 43 percent of their counterparts in the College of Literature, Science, and Arts.

By taking advantage of all the programs and resources available at UM, M-STEM has improved underclassmen student retention and success in STEM fields. Even more important, it has given students the skills needed to succeed at further stages of the STEM education pipeline.

HBCU MODELS OF STEM SCHOLAR CULTIVATION

Among the institutions that prepare minorities for careers in science, historically black colleges and universities (HBCUs) have a special role. Although HBCUs represent only 3 percent of all institutions of higher learning

in the United States, they graduate 20 percent of Black students earning undergraduate degrees. Also, these institutions are committed to provide education to any groups that have systematically been denied higher education. In 2013, 20 percent of all students being educated at HBCUs were non-Black. No examination of interventions that can broaden participation in science careers is complete without considering HBCUs.

HBCUs were developed at a time when most traditionally white institutions denied admission to black students. Today, there are 105 HBCUs in 19 states across the country, the District of Colombia, and the U.S. Virgin Islands. Many of these are public institutions that were built following the Morrill Act of 1890, which established black land grant institutions. This act, targeting confederate states, required that states demonstrate that race was not a criterion for admission to their colleges and universities or, if it was, to establish separate land grant institutions to serve people of color.

The increasing global need for STEM professionals, particularly professionals of color, makes the role of HBCUs particularly vital to the future of the United States, said Anita Wells, Associate Professor in the Department of Psychology at Morgan State University. Students enter HBCUs with varying levels of education and preparedness, and many entering students place into remedial or developmental courses that are not counted toward graduation. These courses can put students behind track, especially STEM students. For example, Calculus I or the equivalent mathematics requirement often serves as a gateway course for students to pursue a STEM degree, but many students are not ready for this level of mathematics upon graduation from high school. HBCUs, however, historically have admitted and cultivated underprepared students to enable them to pursue graduate education.

Many HBCUs lack the resources that are more common at traditionally white institutions. For example, HBCUs traditionally have accounted for a very small percentage of federal grant recipients. Despite resource challenges, HBCUs still produce more than 25 percent of Black STEM students who go on to earn doctorates. "HBCUs unlock a STEM pathway through which students learn and earn the keys that take them to the next level in their education as well as their careers," said Wells.

"Three of the keys to STEM pathways that students earn at HBCUs include intrusive advising, early engagement in research, and graduate school and career readiness," Wells observed. First, intrusive advising results in the early identification of students who are struggling academically or socially. Second, early engagement in research helps increase student competitiveness when they apply for internships and graduate school. Third, programs developed for graduate school and career readiness offer skill development to help students successfully apply to STEM internships and gain entrance into graduate school programs.

3

Theory in Interventions Research

A cornerstone of the Understanding Interventions approach has been the tight link between theory and practice, as demonstrated by this chapter and the following chapter of this report. This chapter describes interventions with a particular focus on the theoretical underpinnings of those actions. The next chapter emphasizes the empirical tools used to gather data to support or modify theoretical approaches. Yet the studies described differ only in degree, not in kind.

CULTIVATING PSYCHOSOCIAL STABILITY AND INTEGRATION IN THE BIOLOGY SCHOLARS PROGRAM

The Biology Scholars Program (BSP) at the University of California, Berkeley, challenges the popular view that SAT scores and high school GPAs are good predictors of who can and should do science. Over the past 23 years, of nearly 2,500 BSP graduates, 60 percent have been underrepresented minority students, 70 percent have been women, and 80 percent have been from low-income and/or first-generation backgrounds. Students in the program tend to come from schools with a lower Academic Performance Index (API), and their GPAs and SAT scores are typically lower than the general population.

The program provides advising, social support, and a safe space for students. Students are advised on both professional and personal matters and are provided with mentorship, seminar, and workshop opportunities. Students are primarily sought who have the ability to be active participants in the community, since student interaction and collaboration are fundamental elements of the program.

At this time, the tripartite integration model of social influence (TIMSI) is being used to better understand how BSP works, said Mica Estrada, assistant

adjunct professor at the Institute for Health and Aging at the University of California, San Francisco. This model describes how, when people are integrated into their community, they are more likely to engage in the norms of that group. In particular, Estrada described three ways in which people integrate into a community. The first element is science efficacy—students' belief that they can do what scientists do. The second factor is science identity—students' belief that they are scientists. The third element is the internalization of scientific values—students' agreement with the values of the scientific community. Students who have high efficacy, identity, and values are highly integrated persons.

Across repeated studies, retention and persistence of BSP students has been shown to be on par with, if not exceed, the rates of "lower risk" students. Data collected between 2002 and 2008 analyzed retention and persistence of BSP students compared to the rest of the Berkeley population. Results showed a 2 percentage point gap between all UC Berkeley biology- and biomedical science-intended freshmen and underrepresented minority BSP scholars in obtaining a degree in biological or biomedical sciences versus a 21 percentage point gap between all freshman and underrepresented minority non-BSP students. In addition, all UC Berkeley freshmen and underrepresented BSP scholars had a 12 percentage point gap in achieving high GPAs, versus a 30 percentage point gap between all freshmen and underrepresented non-BSP students.

These consistent effects prompt the question: "Why do BSP students persist and academically outperform their non-BSP peers?" The "Gift It Forward" study began in 2014 to collect data from 70 BSP students across the academic year at four time points to assess growth, decline, or maintenance of psychosocial variables associated with persistence in STEM careers. Participants included 77 percent females, with 71 percent from underrepresented minority groups, and 69 percent first generation. Virtually all participants reported high interest in pursuing science careers at the beginning of the study.

Surveys show that students remained generally satisfied with their lives. They did not undergo large rises in stress during exam times, and stereotype threat seemed to be steady across time experiences. A broader entry-level survey for biology and chemistry courses asked students similar questions on efficacy, identity, values, level of life satisfaction, stress, and stereotype threat. Students were grouped into those with high and low intentions to stay in the sciences. In both groups, life satisfaction and stress levels remained constant despite intent. BSP student scores aligned much more closely with students of high intention than with students of low intention in value, identity, efficacy, and intentions.

Repeated measures analysis showed that in spite of students being engaged in many entry level biology and organic chemistry classes, which usually result in high attrition of high risk students, BSP students persist in maintaining interest in science careers. At the same time, their sense of efficacy, identity as scientists, and endorsement of scientific community values, which are all related to persistence, remain consistent across the four time periods throughout the year. Levels of self-reported stress, well-being, and joy in work remain stable, without a linear decline or incline. BSP student levels

were not significantly different from other non–high-risk students currently enrolled in entry level science courses who have high intentions to remain in science. BSP values were significantly higher in science efficacy, identity, and values than students who have low intention to pursue science careers in those classes.

To further improve analysis of the BSP program, data should be collected longitudinally and prospectively with comparison groups and the use of institutional data to evaluate the effectiveness of the program's objective to increase student persistence, said Estrada. In the future, the program will analyze student engagement in different components of the program to see which aspects have the most impact. Researchers want to determine whether the program has a dosage effect so that the students most involved experience the most benefit. They also want to further analyze soft variables, including stress level, well-being, and social support.

EXPLORING MECHANISMS FOR UTILITY-VALUE INTERVENTIONS THAT CLOSE ACHIEVEMENT GAPS

Many underrepresented minority and first-generation students abandon their bioscience career aspirations because they struggle to pass introductory biology. Social-psychological interventions have proven effective in closing some achievement gaps, but it is important to understand how they work in order to implement them on a broader scale.

Judith Harackiewicz, professor of psychology at the University of Wisconsin–Madison, leads a successful initiative called Promoting Understanding in Life Sciences Education (PULSE), which is organized around three general questions that students ask themselves: Can I do this? Why should I do this? Do I belong here? The first question concerns questions of efficacy and perceptions of confidence. The second concerns questions of value. The third concerns broader social questions of belonging. Harackiewicz and her team targeted the second question of why students should do this work and developed an intervention to target that process.

The intervention was based on motivation theory, with the underlying ideas first being tested in controlled laboratory studies and the intervention then being developed from the findings. In particular, the theoretical framework used was expectancy value theory, which looks at both students' expectations about performance and the values they perceive in a task. The research literature shows that when students perceive that what they are studying is important or valuable, they become more highly motivated, interested, and engaged. The intervention aimed to change students' perceptions by intervening to help them find more utility value in the material they are studying. Furthermore, utility value interventions are especially useful for students who enter with lower performance levels or who lack confidence.

The intervention was first introduced in the introductory biology class taken by all biology majors. The class is taken during students' sophomore year, after they have made it through introductory chemistry. Any student who wants to go into the biomedical sciences has to make it through this course, but it is marked by large achievement gaps, and many students end

up dropping out because of its high demands. "This is a terrible place to lose students, because this is the make or break class," said Harackiewicz. "They've gotten this far, and it's very important that we get students through this class." A large course with 1,200 students each semester who are taught in multiple sections, lectures, and labs, introductory biology does not have gender achievement gaps, but it does have racial and social class achievement gaps. About 8 percent of enrollees are underrepresented minority students.

First-generation and underrepresented minority students tended to enter the course with lower performance records. In surveys, underrepresented minority students report less biology background and note the importance of doing well in the course. First-generation underrepresented minority students are doubly disadvantaged and the most in need of help, Harackiewicz said. First-generation students wonder whether they belong at the university and report higher levels of doubt about their fate at the school. They also enter introductory biology with the lowest grades, the highest levels of poverty, the least background in biology, and the lowest levels of belonging. Nonetheless, these students are highly motivated to do well and make a contribution to society.

A group of 1,040 students were included in the intervention, with 423 majority continuing generation students, 126 continuing generation underrepresented minority students, 427 majority first-generation students, and 64 first-generation underrepresented minority students. Every first-generation student and underrepresented minority student in the course was included in the study and matched with a set of continuing generation and majority students. The intervention was administered as a randomized field experiment over two years and four semesters of introductory biology. During the second week of each of the three five-week units in the course, students were assigned a 500-word paper for credit. Students in the control group were asked to write a summary of the course material, while students in the experimental condition were asked to write essays describing the relevance of the course material to their own lives and/or a letter describing the relevance of the material to the life of a close friend or family member. The study was double blind: students were emailed the assignments, they turned them in on Dropbox, and the essays and letters were graded by graders blind to the conditions.

The study took an intersectional approach, asking whether the intervention had different effects depending on the interaction or intersection of race and social class. Using linguistic analysis software, student responses were examined based on their content and style. First-generation underrepresented minority students wrote fewer words in the control group than in the utility value intervention, where they wrote more words than anyone else. Mediation analysis revealed that this increased engagement with course material and increased performance in the course. These students also wrote essays that contained more social and family words and more words indicative of cognitive involvement with the course material.

First-generation underrepresented minority students in the intervention averaged half a grade point improvement from their matched peers. In a five-credit course, this improvement makes the difference in whether a stu-

dent continues in the field. These results are consistent with the finding that first-generation underrepresented minority students are especially oriented toward helping their families and their communities, Harackiewicz noted.

To implement this intervention, advocates need to be committed to changing the curriculum, and incentives need to be provided for key players. In particular, instructors need to be convinced that such an intervention is worthwhile. The results of the research show that the utility value intervention, though a small program, can have an enormous impact on the most disadvantaged students: first-generation underrepresented minority students.

LEVERAGING THEORY TO MAXIMIZE THE EFFECTIVENESS OF INTERVENTIONS

First-generation students comprise roughly 15 to 20 percent of students at American universities. These students are more likely to come from working class backgrounds, have lower performance levels, higher dropout rates, and less sense of belonging than their peers. First-generation students face more economic and social barriers to success in school as well as psychological factors related to how they experience the nature of higher education.

Many of these students experience the phenomenon described by Nicole Stevens in her cultural mismatch theory, explained Yoi Tibbetts, a graduate student at the University of Wisconsin–Madison. This theory refers to the idea that first-generation students' interdependent norms for attending university are often mismatched or misaligned with the traditional independent norms inherent in a higher education context. When Stevens polled university administrators and faculty about the kind of skills they wanted to instill in their students, about half the skills reflected independent values, such as promoting individual work and student leadership, and about half were more interdependent, such as learning through collaborative work and being a team player. However, when Stevens polled incoming freshmen about their motives for attending college, she found that first-generation students were much more likely to cite interdependent reasons. As Tibbetts put it, students were more likely to say, "I'm coming to school so I can provide for a better life for my own children, or to give back to my community, but not necessarily to pursue my own intellectual career." When independent norms implicit in university settings conflict with first-generation students' interdependent motives, the resulting mismatch can contribute to identity threat, a lack of academic fit, and poor academic performance.

A values affirmation intervention can effectively leverage students' values and motivations to overcome social identity threats, Tibbetts observed. In a study at the University of Wisconsin–Madison, students were given 12 to 16 values. The treatment condition students were asked to circle the ones of highest importance to them and describe why those values were important. The control condition students circled those values that were least important and wrote about why those values could be important to someone else. The intervention operated under the idea that, when students affirmed their core personal values, their sense of identity and self-worth would increase and

they would be buffered against the stress of social identity, threats, or lack of belonging that might result from cultural mismatch.

The intervention was implemented in an instructor biology class at the University of Wisconsin–Madison with 800 students, 154 of whom were first-generation students. The assignment was given twice, once in the second week of the course and once in the eighth week, right before a stressful mid-term exam. The usual gap in course grades was halved with the intervention in the values affirmation condition. A three-year follow-up of cumulative post-intervention GPA revealed that the discrepancy between first-generation and continuing generation students was reduced by 60 percent in the values affirmation condition.

The intervention seemed to affirm the self, buffer self-integrity, and improve performance for first-generation students, said Tibbetts, starting a cyclical process of success that appeared to continue throughout students' academic careers. In seeking to understand the program's success, evaluators looked more closely at both independence and interdependence. When students affirm their independence, they might feel more aligned with the university context. This scenario is consistent with research on identity-based motivation that shows that when a task feels more aligned with students' values and motivations, they are more engaged and interested and perform better. On the other hand, it might be that when students affirm their interdependence and reflect on their working class backgrounds, they are reminded of their networks of social support, promoting comfort and stability.

Each of the students' essays were coded for both themes. Essays were scored for mentioning independence or interdependence, and student performance was analyzed in accordance with the results. The constructs were not mutually exclusive. Of those students who affirmed their independence, 84 percent also affirmed their interdependence. The study found that students who went beyond affirming their interdependence and mentioned independence benefitted most from the intervention. First-generation students who affirmed their independence performed better than their peers. A similar pattern occurred in post-intervention GPAs.

Evaluators also conducted a linguistic analysis using James Pennebaker's Linguistic Inquiry and Word Count software of nearly 1,600 essays from 798 students to determine what kind of writing was most beneficial for first-generation students. Those students who indicated that they valued learning and gaining knowledge were much more likely to write about independence. Three values were most highly correlated with interdependent words: relationship with friends and family, belonging to a social group, and spiritual and religious values. Only 1 percent of respondents most valued being good at art, government, and politics. First-generation students in the value affirmation condition were more likely to take the second course in the two-semester biology sequence than their non-intervention peers.

A separate study with 300 students in an introductory psychology class at UW Madison analyzed the effect of different value affirmation interventions on a standardized mathematics test. Students were given only those values most highly correlated with independent and interdependent constructs. The study had four conditions: an independent values affirmation, an interdepen-

dent values affirmation, a standard values affirmation, and a control condition. Participants were told that the study was about college adjustment to determine how students' backgrounds translated into academic performance. In fact, the study was designed to activate social first-generation identity status and have first-generation students complete a values affirmation exercise as a writing warm-up prior to a test.

In the standard control condition, students affirmed neither independence nor interdependence, writing instead about a mixture of both values. In the interdependent value affirmation, nearly 100 percent of students wrote about interdependence, with very little mention of independence. In the independent condition, students wrote about many independent themes with few interdependent themes.

After the intervention conditions, students completed a 16-question mathematics test. First-generation students performed better in every question in the conditions where independent themes were more likely to be present. The interdependent values affirmation condition still performed better than the control condition, but not as significantly. The achievement gap among students was completely eliminated in the independent values affirmation condition.

A future direction for the intervention would be to understand how this process transfers to the classroom. The intervention is not trying to force students to assimilate into an independent context but rather to reflect on the values that are important for them in the context in which they are being evaluated. Many people were initially skeptical of the intervention's brevity and its potential to have long-term downstream effects. However, the program seems to activate a cyclical process of positive events. When students affirm their independence, they are less likely to doubt their belonging and background. Establishing a sense of belonging or removing a doubt of belonging facilitates persistence and success. In this way, achievement gaps can be addressed by designing values affirmation interventions to target the unique challenges faced by first-generation students.

IMPLEMENTING A UTILITY VALUE
INTERVENTION IN TWO-YEAR COLLEGES

Student learning and performance are traditionally measured by grades but can also be reflected by student interest in the topics and field they are studying. Different kinds of values promote motivation and achievement, but utility value has been shown to be particularly effective in promoting success. Utility value is when students perceive value in their academic tasks, leading to higher levels of motivation, interest, and engagement. "A person finds utility value in a task that they believe to be useful and relevant beyond the immediate situation," said Elizabeth Canning, a graduate student at the University of Wisconsin–Madison.

Student perception of utility value is malleable—faculty can improve, change, intervene, and help students make personal connections to their work. To do this, faculty need to know how to communicate relevant information effectively. A common intervention has been to have students write

essays about the relevance of course topics to their own life, which has been shown to improve interest and grades for high-risk students with low confidence and low performance. For example, this intervention has been used at UW Madison to reduce the achievement gap for first-generation underrepresented minority students by about 60 percent in an introductory biology class.

However, little is known about how best to implement a utility value intervention in other contexts, particularly in the two-year college context. Two-year colleges can be a crucial step for students who want to obtain a bachelor's degree, yet only 36 percent of students transfer to a four-year institution and only 17 percent complete a bachelor's degree. Students in two-year colleges are more likely to be first-generation students who have families to care for, many are older and work full time, and many lack adequate writing skills. Almost half enroll in developmental education courses during their first year.

Traditional writing assignments typically require instructional scaffolding in which teachers, and sometimes more knowledgeable peers, guide students as they develop their own ideas. But messages from teachers can sometimes be counterproductive. They might be too formal, too distant from students' concerns, or difficult to understand. Peers, in contrast, can be more relatable, engaging, and trustworthy.

A study conducted at UW Madison hypothesized that utility value examples from peers could help students generate more value for themselves in the writing exercise. The study randomly assigned students into three different conditions. In the first, students were provided with utility value examples from former students in the class and then asked to write about the relevance of the material to their own life. In the second, students were given the same instructions but were provided with the same examples from the instructor. In the third condition, students were assigned to summarize the material in an essay.

Introductory psychology and introductory biology students were recruited from classes taught by eleven instructors across six campuses of the University of Wisconsin system. The classes assigned a 500-word essay three times during the semester, typically one essay for each unit or section of the course. Of about 400 students included in the sample, over half were first-generation students, 15 percent were underrepresented minority students, and a little over half were female students. The average age was 19.5, the average ACT score about 20, and the average high school GPA about 2.75.

Students were told to select a concept or issue covered in the section and formulate a question. In the control condition, students wrote a response to the question, summarizing the material. In the utility value condition, students wrote an essay addressing their question and discussing the relevance of that topic to their own life. In the first condition, students were presented with peer examples and quotations. In the instructor condition, these examples and quotations were used only as illustrations.

Student levels of self-efficacy, interest, and confidence were measured as part of the project. Data revealed that the peer utility value condition was most effective in increasing student interest for those with low confidence. When the results were disaggregated by race, the student utility value was

most effective for minority students with low confidence. Getting that information from a peer was far more effective than receiving the same information from an instructor, Canning noted.

Context should be considered in designing scaffolding to encourage student innovation and connection. For example, the interest of high-confidence students decreased more from peer examples than from instructor examples. High-confidence students usually correlate with high performing students, so perhaps utility value may be more effective from instructors since they are seen as more knowledgeable experts in their field. Further analysis could look at the career intentions, background, and high school preparation that characterizes these high-confidence students.

UNDERSTANDING THE COMPLEXITY OF VARIABLES THROUGH THE LENS OF CONTEXTUAL MITIGATING FACTORS

Many diversity interventions aim only to raise students' test scores and graduate them with STEM degrees. In these projects, the construction of intervention variables is handled only at the surface level to investigate social phenomena. This is not enough, said Alejandro Gallard, Distinguished Chair of Education, Teaching, and Learning at Georgia Southern University. To inspire national change, interventions need to address contextual mitigating factors (CMFs).

No variable can either be accepted or dismissed unless one unpacks all of the CMFs found in each variable, Gallard insisted. CMFs are present in every action, since cultural, economic, historical, political, and social factors influence all actions. One's positionality in a situation determines potential and outcomes. Confronting the effects of these CMFs and the power associated with them can be challenging.

As an example of the influence of CMFs, Gallard cited a large-scale NSF program at Florida State University with which he was involved. In the program, every time a female was unable to complete an assignment, her reasons involved taking care of loved ones and the needs of others first. When males were unable to complete their assignments, they gave excuses—traffic, a flat tire, an alarm clock. Are women and men born this way, Gallard asked, or are some CMFs so insidious in society that they shape expressions of gender?

A unique set of CMFs in STEM fields include objectivity, reality, and institutional paradigms. Scientists are trained to believe that reality really exists and that they are objective human beings. But consideration of the issues involved in negotiating questions, methods, and funding reveals that all aspects of research can be subjective. Researchers often fall into the trap of believing that they can distance themselves from their data and look at it coldly and objectively. They lose sight of the fact that data are not produced from a void and always have a context.

Similarly, researchers must play within the rules of their organizations, even though these rules can have implications for understanding the processes they are studying. "What are the values and power positions rooted in objectivity and reality when you define a variable?" Gallard asked. For example, an intervention variable might be the dearth of underrepresented

minority students going into STEM fields. A second variable could be to get these students into STEM fields. But every constructed intervention variable is subject to disciplinary standards. How does one account for persistence in failure and success? Perhaps persistence can be associated with multiple CMFs, including poverty and biases. Recruitment in STEM fields is highly dependent on GPA. Even though a candidate might have a low GPA, controlling for persistence will obfuscate individual efforts. Trying to control for persistence and not unpacking CMFs associated with an individual's persistence makes the variable an indicator with gaps for understanding the potential for success. Forms of persistence are defined by a host of social, economic, cultural, and political issues that are particular to the individual and communities. Not all individuals have the same cultural and social assets that promote social mobility beyond economic means. As this example demonstrates, researchers have to de-homogenize variables when variables are being constructed and used, Gallard said.

Sociocultural constructivists often use words in different ways than their scientific colleagues. For example, Gallard uses the word *phenotype* much differently than would a geneticist. He associates phenotype with prejudice, bias, social injustice, and inequities, with a particular interest in explaining social bias toward certain phenotypes. The moment the definition of phenotype is contextualized, the notion is mitigated by the understanding that social biases and prejudice exist in society. CMFs do not have past, present, or future actions, existences, or thought that has not been influenced by factors that are part of all contexts. Every CMF is unique, defined by a particular context in which its influences is experienced. For this reason, the whole notion of an intervention variable needs to be reformulated, Gallard said.

Once a variable has been chosen, what are the values and powers associated with that particular variable? Also, what are the CMFs that drive those values and powers? Gallard said that he was born in Nicaragua and owes his success to five white people who helped him emancipate himself, develop urgency, take over his professional life, and make necessary decisions. Just as he was awakened to the factors that influence his positionality, researchers need to explicitly address factors that help structure any and all actions.

Intervention variables are not without context, history, or politics, Gallard concluded. They represent value, power, and position. Researchers can integrate CMFs into intervention variables by making them explicit and less dormant. In doing so, they can help build capacity, depth, and meaningful change agents into their research.[1]

ALTERNATIVES TO TINTO: APPLYING CULTURALLY RELEVANT FRAMEWORKS TO STUDY STEM SUCCESS

Tinto's theory of college student departure posits that college students' academic and social integration into the university is central to student reten-

---

[1]Gallard, A. J., W. Pitts, S. L. Ramos de Robles, B. Flores Bustus, L. Claeys, and K. Brkich. Feb, 2016. Rethinking Intervention Frameworks Through the Lens of Contextual Mitigating Factors.

tion. The model was based on an analogy of Durkheim's theoretical work on the reasons for committing suicide, which states that students are more likely to leave a university if they are not socially integrated into their context, said Blanca Rincón, assistant professor of higher education and student affairs at the University of Connecticut. According to Tinto, leaving college is due to students' lack of integration, which can be measured in part by academic performance, extracurricular activities, intellectual development, and interactions with faculty, staff, and peers.

A major critique of Tinto's theory has been its severe limitations in understanding the experiences of students of color on college campuses, said Rincón. For example, Tinto's theory fails to account for the stressors that students face in adjusting to college, including stressors arising from conflicts between a student and the norms, values, and expectations encountered on a college campus. Because the underlying concept of integration assumes that students need to adopt the values of the dominant college environment in order to be successful, and at the same time disassociated themselves from their families and home communities, Tinto's theory tends to place the burden on students as opposed to institutions. The theory fails to acknowledge the various climates—in particular, racial climates—that mediate undergraduate, academic, and social experiences on college campuses.

Instead of using Tinto's theory for diversity interventions, contemporary theoretical frameworks provide alternatives that may be more appropriate for examining the success of underrepresented students in STEM, said Renata Revelo, clinical assistant professor at the University of Illinois Chicago. For example, Yosso's community cultural wealth framework aims to expand upon the conceptualization of cultural capital by taking into account various forms of capital and celebrating the knowledge and types of capital for students of color. Sources of capital includes familial capital, which celebrates both family connections and comparable connections; navigational capital, which examines how students are able to navigate systems; resistance capital, which addresses how students take on oppositional behaviors to challenge inequalities; linguistic capital, which includes a student's linguist and communications assets, such as story-telling; and aspirational capital, encompassing how students are able to aspire even in the face of barriers.

Christopher Newman, assistant professor in the Department of Leadership Studies at the University of San Diego (USD), pointed to three theories that are integrated into approaches to institutional transformation: Sylvia Hurtado's work around campus racial climates, Estela Bensimon's work around equity, and Shaun Harper's work around anti-deficit achievement. Rather than looking at why students fail, these and other new frameworks look at the factors that lead to successful student outcomes. Of particular importance are institutional and historical legacies that are part of an institution's culture and thus difficult to change.

Structural diversity in the classroom can accommodate students' experiences, as can services offered on campus. For example, at one of the institutions within the study, mathematics tutoring is offered from nine to five. This schedule works for most students, but many students of color might work during those hours. This opportunity therefore can serve as a barrier to suc-

cess. Researchers need to examine how these barriers formally and informally play a role in students' educational outcomes and how these barriers can be tracked on an institutional scale.

Tinto's framework also fails to assess the complexities of how programs and interactions build on each other and provide levels of depth, the speakers noted. For example, Tonisha B. Lane, assistant professor of higher education and student affairs at the University of South Florida, conducted a study of a STEM enrichment program at a large, public, predominantly white research university in the Midwest. To design and analyze the study, she drew upon various frameworks from observations, documents, and interviews, including ideas on a sense of belonging and science identity to better understand the environmental influences of the STEM enrichment program. A resulting framework had four main components: holistic support, community building, catalyst for STEM development, and proactive care. The concept of proactive care, in particular, was a unique concept that entailed six sub-components: staff accessibility, trust, positive motivation, reinforcement, encouragement, and student accountability. Care is not a concept often discussed in higher education, Lane noted, although it is studied extensively in K–12 settings. But care is the foundational element in the program, underlying all practices and activities that administrators engage in with students. Proactive care is a combination of proactive advising models, formally known as intrusive advising, and principles of the ethic of care.

Program administrators suggest that advising is at the core of their practices, encompasses the academic, personal, and professional aspects of students. This advising starts even before students arrive on campus in the summer bridge component of the program. With the support of modern technology and social media, program administrators remain constantly available to students. The program's common mantra is to "trust the process."

Many first-generation and lower-income students did not understand this process, including what it meant to transition out of a pre-college context into higher education to pursue a rigorous discipline like STEM. The program administrators therefore reinforce policies in an assertive and caring manner, encouraging students to persist regardless of the academic or psychosocial hardships they encounter. Administrators also reinforce the accountability of students, who are responsible not only for their own success but also for the success of their peers. During the summer bridge program, for example, students have to walk everywhere together and are not allowed to be alone. This built-in peer mentoring and buddy system allows students to maintain bonds throughout the academic year and beyond.

Program administrators were really invested in the success of their students, and participants appreciated these genuine notions of care such that they were trusting of the program's practices and were motivated to succeed because they did not want to disappoint the program administrators or their peers. Program administrators reinforced program policies in an assertive and caring manner and encouraged students to persist regardless of the hardships they encountered. Ultimately, these practices reinforced student accountability such that students were responsible for their success as well as the success of their peers. Finally, relative to student accountability, program

administrators did not allow students to make excuses about underperformance due to a failure to seek help or communicate one's needs. Rather the program administrators worked with students to strategize and address areas that required improvement.

GIFTEDNESS AND TALENT DEVELOPMENT:
ASIAN TEACHERS' PERSPECTIVES

Giftedness and talent are often considered one and the same in contemporary Western culture. Giftedness has long been referred to as one's potential or innate ability to learn and an imperative to achievement. Through school, parents, or oneself, giftedness may be identified and developed in the hopes of high achievement and success later in life. However, these beliefs need to be questioned, said Echo Wu and Yuejin Xu, faculty members at the College of Education and Human Services at Murray State University.

According to Wu and Xu, Chinese literature does not identify talent the same as giftedness (which is regarded as an unchangeable entity), but rather regards talent as something that can be incrementally developed.[2]

As more is learned about teaching and developing talent and creativity, perhaps many people have the potential to become talented and creative adults, said Wu and Xu. Nonetheless, the Western educational system and societal norms dull the elements of talent development in everyone but the select few.

Eastern philosophies rely more on Confucian ideas of giftedness and talent. This philosophy dates back more than two thousand years and is still prevalent in most Asian countries. According to Confucian philosophy, talent development starts with nurturing, and it emphasizes self-effort and hard work rather than an inherent gift—giftedness. A common Chinese saying is, "Through great effort and hard work, you can make a huge iron stick into a tiny needle—grounding, grounding it for days and years," said Wu. Chinese philosophy points out that a child may succeed through his or her own effort with the support of schools, parents, teachers, and/or training and practice. Giftedness is the ability one is born with, but talent and creativity are something that can be developed through the years.

Wu was born in North China and married in Hong Kong, where she lived for 20 years. She went to Australia for a master's degree, back to Hong Kong for a second master's, and to the University of Virginia for her PhD on gifted education. She has been very interested in the differences in gifted education between cultures. She developed a quantitative survey and, together with her co-partner Xu, analyzed Chinese teachers' perspectives on giftedness and talent development.

The study evolved to examine Chinese teachers' ideas about the factor they believed would affect student talent development or future success. At the beginning of the study, she had two focus group interviews, one with eight teachers and one with six teachers. The next step was a survey with

---

[2]Wu, E. H. 2005. Factors that contribute to talented performance: A theoretical model from a Chinese perspective. *Gifted Child Quarterly* 49(3):231–246.

questions developed from the interviews as well as from ideas of existing models of giftedness. The first part of the survey included demographical information on teachers' educational background, teaching experience, age, and gender. The second part, the main body of the survey, focused on nine factors closely related to concepts of giftedness and talent. This section included 70 questions scored on a five-point Likert scale. The final section asked four open-ended questions on teachers' further thoughts and suggestions on giftedness and talent development. About 450 valid surveys collected from 24 schools in Beijing were run through a reliability test to assure their accuracy.

The survey results revealed that teachers considered four of the nine factors to be the most important in student success. They ranked self-effort as the most important component, receiving an importance ranking of 87 percent. Parent or family influence and deliberate training and practice also received high marks, as did school and teacher influence, ranking between 43 and 50 percent. Three factors that were considered important but to a lesser degree were peer influence, chance and opportunity, and social environment, ranking between 33 and 40 percent. Two factors—giftedness and the influence of media—were not ranked as highly as the other factors, with giftedness receiving only 18 percent of importance ranking. The open-ended questions indicated that the teachers are not very concerned with the innate ability or giftedness of their students. Rather, they pay more attention to students' hard work and efforts to learn.

Comparison groups of teacher participants were identified in the results to gauge the effects of years of teaching experience or differences between subjects. The results showed no differences between age and gender among the Chinese teachers. However, it is interesting that the different years of teaching experience made a difference in teachers' perceptions of giftedness and talent development. The middle group of teachers, those between 30 and 50 years old, believed more in self-effort as the key to success. The younger and older teachers believed a student's innate ability is quite important, with a higher ranking than those of the middle group of teachers.

These results imply that many Chinese teachers' perspectives have been influenced by Confucian philosophy of hard work and self-effort, Wu and Xu said. This literature seems to have informed teachers' mindsets, as many believe that even children with average innate abilities or giftedness have the potential to achieve talented performance with encouraging influence and support from parents, teachers, and others close to them. This study provides further support and ideas for modification to a tentative Chinese model of talented performance that Wu had developed before, and could also offer insights for future research and practice on nurturing talent among most if not all students.

4

Data in Interventions Research

The programs and projects featured at the Understanding Interventions conferences typically feature a rich interplay between theory and data. Whereas the previous chapter summarized presentations with a theoretical orientation, this chapter emphasizes data and the tools used to gather data. But a theoretical framework nevertheless supports both the forms and procedures used to gather the data from which conclusions are drawn.

DETERMINING WHETHER INTERVENTIONS WORK

Many NIH-funded programs promote research careers among members of underrepresented groups, including the Maximizing Access to Research Careers (MARC) and the Research Initiative for Scientific Enhancement (RISE) programs. The overriding question about these programs, said Wesley Schultz, professor of psychology at California State University, San Marcos, in the fourth keynote address of the conference, is whether they work. Since 1997, the number of minority PhDs has increased by 80 percent, but the minority population has grown by 62 percent during that period, which could account for much or all of the increase. For site-specific data, each NIH program submits yearly progress reports and longer term evaluation results. But these measures of student success typically lack control groups, making it difficult to identify the underlying mechanisms that have an effect. Programs could simply be selecting students who are on promising trajectories and would have succeeded without support.

For ten years, Schultz and his colleagues—including Mica Estrada, Anna Woodcock, Paul Hernandez, Victor Rocha, Richard Serpe, David Morolla, Brian McDonald, and Steve Mullet—have been doing a longitudinal study of students funded through diversity training programs at NIH, including

RISE and MARC. The Science Study was designed to overcome several limitations in other studies. Large-scale evaluations of minority training programs generally have had difficulty finding former students. In an assessment of NIH minority research and training programs, data were obtained from only 739 of more than 5,000 participants in the programs—and only 83 of those trainees were funded as undergraduates, including just 19 MARC students. In addition, long-term evaluations are often outside the funding scope of a program, retrospective accounts can be biased, and the mechanisms of success are often unclear.

A prospective, propensity-matched, longitudinal, controlled study, the Science Study was launched in 2005 and drew participants from 50 campuses nationwide. It received twice yearly surveys from a starting panel of 1,420 students, almost all from historically underrepresented groups. For each campus with a RISE program, a matched campus was identified with similar demographics and a similar focus. Then, said Schultz, for each RISE student, "we found their twin. We found somebody who looked like them, had the same motivation as they did, had the same academic background that they did, and recruited them. The only difference between these two twins is that one was supported by the RISE program and one was not." For 457 RISE and MARC students, each had a matched control, and 157 students funded through other programs likewise were matched with control students.

The longitudinal panel was 72 percent female, 49 percent African American, 39 percent Hispanic, 10 percent other, and 1 percent Native American. Initially, their majors were in the biological sciences (63 percent), the natural sciences (21 percent), the behavioral and social sciences (12 percent), and mathematics and engineering (4 percent). The researchers realized that one of their greatest challenges was going to be retention. "We wanted to follow these students for a long period of time, and we wanted them to buy in to being part of this panel. So we took a lot of care in how we branded [the project], and we created a methodology that drew on survey research literature but extended it." Instead of just paying people to complete the survey, the researchers tried to build students' commitment to the project. "We wanted to build a communal-based relationship with the participants. We didn't care if they missed one particular survey—fine, we understand things like this happen—but stay with us, you're still part of the Science Study." As Schultz recounted a typical follow-up conversation: "Hey Cliff, this is Wes from the Science Study. 'Yeah, yeah, I know, I haven't done the survey.'" Through this methodology, which they called tailored panel management, they achieved response rates at each wave ranging from 86 percent to 70 percent, even after a decade of participation, and the researchers remain in contact with 97 percent of the panel.

The process model developed by the researchers for RISE outcomes involves programs, constructs, and outcomes. Factors such as mentoring, peer support, and financial support have psychological consequences for students in such areas as motivation, identity, and self-efficacy. These psychological consequences function as mediators for such outcomes as intention to pursue a graduate education, academic behaviors, and accomplishments. With this model, the researchers can begin to answer important questions that include:

- Does participating in a RISE or MARC program cause an increase in the likelihood that a minority student will pursue a career in the bio-medical sciences?
- What types of activities are students involved in RISE or MARC pro-grams exposed to?
- Do some types of students benefit more from RISE and MARC pro-grams than others?
- Are elements of RISE or MARC programs linked with student success?

An initial task is to determine the elements of a program. Based on survey responses from the directors of the 25 RISE programs that participated and from 457 RISE students, the researchers compiled these elements for each program and also collectively (Figure 4-1). At the same time, each program has unique elements that it highlights, which the researchers measured by asking the directors and students which program elements they considered most important. Program directors tended to rank such elements as research experience and guest speakers highest, whereas students ranked paid tuition and direct financial support highest (Table 4-1). "The students are telling us, 'The reason why we are not staying in science is because we can't afford it, we have to work off campus, I can't enroll in 18 units per semester. If you give me money and I stay here on campus, I'll stay in science.' And the directors are saying, 'No, the money is on the side. It's really about that research experience and building those skills and those relationships.'"

Surveys of students show that involvement in a RISE program maintains their intention to pursue a career as a biomedical scientist more than for matched students (Figure 4-2). Though some students inevitably question whether they want to maintain the effort needed to become a biomedical scientist, "the decrease is buffered by the RISE program," said Schultz. Similarly, graduation rates for students who enter a RISE or MARC program as juniors or seniors are significantly higher than for students who were not in a minority training program (52 and 68 percent, compared with 45 percent).
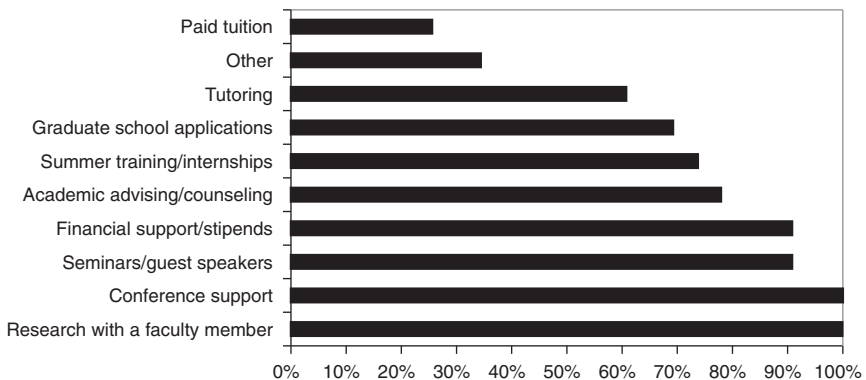

FIGURE 4-1 RISE directors and students identified the important elements of RISE programs.

TABLE 4-1 Rankings of RISE Program Elements from 25 RISE Directors and 454 RISE Students

Activity	Ranking	
	Students	RISE Directors
Paid tuition	1	6
Direct financial support/stipends	2	6
Research experience with a faculty member	3	1
Summer training/internship programs	4	3
Support to attend/present at professional conferences	5	4
Tutoring	6	8
Academic advising/counseling	7	8
Seminars/guest speakers	8	2
Graduate school applications (e.g., GRE courses, help with personal statements	9	5

Students in a RISE or MARC program applied to graduate school at rates of 64 percent and 80 percent, compared with 29 percent for students not in a minority training program.

After five years of surveys, 86 percent of RISE students had earned their bachelor's degree compared with 77 percent of the matched students. Fifty-
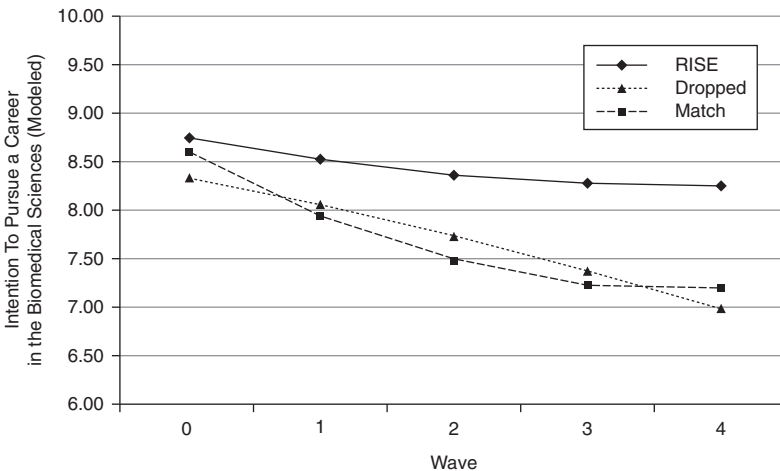

FIGURE 4-2 When asked at six-month intervals (waves 0 through 4) during their junior and senior years about their intention to pursue a career as a biomedical scientist, students continuously funded in a RISE program were more likely to retain their interest than matched students who were never funded by a program or students who were at one time enrolled in a RISE program but did not complete it.

eight percent of RISE students had been accepted into a science graduate program, compared with 32 percent for matched students. Ten years out, 37 percent of RISE students and 46 percent of MARC students were enrolled in PhD programs, compared with 26 percent of matched students. Similarly, for those no longer enrolled, 18 percent of RISE students and 26 percent of MARC students had earned PhDs, compared with 5 percent of matched students. "Relative to that matched control [of students with high intentions to pursue biomedical research careers], we see sizable gains for students who are in these programs."

Schultz and his colleagues also have analyzed the program elements that mediate these effects, looking specifically at research experience with the faculty member, faculty mentorship, and financial support, which was operationalized as hours spent in employment off campus (though Schultz added that this latter factor could be operationalized in several different ways). They found that research experience is a very strong predictor of intentions to pursue a biomedical research career. It does not explain all the effect, but "the program directors were right" in describing it as a major influence, Schultz said. In fact, RISE students who did not participate in research lost interest in research careers at a faster pace than matched students who did participate in research.

Mentorship also mediates some of the retention of interest in biomedical research careers, but not as much as research experience, said Schultz. In contrast, financial support, as reflected in the number of hours worked off campus, did not have a significant effect on intentions to pursue a career in the biomedical sciences, though Schultz acknowledged that incentives can be important in motivating interest in a particular option.

In analyzing more deeply why these programs work, Schultz discussed the three psychological processes of self-efficacy, scientific identity, and seeing value in the processes and outcomes of science. Applying these three processes to the effects of research experiences, he and his colleagues found that self-efficacy was a statistically significant mediator. Values also turn out to be a statistically significant but not particularly strong mediator for the effects of research experiences. The largest mediator for effective research experiences is science identity. "Over time, students who come to think of themselves as scientists are more likely to stay and are more likely to persist in their efforts within science."

The group plans to continue to study the mediators of intentions to remain in science. Schultz speculated that students undergo a growth process over time. They begin by learning the skills of a scientist, then start to see themselves as scientists, and then begin to develop the values and see the importance of doing the science. The students he was studying seemed to have already built some level of self-efficacy and were starting to see themselves as scientists and value the processes of science. In that regard, one interesting line of future research would be how students balance their identities. "Students don't just have one identity," Schultz said. "What happens to their other identities as they develop a sense of themselves as a scientist? [For example,] there's a stereotype between science and being female. What happens to that stereotype? Our hypothesis is they have to reconcile that stereotype to estab-

lish a balanced sense of identity, and it's that balance that's going to help them persist over time. In the absence of a balanced identity, you end up living in separate worlds, where in one world you're at the university, you're a scientist, but in another world you are a woman." They are also interested in how students develop identities, in part because it may suggest how to enhance training programs to create more researchers from underrepresented groups.

QUALITATIVE INTERVIEWING

Many studies of STEM careers and participation use quantitative methods, leaving some researchers unfamiliar with qualitative investigation. However, it can be a useful tool for a range of users, from those who have small questions to answer with small numbers of participants to those conducting more elaborate studies. Dr. Christine Wood, a research associate with the Scientific Careers Research and Development Group at the Feinberg School of Medicine at Northwestern University, has been involved in a long-term longitudinal project that looks at career decision making of biomedical PhD students. The core research component for the project is qualitative interviews conducted on a year-to-year basis with more than two hundred biomedical PhD students recruited at the beginning of their PhDs, or during their senior year of college, and progressing through the time when they make career decisions or complete PhDs. The study aims to assess the factors that influence a student's career decisions, with a particular emphasis on issues like gender, race, and social class. The study also examines a student's relationships, research experiences, and interactions with mentors and how those social components may play into the decision-making process.

Interviewing is a key component of capturing these experiences and interpretations. The interviews are designed and conducted in such a way as to reveal, richly describe, and analyze the subject's experiences. Wood is part of a team that includes Remi Jones, a linguistic anthropologist with a particular emphasis on word level meaning, and Anne Caliendo, an anthropologist who works on the coding of the interview data.

While quantitative data draws analysis from a numerical dataset, qualitative research draws on participants' observations. Interviews are often composed of open-ended questions that probe how a participant makes meaning of their experiences. A participant's interpretation can be just as important as the experience itself. The narrative data is the core component of qualitative research, whether that narrative is developed by interacting with participants or in an interview format.

Qualitative research has two distinct approaches. The first is based in "grounded theory," an inductive method where data are collected that are relevant to a general topic or interest area. Individual cases, experiences, and incidents are captured through interviews and narratives. After compiling data, a software program like *Nvivo* is used to systematically identify patterns and analyze experiences, with the goal of building theories that address the central research questions and provide templates for future analyses. In this approach, hypotheses tend to "bubble up" from the data rather than preceding the analysis. The opposite model uses a deduction method, where

a distinct hypothesis is tested and the data collection centers on confirming or rejecting the hypothesis. The deduction method is also used with the goal of building theory or introducing a new theory based on results but proceeds more systematically from existing theories.

In both grounded theory and deductive reasoning, research questions guide the design of interview questions. The researchers at Feinberg use induction to let hypotheses surface from the data, mainly because a long-term longitudinal study of biomedical PhD students is unprecedented. They try to ask broad, conceptually-driven questions that do not suggest hypothesis testing, such as "How do social identities influence students' experiences in biomedical graduate program?" During interviews, researchers utilize various tactics to gauge participants' views of gender identities, race and ethnicity, and other factors that influence their experiences. However, interviews also can be used to test the efficacy of a program by using an established theory and seeing the extent to which one's data support or refute that theory.

A project's concepts and the specificity or broadness of the research question are critical factors in designing a qualitative study. After these elements have been determined, a study needs to be operationalized by measuring and describing concepts in categories. One of the key concepts in the study at the Feinberg School of Medicine was social identities, which can raise sensitive questions. To deal with loaded concepts, questions need to be designed in more accessible terms, perhaps asking a participant about experiences with gender and race rather than asking directly about social identity.

Guidelines can help the interview process. A semi-structured, carefully designed interview guide allows for exploration while also offering consistency in what is being captured. "Yes or no" questions are not ideal, and qualitative researchers favor questions that capture the substance of a subject's experiences, more of the how and why of their narrative. Interviewers should be cautious of leading questions that pigeonhole someone into a response. Questions that confirm interviewers' assumptions should also be avoided.

Interviewers can use a technique called Active Listening to convey acceptance and empathy toward subjects. "It's a way of listening or responding that builds rapport and mutual understanding between the interviewer and interviewee," said Letitia Onyango, a project coordinator with the study. Techniques vary based on whether the interview is in person or by phone. In person, non-verbal behaviors can include leaning in, eye contact, and nods. Leading questions can corner a respondent into a certain response, but they also can act as a signal that the interviewer has been listening. A better way to lead a conversation is to construct a hypothetical scenario. A participant can be asked a "what if" scenario that allows for active imagination and reveals their personal inclinations. A possible questions regarding social identity might be, "How do you think that their experiences of people of the other gender are different from yours? Do you think others of a different race have the same experiences, or do you think race impacts their experiences?" These questions both address interviewees' experiences and their understanding of those experiences.

Coding is a way of assigning patterns and meaning to interview data. Coding is project specific, depending on databanks, research questions, funds,

and the support team. Publishing and liability have different models of acceptability. The videotapes made as part of the study were coded through *Nvivo* using a rigorous system in which big bucket codes were determined that separated themes into general coding categories, including gender, race, ethnicity, mentor relationships, and mentor interactions. Next the team developed more analytically driven codes called child nodes, which allowed specific ideas and theories to surface from the data. Since grounded theory analysis features constant comparison or iteration, data were compared with findings from the previous literature to help develop the smaller codes.

A team of about ten people did the coding for the project. Big bucket coding works better with more people because less interpretation is required. The team developed ground rules among coders to maintain consistency. When a statement was coded, the question and the entire paragraph or statement answer were included, minimizing discrepancies in data. A tool in *Nvivo* systematically measures reliability, reporting on the likelihood that a statement would have been coded similarly by chance. Frequent group meetings helped ensure that everyone understood the codes correctly.

The resources for the project can affect the modes of qualitative assessment. Sometimes, resources are better invested in focus groups than interviews. Since the project at the Feinberg School of Medicine was focused on career decision making, it was imperative to talk with each student. Sometimes, people feel they can speak more candidly about their experiences in an individual setting. The two tactics can also be combined to a certain extent. For instant, after a group discussion, a survey might ask a participant if they had the chance to contribute in the way that they wanted with an opportunity to add details that they were unable to add in a group setting.

Designing a qualitative study can be difficult, especially in developing interview questions, interview techniques, and strategies that help participants effectively share their experiences. Interview guides and a concrete coding system can help ensure that a study's data reflect its research and evaluation questions. Qualitative interviews can reveal depths of experience that are often inaccessible in quantitative studies, and strong interviewing skills can make the format effective for a wide range of programs.

EVALUATION AS A TOOL TO STRENGTHEN PROGRAMS

"This workshop is intended as a primer for people to learn about evaluations—why they're necessary, how they're conducted, and things to consider especially if you're designing a program or running a program," said Anthony L. DePass, associate professor of biology at the Brooklyn campus of Long Island University. Often, successful interventions are measured by the number of students who enter doctoral programs or attain their PhDs. However, evaluations can measure many different aspects of a program, such as broader institutional impacts or the effects of an intervention on a student's cognitive and non-cognitive development. Evaluation outcomes also can reflect on program design and/or institution structure and climate, though sometimes in unexpected or unintended ways.

As STEM educators move toward more integrative and active modes of teaching and learning, evaluators must determine whether these approaches in general, and components of the approaches in particular, lead to the intended student outcomes. In this way, evaluation and assessment methods can be designed in ways that connect quantitative and qualitative data to help refine learning environments. These formative assessments can reveal, for example, whether the activities performed to reach an objective are effective, accurate, and suited to the program goals. Sometimes, a program's goals are not accomplished for good reason, and formative assessments can inform decisions that move activities in another direction. "Inherent in the design of a program is the implication that the activities that you will conduct actually contribute to the options you seek," said DePass. This is not always a correct assumption, and evaluations can help make this determination.

Successful evaluations typically include a number of components. First, evaluations should start early and be a collaborative experience. Second, when developing a program, it is important to align the goals, objectives, and outcomes of those objectives with the proposed activities. Third, evaluators must determine how to measure success. "In conducting the program and looking at how it fits with the evaluation, it is very important that the implementation of the evaluation or the evaluation plan is such that the measures are aligned with the outcomes, activities, and goals and can be collected in a way that one can say is purely objective."

Objectivity is difficult in some situations. While the evaluator does not necessarily need to be external to the program, he or she does need to be removed from the implementation process. Say, for example, that a biology teacher is charged by his institution to try and raise student performance. He goes to a conference and decides to try something new, which he explains to the students during the course introduction. The students recognize that the teacher is doing his best, but the program is not successful. However, when asked about the effectiveness of the program, students respond that it worked, wanting to give the instructor positive feedback for his earnest effort. Students can be influenced by many types of worries—for example, that a teacher might recognize their handwriting on an evaluation, that an evaluation might affect their grade, or that it might lead to an imbalance in their relationship. For these reasons, it is important that an evaluator be removed from the situation. Sometimes, someone else in the department can serve as an evaluator, but a loss of objectivity can still result if an evaluator is seen as a cultural part of the organization.

A successful evaluation needs to consider all aspects of a program. Literature specific to the program should be consulted to see what contributes to success. The student pool can determine the success of a program, if a student's success depends on previous training. If the appropriate students are not participating, the evaluation results will not be accurate. An instructor might discover that an in-class announcement for a program gets more students who are likely to succeed in the program, even though the website receives more applicants. An evaluation may reveal the factors that contribute to success, allowing a system to be constructed for proper recruitment, placement, and follow-up.

One strategy for creating successful programs is working backwards. First, formulators can look at temporary, short-term, mid-term, or long-term outcomes that they hope to accomplish. They then can ask what it would take to reach those goals. In some cases, external factors might affect a program's ability to achieve its objectives. But a program may still have flaws, even if external factors are used as a scapegoat. If a website for the program is designed for $50,000 but no one is using it, that money can be invested elsewhere.

Sometimes passion can replace discipline, and sometimes the original goals for a program become unrealistic. When either of these situations arise, an evaluator must be realistic and adaptable, said DePass. Effort is not the same as results.

Improper evaluation design can lead to misleading results. The way in which a question is phrased or who asks a question can have undue influence on a responder's opinions.

Measuring data is not always clear cut. For example, while it is important to have a numerical evaluation component, qualitative measures can be incorporated if the review system is sensitive enough in its evaluation objectives. While quantitative data tend to be more reductive, either supporting or refuting a given hypothesis, qualitative data can be more inductive. In scenarios where a team is unsure of what to ask, qualitative assessment also can provide multiple avenues for exploration. Participants can have the opportunity to better communicate their feelings, enabling a deeper sense of understanding for the topic.

Qualitative assessments can be more challenging than quantitative assessments due to their open-ended nature. Certain qualifications are needed to work with certain groups of people, such as minors, and sometimes situations arise when an evaluator's training is not enough. "Always think in terms of the nature of evaluation efforts and how intrusive they can be," DePass said. If a certain aspect is of particular interest, measure that aspect as precisely as possible.

Data must be evaluated in their entirety or they can lead to false results. For instance, a study on salt consumption revealed that salt will kill a person in excess, but the same study showed that a salt deficit could have the same consequence. "The perfect evaluation is one that is normalized and validated with the specific program that you are doing," DePass said.

While evaluations can serve as measures for a program's success, they also have their own objective. Dissemination of results informs future practices and programs. Information is power, DePass reminded the group, and assessment can reveal faults in long-held assumptions as well as reveal future avenues for innovation. Without a well-designed evaluation, the knowledge gained from a program cannot be interpreted or shared.

ENGAGING AND RETAINING STEM STUDENTS USING A STRENGTH-BASED HYBRID BRIDGE PROGRAM MODEL

Emory University received an NSF STEP grant in 2012 focused on increasing STEM retention and graduation rates. To implement a successful intervention, the grantees first identified the key academic and social skills

needed to help garner student success. One of the biggest retention challenges in STEM is the transition from high school to an undergraduate institution. After assessing the context of the grant, a team developed Getting a Leg Up at Emory (GLUE), a summer bridge program that provides a controlled transition for students going from a high school to a college experience.

In 2011, Drew Kohlhorst, associate director for the Center for Science Education, started working with the Office of Institutional Research on a predictive model to determine which students could best benefit from the intervention. The model showed that underrepresented minority students, first-generation students, and students with lower high school GPAs and SAT scores most needed an intervention. Based on a needs-based analysis, five areas were determined to be of critical importance to student success, including campus resources, mentorship, self-reflection, and mathematics skills. GLUE is not a remedial program, Kohlhorst emphasized. Students feel honored to be invited to GLUE, whose primary objective is success in college readiness. As one student said, universities "have lots of different opportunities, and I need to go out and find those opportunities. That is my job now that I'm in college."

GLUE offers both an online and a residential component. The online program begins in the middle of June and, depending on a student's performance and the selection process, he or she he might be invited to attend the residential component. Over time, the residential component has been shortened from three weeks to ten days, making the program more intensive but also cheaper.

GLUE uses a problem-based learning approach to encourage students to collaborate, reflect, and develop new skills. In the program, students are given a series of problems around a specific topic, and then team activities are built around these problems. "One of the strengths of problem-based learning is that everybody brings something to the table," said Kohlhorst. Students begin to understand their strengths and the strengths of their classmates. GLUE emphasizes that students find their passions and develop a five-year plan, since life can change and students need to be ready to accommodate those changes. Through this process, students learn about time management and professionalism.

A prominent part of the program is an interactive tutoring system known as ALEKS. After students take a general assessment, ALEKS designs a six-week tutoring course that builds on their skills to get students to the next level. Virtual mathematics tutoring sessions include problem-based learning activities. Additionally, students who participate in GLUE are asked to be a GLUE mentor the follow year and then a senior mentor.

GLUE has continued to grow over the last four years, and costs continue to decrease as online platforms are used more effectively. Bridge program participants had an overall decrease in DFW rates in introductory biology and chemistry (3 percent and 3 percent, respectively) and a decrease in students electing to take STEM courses for which they are unprepared during their first-freshmen semester. Additionally, among students eligible to declare a STEM major, GLUE participants had a 10 percent increase in STEM retention compared with students who were eligible for GLUE but chose not to

participate. Students in the program reported high levels of satisfaction with the program, the institution, and the formation of needs-based analysis. "The biggest lesson is to make it important to the students," Kohlhorst said. "Make it valuable to them, make it valuable to your staff, make it valuable to your faculty, and they will get engaged with the program." Over the next two to three years, GLUE intends to expand to all incoming pre-freshmen, with further development in the social sciences and humanities.

CAN GRE OR GPA PREDICT BIOMEDICAL GRADUATE STUDENT SUCCESS?

New York was 50 percent African American in 2007, but only 10 percent of the New York fire department's working employees were African American. Seven years later, this severe underrepresentation had been eliminated, with 43 percent of the 2014 class of New York firefighters African American. A large part of this radical racial shift was due to a reexamination of the entry test used in the fire department. Analysis showed the test had a discriminatory effect but little relationship to the actual job.

A similar relationship may exist between GRE scores and graduate student success. Universities in the United States rely heavily on quantitative measures such as the GRE to select students for admissions into their graduate programs. However, increasing evidence indicates that this practice may, at best, select for qualities that do not necessarily contribute to graduate student success and, at worst, disproportionately restrict women and minority applicants from entering graduate school.

A team at the University of North Carolina at Chapel Hill sought to investigate what makes a graduate student successful. Joshua Hall, director of science outreach and the Postbaccalaureate Research Education Program (PREP) at UNC Chapel Hill, became interested in this topic while working with students in the one-year PREP program. During the program, students apply to graduate school, work in labs, and take graduate-level course work. Many students excelled in the program, and Hall knew that these students would succeed in graduate school. But again and again during graduate school applications, these students would have few acceptances because of poor GRE scores. This made Hall wonder if the GRE being used to select graduate students actually predicted student performance.

A recent UCSF study examined this issue and determined that general GRE scores and GPA were not predictive of graduate student success as defined by faculty assessments. However, this was a low-resolution analysis that only factored in high and low student performance and had a relatively small sample size. Hall and his team at UNC wanted to build on this study by objectively examining the factors that may predict graduate student success.

Their first question was whether GRE scores are a predictor of graduate student productivity. GRE scores vary by ethnic groups, with Asian and Caucasian students receiving the highest scores and women and minority test takers, on average, scoring lower. The team decided that the best objective measure of biomedical graduate student productivity was student publication number during their time in the program. Between 2008 and 2010, 280 gradu-

ate students in 15 biomedical PhD programs entered the graduate school at UNC Chapel Hill. The students were divided into four groups based on their number of first-author publications: those with three plus, those with one to two authorships, those with zero first author but at least one middle authorship, and those with zero publications. They discovered no statistical GRE score or GPA differences among groups of students with most to least publications.

In addition, they looked at student GRE scores versus PhD completion. They divided the group into those who had finished their PhD, those who left early with a master's degree, and those who had not made it through the program. Again, they saw no statistical differences among the groups based on quantitative or verbal GRE scores or GPA. There also were no differences among groups of students who received fellowships.

The study at UNC revealed the flaws in relying too heavily on GRE and GPA scores as predictors of graduate student success, Hall observed. Sometimes low GRE scores can cause an admissions officer to overlook strong recommendations and compelling personal statements. The converse also can be true, where lukewarm letters are overlooked because of amazing test scores. "The more heavily you emphasize the GRE in your admission decisions, the more you are disadvantaging certain groups. In fact, that's not even helping you get better grad students," Hall concluded. Reading applications and assessing applicants in a more rigorous way is crucial to achieving diverse graduate school populations.

Starting last year, the UNC admissions office gathered all faculty involved in admissions decisions for biomedical PhD programs and presented the data gathered from this study. In addition, faculty were trained in ways to minimize bias. After the training in 2015, many more interviews were granted to underrepresented students. Currently, 26 percent of the incoming class are underrepresented minority students, the highest it has ever been at UNC.

RETROSPECTIVE TEST OF NON-TRADITIONAL PREDICTORS OF PERSISTENCE IN RESEARCH

Students identify several factors in defection from STEM majors, including uninspired teaching and an inability to see the prospects for lucrative and successful careers. Student retention is especially difficult when it comes to diversity enhancement, with African American students completing graduate school programs at even lower rates than other demographic groups.

While quantitative measures such as the GRE and GPA are often used to predict success in research programs, non-traditional measures may be a bigger factor in student persistence. A 2007 qualitative review at Northwestern University asked what compelled students to persist on a research pathway. Over 300 students in education and training programs at Northwestern were interviewed, and the interviews were analyzed for students' interest in science, motivations, interests, and aspirations for the future. The study found that non-traditional measures such as curiosity to discover the unknown, enjoyment of problem-solving, independence, helping others indirectly through research, and minimally structured views of the future may be better predic-

tors of persistence in research training among college undergraduates than traditional measures.

Kyle Frantz, professor of biology and neuroscience at Georgia State University (GSU), took the concepts from this 2007 study and asked whether these non-traditional qualities predicted a student's current status or career path. She and her colleagues drew their data from applicants for an intensive, two-year undergraduate neuroscience education and training program in the metropolitan Atlanta area. This program started as an intensive summer research immersion with national recruitment. Students from the program had the opportunity to go into a two-year research assistantship program in neuroscience education and training, funded by the NIH, with aims of enhancing neuroscience diversity through undergraduate research experiences. Only underrepresent minority students could be part of the network, and these students applied for the program in the spring, worked in the brain program the summer before their junior year, and completed mentor research throughout academic junior year at Georgia State or Emory University. In the second summer of the program, students had the opportunity to join one of the partner institutions with a T32 graduate training for an intensive research assistantship experience. By the end of the program, students return to their home institution for a senior year research project, at which time they graduated from the program and usually from college.

While implicit indicators of curiosity were considered in the admissions process, none of these non-traditional predictors were explicitly queried at any time during the program. However, participants submitted application essays and annual progress reports, which provided the opportunity to communicate these qualities spontaneously. The study took a retrospective approach to this material. Frantz and her team tracked over 200 alumni from the brain program and found that a good proportion were going into PhD programs and had been retained on a science trajectory. Then they closely analyzed 17 students' applications and progress reports, looking for exemplars of persistence in research.

Participants were assigned to one of two categories: research path (graduate school in basic STEM fields, MD/PhD, or research technician), or clinical path (medical school or counseling). Phrases from the participants' application essays and progress reports were analyzed and scored as strong or weak exemplars of the five categories predictive of persistence in research: curiosity, enjoyment of problem-solving, independence, helping others indirectly through research, and minimally structured views of the future. Other phrases were scored as strong or weak exemplars of predictors of migration into no-research paths: helping others directly, and highly structured views of the future.

Applications provided an average of 4.9 relevant exemplars, and progress reports provided an average of 2.1 relevant exemplars. Exemplars did not significantly predict a students' current status in either a research or clinical career. Participant career status was divided in a variety of ways, but still there was no difference in the number of predictors. The results may have been skewed by the small sample size. One student had all the markings of being retained in a science career who was not currently in a research career.

When looking only at individuals who had complete data sets with all applications and progress reports, the team did not find any difference on applications. However, they discovered a significant difference on the first progress report, leading to the conclusion that a year of research experience significantly influences a students' persistence along the research pathway. One student wrote in the report, "I hope to establish my own research question and develop my foundation in academia by continuing to ask more and more questions. This is my research foundation. Research is an immense part of finding the answers to my questions and the more I know, the more I will be able to help the world."

The preliminary study at Georgia State University partially supports the hypothesis that non-traditional predictors indicate future career decisions. More exemplars of research interest or predictors of research retention were discovered in student applications than student progress reports, perhaps because students had not yet differentiated or because they had a response bias in applying for a research program. In the future, the team hopes to conduct a blinded review with over 200 applications from the brain program to see whether additional predictors might surface. Future direction will also include more mixed methods and mentors' assessments of student research skill. An alumni survey is also being developed that asks students to identify their level of dispositions and the degree to which these dispositions influence their career decisions.

Ultimately, these studies have the possibility to benefit admissions procedures and create a more diverse research work force, Frantz concluded. As she said, "If we are trying to diversify the research workforce, then we need to retain good people in that workforce."

5

Mentoring

Mentoring is so important to the development of STEM students that it may be inappropriate to consider it an intervention: every such student needs mentoring in the process of becoming a biomedical researcher. However, more effective mentoring, or mentoring that emphasizes specific aspects of a student's development, can be seen as an educational intervention, and a particularly effective one. As demonstrated in the previous two chapters, theory and practice are intertwined in the approaches to mentoring discussed at the conference, both in the service of particular goals.

PEER MENTORING AT THE UNIVERSITY OF MISSOURI

"My grandmother had a sixth grade education," said Brian Booton, IMSD undergraduate coordinator at University of Missouri (UMO). "She was a housekeeper by trade, but also one of the wisest, smartest women I knew. She took that housekeeping salary and invested it. She owned multiple properties and became a landlord and taught me a lot about mentoring." Mentoring is not an easy task, Booton acknowledged, but with the right training and support, mentors have the ability to influence and ultimately reshape the workforce at large.

A peer mentoring program run through the University of Missouri's IMSD program has resulted in the growth and success of program participants and has yielded significant learning outcomes for peer mentors. Peer mentoring is a symbiotic relationship; both participants can gain new understandings and knowledge. In the past eight years, the program at the University of Missouri has grown from 20 underrepresented minority undergraduate students to more than 100, with a cadre of ten trained peer mentors working with 90 freshmen, sophomores, and transfer students.

A common misperception about peer mentors is that they should have all the answers and know everything, said Booton. In reality, mentors should be viewed as shining a light. They should inspire questions and discussions that help students find the answers on their own. In mentoring, one size does not fit all. Context is key in structuring an effective mentoring program.

The University of Missouri is a major land grant institution with 35,000 students. Last fall the institution enrolled its highest number of underrepresented minority students—roughly 17 percent of the student body, or 5,500 students, compared with just 11 percent in 2005. Halfway between St. Louis and Kansas City, the university enrolls many students from Ferguson, Missouri, and student anger at an unresponsive administration in the fall of 2015 spurred protests that made national news.

The University of Missouri's changing environment highlights the need for a strong peer mentoring program for underrepresented students, said Booton. These are the students who struggle most in the university context but have the capacity to foster institutional and societal change. The IMSD programs at the university has both a graduate and undergraduate component and features research career exposure, mentoring, peer and faculty academic enhancement, and social support. The program is not an honors program but a gateway program to ignite interest in research.

Students' ACT, SAT, class ranks, and grades are not examined before students enter the program. Instead, if a student is admitted to the University of Missouri and has an interest in science, he or she fills out an application and writes a series of short essays. Then each student has a conversation with Booton and a group of peer mentors for about 30 minutes. The interviews are not a selection process but serve as professional development for the students, who wear business attire and have an opportunity to practice their STEM communications skills. This is one of many ways in which peer mentors have the ability to guide, shape, and inspire their mentees.

A MULTILEVEL MENTORING PROGRAM AT THE UNIVERSITY OF DELAWARE

For the past three years, the University of Delaware has instituted a tiered mentoring program to provide enhanced support and interaction for the diverse student population in two introductory-level science courses: an integrated biology and chemistry course and a physical science and astronomy course. Faculty, preceptors, and graduate teaching assistants provide active and significant learning experiences that integrate knowledge typically restricted to individual fields or courses. The program is designed to promote social interaction and enhanced application of course content across disciplines, but this can only be accomplished when educators take a less traditional, more hands-on approach, said Christina Wesley, a preceptor at the university. Ultimately, the program intends to improve knowledge retention and student retention in these courses.

A unique aspect of the program at the University of Delaware has been its use of preceptors, who traditionally have been professionals in medical schools who facilitate programs. "Essentially our role is to help coordinate all

the different mentors that we work with," said Wesley. Preceptors also work on curriculum development and help create laboratories that students can conduct in home-based learning activities. Since the preceptors do not grade student work and students can come to them without misgivings, preceptors can build a foundation of trust with the student population. For example, they can be proactive with students who are not performing well.

The two courses in the program have very different populations and objectives. The integrated biology and chemistry course combines two foundation courses, each with a lecture and a laboratory, into a cohesive 16-credit program, taken mostly by life science majors during their freshmen year. The course includes general chemistry, which is normally a two-semester course, and introductory biology, also a two-semester course. In the fall of 2015, about 600 students were enrolled in both honors and non-honors classes, with seven biology faculty members, two chemistry faculty members, six preceptors, ten biology graduate teaching assistants, and eight graduate chemistry teaching assistants. Counting other instructors, the 600 students had an 84-person teaching team.

The large chemistry lectures include 150 to 200 students, whereas the biology courses are divided into small classes of 48 students. Within these small classes, workshops have a maximum of 12 students, and these are broken down into groups of three, each led by a peer leader. Workshops meet for seven hours a week and provide in-depth learning of the course material. Peer leaders are paid $10 an hour, with the leaders being trained annually toward the end of the summer session. They are typically sophomore and junior students who have successfully completed the course and have shown the teamwork, leadership, and skill set necessary to provide peer mentoring. The workshops are one to two hours long and neither faculty members nor preceptors are present. Instead, students work in a coordinated effort and receive credit for their work.

The second course that uses the multilevel mentoring program is physical science and astronomy, a course for non-science majors. Several years ago, the University of Delaware examined retention and graduation numbers and found that the science requirement was not working well for their students. The university decided to revise the curriculum for the nearly 1,000 freshmen who take these courses.

Students have many opportunities for support outside the classroom. The academic admission center and tutoring center are housed in the same building on campus and offer workshops, individual tutoring, and peer tutoring services. However, the activities often start the second, third, or fourth week of the semester, and the new program is working toward helping students from day one. The team is trying to help tutors be not individuals who answer questions or complete the work sheet of students but people who can lead students and guide them through the problem-solving process.

Training this kind of tutor is not an easy task. The University of Delaware examines four components in promoting success for mentors—identity, characteristics, needs, and motivation. Mentors are chosen who communicate well with both students and faculty, who are relatable, who are personable, and who are open to personal growth with enough time to fulfill the responsibilities of a mentor. Two orientation sessions are held in the spring and the fall

where mentors are introduced to the program, the courses, and the expectations as well as the program's basic pedagogy. "We set them up for success by being very explicit in what we expect from them as student mentors," said Anne Terrell, a preceptor at the university. "We let them know exactly how we would like to see them in their positions and where we see things going."

Mentors are also instructed in assessment. Faculty work with the mentors to understand the importance of grading, formative, and summative assessments. Mentors are taught to review the intended learning outcomes from an assessment to grade fairly, accurately, and consistently. Mentors co-grade assignments and discuss how learning outcomes can be emphasized in the course work. As mentors continue to grade student assessments, faculty provide feedback and standardize scores to ensure course-wide equality. Mentors are encouraged to incorporate this feedback and their own reflections into future grading.

Analytical programs are used to analyze mentor grading patterns. When a mentor consistently grades too high, those scores can be adjusted, and the mentor can be counseled in how to grade more accurately in the future. Mentor grading habits can also be tracked over time, and mentors who are struggling can be identified.

The program hopes to continue to secure adequate resources and time to adequately coach mentoring interactions. The team also would like to further assess the benefits of participating in the program for both enrolled students and peer mentors.

A DISCIPLINE-BASED PEER LEADERSHIP PROGRAM
AT THE UNIVERSITY OF WISCONSIN–MADISON

An HHMI-funded program at the University of Wisconsin–Madison is designed to help underrepresented minority students overcome challenges in integrating into STEM fields. Specifically, the program has sought to create a leadership learning experience that integrates students into community activities and connects to personal leadership growth. "We wanted them to come into our spaces and feel like it was a home away from home," said Jerry Whitmore, Jr., faculty associate for first-year and retention programs at UW-Madison.

Mentoring is the key component of the program. Minority undergraduate students have identified mentorship as one of the most salient factors in academic and social success, fostering higher levels of persistence, retention, and individual satisfaction. At UW-Madison, where just 2 percent of students are African American, the mentor–leader relationships focus on the importance of fostering a critical mass of underrepresented students who lack access to formal and informal networks of information. The team at the university wanted freshmen students to go through STEM programs with peers who looked like them. They also wanted the program to include majority students, but with the aim of giving them the tools to work with students of color in the STEM environment.

The peer mentoring and leadership program at the institution is not attached to a particular college or department. Previously, underrepresented minority students felt that they needed to go to the department of diversity

or the multicultural affairs office to feel more connected to the institution, and the program wanted to give students those experiences while also helping develop their scientific identity. The program is structured to create a cycle of participating students, with peer leaders forming the foundation for success within the STEM departments. These leaders aim to support student success in a diverse population. In this way, communities of peers can facilitate student reflections, explore student development issues, learn new strategies, and foster discussions of diversity.

Students are selected and trained for the leadership program in the spring semester. Training includes a one-credit course, a retreat, and co-current training workshops. The program supervisors are faculty associates and other administrators in STEM fields. Both students and faculty are given the opportunity to hear from one another and complete subsequent training.

After going through the selection process, retreat, course program activity, and monthly in-services, students become student leaders or peer mentors. By the end of their sophomore year, students are expected to be peer leaders or mentors in the program. Senior student leaders become student ambassadors who act as guides to both students and student leaders. Student leaders assist faculty members in courses and help students understand the resources available on campus. They demonstrate how to be a socially responsible participant in the campus environment, foster positive group behavior, and address problem-solving issues that may arise. The program hopes to reach its goal of giving students the tools necessary to take action in and out of the classroom by focusing on how mentoring fits in with the students going through the program.

Eighty-two percent of students who attended the spring leadership training rated their experiences as somewhat to very relevant, showing that the majority of students enjoyed being in the program. Among future plans are to engage second-semester freshmen so that a sustainable cycle of mentorship can be created.

THE IMPACT OF MENTOR TRAINING ON
FACULTY PERCEPTIONS OF DIVERSITY

Proper training of mentors can both improve mentoring relationships and act as an important link to prepare mentors to work with diverse mentees. To better understand the effects of training on mentors, a team at UW-Madison conducted a qualitative study examining faculty mentors' awareness of diversity and their subsequent behaviors. "There's been a lot of research out there on diversity training in all kinds of contexts in academia and beyond, but there hasn't been a whole lot about what people do differently as a result of that training," said Stephanie House, research program manager at the university. "Even though behavioral change is generally the primary goal for an intervention, not a lot of us know about that—and particularly in the context of mentoring relationships."

The qualitative analysis at UW-Madison was drawn from interviews with 1,354 mentors from 16 academic health centers who participated in eight hours of mentor training, with one hour specifically focused on issues of diversity and with diversity topics integrated elsewhere throughout the train-

ing. The workshops were done as part of a randomized trial where subjects were recruited from the 16 health centers by mentoring advocates and placed in the control or experimental group. The average mentor in the study was a 60-year-old white male professor with 15 years of mentoring experience. The training focused on six themes or competencies—maintaining effective communication, aligning expectations, assessing understanding, addressing diversity, fostering independence, and promoting professional development.

Baseline interviews were conducted and further data were collected via phone interviews three months after mentors participated in the training. Mentors were asked whether they had changed their behavior in each of the competencies in the follow-up interview. In relation to the diversity session, participants were specifically asked whether they had changed the way in which they thought about diversity and how it might impact the mentoring relationship. Follow-up questions were asked as needed during the interview. If the subject reported that they had changed their behavior, their positive response was coded as either awareness, intent to change, or implemented change.

Those who responded that they had not changed their behavior tended to fall into three groups, those who did not see diversity as an important issue, those who related they were already familiar with the topics addressed, and those who were critical of the training. One problematic aspect of the course was that it raised awareness but did not necessarily give participants the tools to better handle diversity issues, House noted.

While some mentors did not change their behavior after the training, many mentors learned valuable lessons, such as seeing diversity as involving more than race and gender. Some mentors realized that they should think about using different strategies for different mentees rather than treating everyone the same. Mentors came to understand that bias exists, particularly unconscious bias.

Among those who reported increased awareness, mentors tended only to bring up the topic of diversity when specifically asked about it. However, those who managed to implement change in their behavior tended to bring up diversity issues without prompting, particularly when talking about communication. Mentors brought up new conversations on such topics as work–life balance, managing families, race, gender, and comfort within a department.

Participants further discussed adjusting timelines and expectations on an individual basis. Some discussed making adjustments for new mothers, although nobody brought up doing so for new fathers. Mentors reported using new techniques with English language learners to test their understandings. A few mentors talked about their attempts not to marginalize people.

While the UW-Madison study was a qualitative analysis, the team was also curious about whether specific attributes correlated with attitudes and behaviors. They did not find significant correlations with a mentor's gender, race, ethnicity, or career stage. However, they did discover a significant correlation with age. The older the mentor, the less likely he or she was to report changes to his or her behavior. Also, mentors who reported higher skill gains overall were more likely to report changes in their behavior. These changes included an expanded understanding of difference, a general awareness about bias, and engaging in some new conversations with mentees.

Translating awareness into action is not easy. The UW-Madison study developed a process-based curriculum where much of the content in the training sessions comes from the group. The team would like to improve the training by trying to find additional ways to move beyond understandings of diversity as being only about race and gender without underplaying the differential impact of certain identities. They also intend to incorporate strategies to combat implicit bias. Finally, the team would like to further analyze whether the mentees saw changes in the mentors.

USING INTRUSIVE ADVISING TO INCREASE FIRST-YEAR RETENTION

Delaware State University was one of the United States' first 1890 land grant institutions and is the only HBCU in the state of Delaware. The university is comprised of approximately 4,600 undergraduate students majoring in 21 academic departments. In 2015 the average entering student had a 3.08 GPA and an SAT score of 907. The university is comprised of six colleges, including the College of Mathematics, Natural Sciences, and Technology (CMNST). CMNST has five different departments that offer bachelor's, master's, and PhD programs in biology, chemistry, computer and informational sciences, mathematical sciences, physics, and engineering. Approximately 140 new freshmen students enter CMNST annually.

Of the 900-student incoming class at Delaware State, 69 percent tested into developmental mathematics and less than 1 percent into developmental English. For CMNST, 57.3 percent of incoming students tested into developmental mathematics and less than 1 percent into developmental English. These results reveal that students' aptitudes in mathematics are far below their writing skills.

Between 2008 and 2011, retention and graduation rates were low at Delaware State University as a whole. Half of students left without completing their degree, and the numbers in CMNST were similar. During this time, advisement faculty focused on getting students in and out and were not spending enough time to understand each student's academic needs and motivations. Often, students did not connect with an advisor during their initial experiences on campus. Students seemed to fail for a variety of reasons, including financial burdens, lack of preparation, difficulties in the transition from high school to college, and the demands of college life. In CMNST, advisors said that problems include poor class attendance, students not completing assignments, and students lacking proper class materials.

The university has introduced the use of intrusive and proactive advising to combat poor retention rates, said Clytrice Watson, CMNST's interim dean. These measures aim to assess why students struggle to succeed. They operate on a dual or satellite model, where each college has its own academic advisement center. First- and second-year students receive all of their academic advising in the academic advisement centers. Students are also partnered with a faculty member to deal with matters related to their major. At first, faculty were upset when they found out about the academic advisement center. It was difficult to tell them that they were not doing a sufficient job, said

Watson. But after the program's initial success, faculty members no longer complained about the program.

Three advisors are employed at each center—two academic advisors and an Individual Development Plan (IDP) coordinator. In CMNST the two current primary advisors have masters' degrees and the IDP coordinator has a doctoral degree. Academic centers provide career counseling to help students understand their motivations and their career aspirations. Once students spend 45 or more hours in the academic advisement center, they begin to transition to a faculty advisor in their department, usually during the second semester of their sophomore year. Additionally, each department has a university seminar class where students learn about faculty in their departments. Each student is assigned to talk to a potential academic advisor in their department to start building a mentee–faculty relationship.

Intrusive or proactive advising includes a five-week check-in, a midterm review, and an early-alert system that reports such information to the advisement office as poor student attendance, assignment completion, and behavior. The five-week check-in occurs during the early alert period. If necessary, students are notified via email that they must meet with an advisor. During this meeting, advisors go over students' grades, help them learn how to calculate grades, and help them develop a co-curriculum pathway. "We target those high-risk or high-needs students for that five-week check-in," said Watson.

Financial aid and scholarships at Delaware State University are directly linked to student performance. The advisement center helps students understand the requirements to retain funding. For example, the INSPIRE scholarship requires students to maintain a 2.8 GPA and do ten hours of community service per semester. Many students were failing to keep the scholarship because they were unaware of the community service requirement. Advisors also connect with the directors of residential life. If students do not attend class or respond to email or phone calls, the residential life director will find them and direct them to the advisement office.

Pre-matriculation intervention strategies are used to immediately get students on the right track. If students do not do well on the placement tests, they can take a free online summer mathematics course. If they pass the class, students can matriculate in the proper mathematics course for their major in the fall. Students also have the chance to take an online mathematics module. If they can successfully complete all ten modules with a score of 80 percent or higher, they can advance to the next level.

First-year retention rates have increased with the new practices, particularly at CMNST. While the advisement program is still in its early stages, Watson hopes that these increases will be reflected in four-year graduation rates. In addition, all freshmen take part in the new university-wide IDP initiative, where students develop a four-year success plan. IDP aims to increase retention rates, four-year graduation rates, and placement rates for employment while reducing the cost of education for students. "We have horror stories of students graduating after six or seven years with $100,000-plus in student loan debts," Watson said.

The first year of IDP focuses on building a strong academic foundation, the second on career development, the third on professional development,

and the fourth on transformation and transition. IDP advisors monitor students to ensure that when they leave the university they have a plan for the future. "Too often our students graduate without a plan, so we at least want to get them on a course to pursue a plan," said Watson.

The new advisement model at Delaware State University has increased fall to spring semester retention for STEM students from 59.6 percent to 74 percent. In the future, the university would like to acquire the software for predictive analysis and data analytics to track student engagement, including tutoring and meetings with advisors.

INCREASING MENTORS' ABILITY TO PROMOTE RESEARCH SELF-EFFICACY IN THEIR STUDENTS

Amanda Booth, a postdoctoral research associate at the University of Wisconsin–Madison, illustrated the challenges facing underrepresented minority retention in STEM fields through a fictional student named Winona Davis. Winona attends a liberal arts college and is involved in research with Professor Rebecca Timon. Winona is an excellent researcher and the right hand of the professor. Rebecca is excited by Winona's potential and urges her to consider getting a PhD. But when Winona talks to classmates in her laboratory, she tells them that she is not sure she has what it takes. This question—"Can I do this?"—is at the crux of self-efficacy, "the confidence in one's capabilities to complete a specific task or goal," said Booth.

Mentors have the potential to profoundly influence students' beliefs about themselves, their capabilities, and their future career plans. Therefore, it is critically important that mentors receive effective training on the development of self-efficacy, Booth said. However, few mentor training interventions have employed a theoretical framework to inform their practice.

A recent study conducted at UW-Madison sought to use social-cognitive career theory as a framework to build on existing literature by examining the effectiveness of a mentor training intervention focused on self-efficacy. First, underrepresented minority students can have unique characteristics, Booth observed. In her example, Winona is female and Native American. She is close to her family, and her college is close to her home. She helps take care of her grandparents and is reluctant to leave the area, even for a short period. She is a first-generation college student, and even though her family provides emotional support, they are not able to provide the instrumental support that can guide her through the college process. All of these background factors help determine what kind of mentorship is needed.

Social-cognitive theory recognizes four sources of self-efficacy. The first is master experience. Since Winona has successfully conducted research in the past, she can probably conduct research at a graduate level. The second source is experience or observation. Rebecca was a first-generation woman who completed her PhD and achieved success; she serves as a model for Winona and offers a way to see herself in the field. The third source is social persuasion. By urging Winona to consider a PhD, Rebecca sends the message that she has what it takes. The fourth is emotional or psychological states. If Winona is able to make sure that her family is taken care of, then she can feel better about her decision to go elsewhere for school.

These four sources of self-efficacy form the foundations of the learning experience and mentoring relationship. Mentors can learn to be attuned to all four sources, as well as to the messages a mentee is sending them about self-efficacy. To help mentors acquire these skills, the intervention at UW-Madison developed a practical format for training that included 60- to 90-minute training modules that emphasized four learning objectives. First, define self-efficacy and its four sources. Second, identify mentee self-efficacy and its relationship to the research task. Third, articulate the mentor's role and foster mentees' research self-efficacy. Fourth, practice those strategies for building mentees' self-efficacy and research.

Mentors were put in challenging situations to understand how to assess mentees' research self-efficacy, and a process-based learning approach was used with numerous case studies and discussion. One exercise asked mentors to help mentees come up with four steps to help them write a research abstract. Possible steps included reading journal articles, providing mentees with examples of abstracts, exchanging with another mentee to do peer review, and providing constructive feedback.

The training ran through four implementations over the summer of 2014 and the summer of 2015. Fifty-five mentors of undergraduate mentees participated in a one-hour mentor training workshop designed to educate mentors about the concept of self-efficacy and its sources in the context of a research laboratory experience. Fifty-seven percent of participants were graduate students, 71 percent were white, and 53 percent were female. At the end of the training, all mentors were invited to participate in a brief online survey that provided the opportunity to evaluate training and provide feedback. Participants in 2014 saw significant increases in perceived confidence to employ strategies to build mentees' research self-efficacy. However, no significant gains were found in assessing a mentees' confidence for research or recognizing deficits in mentees' confidence for research.

The intervention has developed a one-page toolkit that provides practical examples of each of the four sources of self-efficacy. In the future, the program would like to create a tool to help mentors measure self-efficacy. Mentors were taught to notice self-efficacy, but many wanted to track those changes over time to complement those beliefs. The training model is currently being tweaked to develop a mentee version that will educate mentees about self-efficacy and how the four sources of self-efficacy are incorporated into undergraduate experiences.

USING TEAM SCIENCE AND MENTORING CONSTELLATIONS TO ENHANCE TRANSLATIONAL RESEARCH ACTIVITY AT THE MOREHOUSE SCHOOL OF MEDICINE[1]

Over the past 40 years, the Morehouse School of Medicine has established a nationally recognized track record of success in developing minority investigators through its pipeline programs. Recently, the medical school decided to move away from its traditional research professional development structure

---

[1]Winston Thompson, professor and chair of physiology and director of the MSM Mentoring Academy, helped lead discussions at the conference.

to a broader and more integrated translational approach. The renewed focus on health equity called for more centralized research training and professional development programs for academic faculty. The resulting program—the Mentoring Academy—aimed to create a robust and vibrant research training environment that is responsive to advancing health equity.

To accomplish these goals, resources needed to be aggregated from across the institution. A major challenge at Morehouse School of Medicine was the lack of a critical mass of mentors to meet the needs of the student body and developing faculty. Senior investigators across the various departments, centers, and institutes were seeking a solution to accommodate mentoring and career coaching of over 300 students and 200 faculty members.

The Mentoring Academy is based on the principle of team science, "bringing people from different disciplines and perspectives into the same space, to have these multidisciplinary conversations," said Japera Johnson, PhD, Research Associate at the Morehouse School of Medicine.

Activities within the Mentoring Academy focus on developing scholars within an organizational framework where collaboration is a key component of success. The academy works on the concept of mentoring constellations, where multiple mentors share the responsibility of mentoring. Constellations allow greater access to resources, information, and career sponsorship while allowing for different types of mentoring for different activities.

The Mentoring Academy allows mentoring of those who will mentor others and provides effective, sustainable mentoring to the faculty at Morehouse School of Medicine, said Johnson. Further, it promotes the development of a team science approach through the conduct of multidisciplinary research and the use of team and peer mentoring for mentees.

The Academy strives to get mentees to the next level in their careers. For example, typically mentees are early- to mid-stage career investigators who have perhaps received some pilot funding in the past but have not received the level of NIH independent investigator award. The goal is for independent investigators to mentor the next generation of independent investigators in a continuing cycle.

The Mentoring Academy would not work without institutional buy-in, Johnson said. Dr. Winston E. Thompson, Director of the Mentoring Academy, points out that in order to institutionalize the mentoring academy's structure it must be systematized and incentivized with an expectation of participation from senior leadership. Only then will the full potential of the concept be realized and lend itself to duplication across other areas. Senior investigators are strategically chosen who have served in executive positions across campus to make mentoring part of the institutional fabric. The program's success stems from its ability to connect people to resources that help them conduct their research.

The Mentoring Academy has positioned the Morehouse School of Medicine to more effectively and efficiently leverage its scarce resource of senior-level investigators to provide intensive mentoring to accelerate the professional development of translational scientists. The combination of mentoring and team science creates a synergistic platform from which early career scientists are optimally equipped to benefit from access to cross-disciplinary

senior level mentors who are engaged in translational research and have sufficient social, technical, and scientific capital to develop junior faculty.

A CROSS-COHORT STEM NETWORK AT UC-BERKELEY

The Berkeley Science Network (BSN), funded by the Kapor Center for Social Impact and the National Science Foundation, was designed to increase the recruitment, retention, and advancement of underrepresented minority students in science. The cross-cohort network includes high school, undergraduate, and graduate students and faculty members in mathematics, physical sciences, and computer sciences. These fields provide the greatest challenge in increasing diversity, said Colette Patt, the director of BSN, the BSN Scholars Program, the Berkeley Edge Program, and the Berkeley Science Connections Program.

BSN is a vertically linked mentoring network that provides mentoring for each group by a more senior cohort. The network provides a social network deeply embedded into specific academic disciplines. Those disciplines are sufficiently intellectually related to make interactions between individuals in the network academically meaningful. Mentoring, professional development, and academic enrichment activities are delivered through the network. The goal is to create a largely self-reliant structured network that depends on staffing primarily for coordination rather than for direct service provision.

For men and white students who intend to pursue a mathematics or physical science degree, representation increases from point of entry to completion of degree. For Asian American students, representation remains static. For underrepresented minorities and first-generation students, representation goes down within the fields. BSN was started to increase these students' sense of belonging and identification with the scientific community; to ensure they received access to both information and resources like research opportunities; and to connect them with reliable and trusted mentors who were knowledgeable experts who knew how to give proper guidance.

A baseline survey conducted in 2012 found that 40 percent of participants were in mathematics and the physical sciences, half of whom were underrepresented minority students. Network analysis was conducted to examine the strength of relationships between items on the survey. A graphic was created where each node represented an item, and the thickness of the connecting lines represented the strength of the correlation. In one question, students were asked to rate the importance of different sources of guidance in selection and success in their courses. At baseline, underrepresented minority students responded that university staff, fellow students, other undergraduates, and professional development workshops helped inform their decisions. However, these students also reported a negative relation between guidance and faculty and staff in the department. The only faculty guidance reported by underrepresented minority students was from laboratory sessions, but this guidance could have been provided by undergraduates, too.

In the baseline survey of women, informal faculty advisors, faculty members in other departments, and scientists in their own lab were cited as important sources of guidance. Minority men who are not underrepresented cited

staff in other departments, other university staff, and other undergraduates as the key players in their success. Information for students based on demographics thus reveals critical differences in support.

More than half of underrepresented minority graduates in mathematics, physical sciences, and computer sciences have participated in the network, along with 30 mathematics and physical science faculty. One-third of all mathematics, physical science, and computer science underrepresented minority undergraduate students participate.

BSN provides an academically embedded science network, said Patt. There is no physical meeting center. The program aims to help students identify with their departments and link them to mentors in more advanced stages of preparation. One of the biggest problems at universities is that students struggle to navigate resources. BSN deals with this issue by providing not just encouragement but also access to information and tangible resources.

BSN recognizes that financial support is a huge issue for students. As a result, the network won grants for students through NSF STEM proposals and has since awarded many scholarships. At Berkeley, underrepresented minority students who intend to major in STEM fields are retained at a rate of 32 percent. The persistence rate for scholarship program recipients is 47 percent.

Persistence is one thing; achievement is another, said Patt. The program at Berkeley does not just aim to graduate students of color in mathematics and science but aims to graduate students to be competitive in those fields in graduate school and in the workforce. Getting into Berkeley is difficult. All enrolled students are brilliant, but they arrive on campus with varied levels of preparation. Berkeley admits students both in terms of rank in the state from high schools and rank ordering at their own high schools. Students who have excelled at their own high schools can come to Berkeley without sufficient levels of preparation. Berkeley is developing a six-week program for pre-freshmen to provide intensive preparation.

To help students who struggle in lower division gateway courses in mathematics and science, Berkeley is developing a faculty community of practice where faculty will experiment with and implement interventions based on the social science literature to enlarge gateway success. For example, Summer Rising, a pre-sophomore program for students who are performing below expectations after freshmen year, is an intensely focused six-week program that focuses on conceptual problems. Two-thirds of underrepresented minority students who enter Berkeley aspiring to major in mathematics and science are not retained. Among majority students, only a third are lost. The middle third is considered crucial. These are the students who need to get past their low levels of preparation, said Patt. The students selected for Summer Rising include many in the middle third who can make it through the program with additional assistance.

Starting with in-person connections that are cultivated while on campus, relationships become virtual as students graduate and migrate to jobs and graduate school. The network is structured and designed to allow for continuity of connections among students within and between cohorts, and also among alumni and between students and alumni for the long-term career enhancement of members.

IMPROVING SCIENTIFIC COMMUNICATION
SKILLS TO ENHANCE SELF-EFFICACY

Improvement in scientific communication skills can improve a student's self-efficacy, outcome expectations, and sense of identity. However, mentors often struggle to determine the best way to teach these critical skills. Carrie Cameron and Shine Chang from the University of Texas MD Anderson Cancer Center have developed strategies that rely on transformative rather than didactic approaches to communication skills that can provide students with the opportunity to develop as professionals in their field, especially for those whose backgrounds include less exposure to the academic register of English than their peers.

Cameron and Chang surveyed mentors and found that 54 percent reported that the scientific communication skills of trainees are a considerable problem or a very significant problem. About half said that they sometimes or often see trainees whose skills are so poor that they should reconsider a career in academia; 52 percent said that they always rewrite large sections of trainee manuscripts; 42.3 percent reported spending up to 40 hours helping trainees with the first draft of a paper; and 49 percent said they spend 10 to 30 hours on this task. Cameron and Chang decided there had to be a better way to improve both the quality of mentoring, scientific writing, speaking, and presenting.

Academic culture places a very high value on a specific style of communication, with a style that, by design, is inaccessible to most people. In social settings, dialects shape people's opinions of one another, although most people are unaware of the attributions they make based on language. For example, women can feel pressured to lower their tone of voice when giving a presentation to sound more like men, or students can feel anxious to voice their opinions for fear of sounding different than their peers.

Scientific communication is comprised of three key competencies: scientific writing, oral presentation, and unrehearsed speaking about science. These skills play a significant role in shaping a trainee's intention to remain in a research career, even though some trainees are more disadvantaged from the start. Continuing generation, postdoctoral, and native English speakers tend to have higher degrees of self-efficacy than first-generation students, PhD students, and non-native English speakers. A first-generation male doctoral student reported, "I feel people are smarter than I am or have access to a broader range of vocabulary than I have, particularly around scientific conversations." People often fail to realize how emotional they feel about language and the extent of its contribution to one's sense of identity.

Mentoring can improve skill development and communication. Three types of mentoring provide possible avenues for support: instrumental mentoring, where a mentor guides rather than tells; psychological mentoring, where a mentor provides encouragement to develop resilience when experiencing a setback; and sponsorship, where a mentor advocates for students across their whole experience.

Language is learned by repetition, imitation, participation, and response from peers and seniors. All aspects of language—speaking, listening, writing,

and reading—reinforce each other. The obvious elements of communication include grammar and syntax, vocabulary, and organization, but there are also less obvious elements, ones that are harder to teach. These include voice, register, rhetorical modes, rhetorical style, disciplinary style, and disciplinary vocabulary.

In linguistics, 'register' means the level of language or the language spoken in a given situation. Different registers are used in different settings. In a research setting, a general public, educated, semiformal register is appropriate. But with family one uses an intimate register.

Rhetorical style is the way in which language is organized and presented. It includes elements such as the author's voice, the audience, the purpose, the appeal, and the tone. Rhetorical moves are key points in a text that purposefully direct the audience's understanding.

Many people whose language or dialect is not the one primarily being used by the larger group are apprehensive about public speaking. There are concerns about fitting in, knowing the rules, speaking like a scientist, turntaking and interrupting, hesitation and speech planning, and articulating abstract concepts and deep assumptions. Many such speakers say, "When I try to speak in English I feel like I sound like a fourth grader." Many are uncomfortable owning their material and going beyond the slides during presentations. Since it is impossible to rehearse a conversation, many feel unwilling to take the risk. While many of these people are listening, paying attention, and have thoughts on a given subject, they often wait until they can say it perfectly before they start, resulting in frequently missed chances. In addition, other cultures may value modesty, respect, and reticence, traits that conflict with mainstream American preferences in speaking and presenting. Structures and expectations, such as whether to state the conclusion at the beginning or the end of an argument, vary and can take a long time to adopt.

In a 2008 study done with 38 L2 speakers, 35 people said it took them between 30 and 400 percent longer to develop a presentation, abstract, article, or grant in English than in their native language. Another survey question asked whether those L2 speakers felt that the level of their English had interfered with professional opportunities that they might otherwise have received. Seventeen responded that it had impacted them a lot, 14 responded that it had impacted some, and only 7 were neutral or negative.

Several strategies can help L2 speakers succeed. An especially useful exercise is having such speakers summarize and paraphrase what they read; the ability to restate accurately and with the same nuance using synonyms is a key feature of advanced academic-style language. Trainees also may be concerned that their language is appropriate and polite or unsure of the connotations a certain word or phrase might carry, so many remain quiet rather than risk being misunderstood. While appropriate usage is certainly important, mentors can be effective by thinking about language as a reflection of a sense of belonging and confidence and about skill in writing and speaking as something to develop over time. Focusing on the big picture by encouraging participation and productivity wherever possible is important.

Even though L2 speakers can often feel hesitant to speak up, it is important to encourage them actively in discussions, meetings, and presentations.

Mentors should be aware that accent reduction is a very difficult and long-term task. Many L2 speakers may never lose their accents, no matter how much they practice.

Four general principles can be used to foster effective communication skills in all trainees regardless of their native language. First, mentors need to understand and encourage students. Writing, speaking informally, and presenting are all important and come with different skill sets to be mastered. Second, mentors should offer responsive feedback rather than reactive or passive responses; address the content of the work first and discuss it in a collegiate way. Third, trainees need positive, direct suggestions that tell them how they should proceed rather than just having errors pointed out. Finally, a mentor needs to provide structure by expressing expectations as early as possible, setting deadlines, and organizing learning activities. They can provide checklists or templates that a trainee fills out before beginning a project.

Students can be instructed to take courses or workshops and can work with a peer or developmental editor. Laboratory meetings can be dedicated to explaining writing policies and procedures, and students who excel at writing can instruct other trainees. Trainees learn by doing, so educators should create many low-stakes writing opportunities. These assignments should be graded with an emphasis on content, especially in the first round. Comments might address how a student can get an idea across more successfully, but grammar corrections should be minimized. Instead, a symbol in the margin can indicate grammar mistakes, so that the student has to work to find and fix the error.

In speaking, educators should emphasize the expectation for trainees to actively participate in meetings. They might require that trainees ask at least one question at every presentation and consider the use of elevator speeches, including ones outlining upcoming presentations and manuscripts. Trainees also can be provided with short scripts that provide possible speaking scenarios, such as phrases for disagreeing or clarifying or for jumping into a conversation politely. Language laboratories, audio programs for practicing pronunciation, and phone apps also can be used.

Addressing linguistic issues in a scientific community can be a complex task. But frequent speaking and writing activities can boost students' outcome expectations and career commitment. The first-generation doctoral student who said he felt his colleagues were smarter than him also said, "It's been extremely challenging for me, particularly in the first two years. I felt like I was sort of out of my league. I wanted to quit. I guess the determination to finish the degree has to be more important. So it's really been about trying to learn to speak the way they do, to write the way they do, to act the way they do, to assimilate myself in the particular culture that I now find myself in."

6

Undergraduate Research

An especially effective way to diversify STEM disciplines has proven to be involving underrepresented minority students in research. Doing research helps students think and act scientifically, so that they can more easily make the transition from student to researcher. Student researchers develop self-efficacy, confidence, and a scientific identity, all of which help orient them toward scientific careers.

UNDERGRADUATE RESEARCH

Three interventions involving disadvantaged groups were included as part of the Summer Research Opportunity Program (SROP) sponsored by the Committee for Institutional Cooperation (CIC), which consists of 14 universities that have an academic partnership. The summer program brings underrepresented minority students to campus to work with a professor on a research project for eight weeks over the course of the summer. It is an intensive program that offers a rich array of other formal support activities, including academic coaching for the GRE and a summer conference where students present their work. This broad set of enrichment activities is meant to encourage and inform students about opportunities for graduate study as well as formal and informal activities during summer months.

SROP has two branches: one for STEM majors and one for non-STEM majors. A dataset of just under 700 participants from STEM, non-STEM, and non-intervention groups was collected. Data were collected at four different time periods: when students first started the program, directly after the summer program, a full term after the program, and a year after the program. While the three interventions focused on different groups—minority women, minority men, and first-generation students—all three support the notion that

social factors such as student talent and interest, critical racial consciousness, and informal social support are valuable personal resources that program interventions can use to mobilize students. The studies focused not only on student self-efficacy but on a set of social cognitive factors that are convergent with a growth mindset.

The transition into college is a critical time, especially for underrepresented minority students. Oftentimes, students feel lost and overwhelmed by the radically new environment and experiences they face. These feelings prevent them from seeking out the resources that are fundamental to success. By targeting pre-college and first-year students, retention rates can improve and students can understand and access the tools that support an effective culture of learning. Creating a community of peers and faculty during these early interventions provides students with the information, instruction, and skills needed to excel in the institution and ultimately in the workforce.

ACADEMIC SUCCESS AND RETENTION THROUGH INSTITUTIONAL RESEARCH IMMERSION

In 2014–15 the University of Maryland established a major new program to provide authentic faculty-led research experiences, mentorship, and accelerated opportunity for first-year freshmen from a wide range of academic backgrounds. The 27,000-undergraduate University of Maryland is a highly diverse institution with a 44 percent minority rate in its first-year population. It has a strong first-year retention rate of 95.7 percent; 35 percent of first-year freshmen are in the honors college; and more are in a larger live-in learning program called the College for Scholars. In addition, 30 percent of every first-year class comes from the transfer student population, a group that traditionally needs more attention and assistance than the majority of freshmen students. Another group that particularly suffers is the large number of undeclared first-year freshmen. These students are placed in the College of Undergraduate Studies, where they often take a long time to find their major. This directly influences the likelihood of retention and the time to graduation.

The First-Year Innovation and Research Experiences (FYRE program) primarily focuses on first-year freshmen not affiliated with any program. FYRE was heavily based on the University of Texas' Freshman Research Initiative (FRI), which began in 2005 in that institution's College of Natural Sciences. The program in Texas admits 900 freshmen annually, 40 percent from underrepresented minority groups. Seventy percent of participating students are still doing research at the end of their third year. Based on comparisons with a demographically matched control group, FRI students had 70.7 percent retention at the fourth year versus 48.8 percent retention in the control group, with even greater differences for students with low ACT scores, women in specific disciplines, first-generation students, and other underrepresented minority groups.

Unlike FRI, FYRE is based in the Office of the Provost rather than a specific college. While FRI was largely imagined and deployed as a retention initiative, FYRE is attempting to reach both STEM and non-STEM students

and faculty members, said Patrick Killion, director of the program. FYRE stretches across disciplines that are not traditionally associated with high levels of undergraduate research. Geared predominantly toward freshmen and transfer students, FYRE aims to provide them with an authentic research experience, not research demonstrations, exposure, or seminars. Research breaks down the wall between an institution's research mission and education mission, said Killion, and studies demonstrate that students involved in research have a higher probability of completing their degree, attending graduate or professional school, interacting with faculty members, and getting involved in other campus opportunities. The hope is that FYRE enables accelerated professional development for those students who are not part of the honors program. Helping students develop CVs and résumés also makes them more marketable for competitive internship opportunities.

"What we're attempting to do at the University of Maryland is to put up a program that broadens inclusion and support for diverse populations of students," Killion said. A vast majority of undeclared students do not decide their major until the midpoint of their junior year. At that point, it is difficult to integrate the student into a degree plan. By giving students experiences that broaden their major options, FYRE aims to accelerate these decisions while also increasing student confidence, resilience, and self-efficacy. The program also offers the University of Maryland the opportunity to increase its profile by offering benefits at the admissions step that encourage students to matriculate at the institution.

FYRE establishes research groups called streams led by a faculty member—or, in the case of a collaborative stream, faculty members—who think of a research agenda that can engage 30 to 40 students. A research educator and a team of four to five peer mentors are also employed in each stream. The research educator oversees the operation of the stream on a day-to-day basis. They manage the curriculum, instruction, assessments, operation of research facilities, and oversight of peer mentors. They are available to students all day, every day. These research educators are PhD-level scholars who are not appointed as lecturers and are not tenure track faculty. They are mostly first-year assistant professors who enter the program with limited levels of teaching experience. New research educators are assigned a mentor from an established pool and have weekly meetings with Killion to discuss their progress. They guide students from highly facilitated, highly mentored research to being independent, critical thinkers. Currently, ten research educators are employed to run the different research groups.

Peer mentors are typically taken from the research groups. First-year students who emerge as leaders and stay for a second year can serve the next cohort of students, with training facilitated through a one-credit semester course. Roughly 25 percent of the students per research stream stay over the summer for a fellowship period. During this time, students develop the leadership skills and independence necessary to be peer mentors the following year.

All first-year students are required to take a course called FYRE 120 that focuses on the development of student capacity to reach and work with primary literature and develop a proposal base. The goal of this course is to

wean students off journalistic literature and give them the opportunity to work in an authentic research group based on primarily scholarly literature. The skills imparted in this course are essentially discipline independent, with students trained to be able to move into any research group.

Students choose a research group in the first semester and then join that group in the spring semester of their first year. At the end of the second year, students are offered a final one-credit seminar to help transition them from the program into the next step. For many students, this next step is moving to a faculty lab, to a corporate or research institute in the DC area, or to studying abroad. The program is not extracurricular. For each semester that students are involved in FYRE, they earn a credit. These credits especially serve undergraduate students, since they count toward the scholarship and practice courses that are part of the general education requirements at Maryland.

After being launched with just over 200 students in eight streams, the program has grown to include over 400 students participating in 11 streams, with the intention to reach 500 students. The demography of the program is designed to match the university, although the program has higher levels of underrepresented minority students than in the university as a whole. Students can participate in research groups in the natural sciences, the social sciences, engineering, agriculture, and resource economics.

The program is assessed around its mission statement and compared with a demographically matching control group. In the future, Killion would like this group to include students who also express interest in the program. The average GPA of the students in the program at 2014 was 3.26, with the comparison cohort at 3.02. The student retention rate was 96 percent versus 92 percent. A tertiary assessment will be performed in partnership with the University Career Center across a number of issues, including post-graduation plans, education and employment information, the development of skill sets, and experiences at the university, including research, study abroad, and internship participation.

Recruitment has been a major challenge. Students and parents need clear messages as to why they should participate in the program, Killion said. The most important thing for students is to make their first year at the university a career relevant experience. Students in FYRE develop critical thinking, research skills, and scientific literacy and learn to work collaboratively in interdisciplinary settings. They develop ownership of their work and a positive attitude toward degree processes and awareness of the research enterprise of the institution.

EFFECT OF EARLY RESEARCH ON CAREER INTEREST AND INTENTIONS IN CLINICAL RESEARCH

While minority physicians are more likely to provide care for minority populations, they are still underrepresented in the workforce. Differences in cultural competence around issues like end of life care make it especially important that these figures change. In addition, generating hypotheses in the health care field depends on lived experience. Thus, bringing diversity to clinical research improves the quality of research.

Training Early Achievers for Careers in Health (TEACH) Research is a NIGMS-funded program led by Drs. Vineet Arora and David Meltzer. TEACH Research is a theoretically-based program that provides access to realistic career experiences and a multi-tiered structure of mentors resulting in formation of "aligned ambition" consistent with entry into a clinical research career.

The theory of aligned ambitions was described by Barbara Schneider, formerly at University of Chicago and now at Michigan State University. She says that while minorities have high aspirations, they may lack the knowledge, attitudes, and behaviors needed for entry into these careers. Minorities may also lack access to role models and mentors that can shape that intent and interest into realistic career experiences, said Audrey Tanksley, assistant professor of medicine at the University of Chicago.

Exposure to realistic career activities and multi-tiered mentorship structures can translate into career-specific knowledge—the attitudes and behaviors needed for successful career entry. TEACH Research is presented as a summer option for rising juniors in the University of Chicago Collegiate Scholars Program (CSP), a three-year enrichment program for high-achieving and talented Chicago Public Schools students. Students and their parents are given information about the TEACH Research program and invited to an interview made up of the consent process and a series of pre-evaluations. Randomization matches gender and race into two groups—a TEACH research/intervention program and field/control program.

The TEACH research intervention is based on the theory of aligned ambition and is a full-time immersion experience based in the University of Chicago Medical Center. Students gain hands-on experience in a clinical setting through the University of Chicago Hospitalist Project, an ongoing large clinical research project led by Dr. David Meltzer to assess patients' quality of care. Students work closely with faculty, medical students, and University of Chicago undergraduates, shadowing hospital medicine doctors and learning how to interview patients, analyze and collect data, and present research findings.

The multi-tiered structure of mentoring is made up of a University of Chicago physician researcher, a medical student, and one or two undergraduate research assistants. This mentorship structure allows for peer mentorship at every level while also allowing for students to engage with upper level faculty. In these groups, students work to complete a capstone research project that they present at the culminating poster session to the larger University community. In their research, students address diverse study questions such as the effects of transfusions on fatigue in patients with anemia, quality of life and hospitalization, outcomes and needs of patients with impaired vision, and ways to present and understand informed consent. Research questions are fueled by data collected from the hospitalization project.

Students in the control group attend a combination of science, mathematics, and humanities classes through the CSP, while participating in a college-style course in biological science, with an emphasis on experimental techniques used in health research. The course begins with an overview of the fundamental building blocks of life—elements, atoms, and states of matter—evolving into a discussion of cell biology, human anatomy, and evolution.

Students have the opportunity to apply these concepts to weekly hands-on lab exercises and interactive lab exhibits at local museums.

Since 2004, 227 students were enrolled into TEACH Research overall, with 117 students allocated to the intervention program and 108 designated to the control program. At least half of the enrolled students are first-generation college students, and a little less than three-quarters receive free or reduced price lunch. One hundred fourteen students in the intervention side and 86 students in the control side completed pre- and post-evaluations.

The program is evaluated through a number of different methods. Students' career knowledge and interest is assessed using the Career Orientation Survey (COS) administered pre-program and one year after completing the program. The COS instrument used for TEACH Research includes standard occupation survey items and survey items modified given results from other surveys and work on aligned ambition to ask more specifically about job knowledge and aspirations. Preliminary results show no significant differences between race, ethnicity, and gender in the TEACH and control group. Two-thirds of the TEACH Research and control groups are underrepresented minorities. Two-thirds of the intervention group identify as underrepresented minorities, and two-thirds of all TEACH Research participants are female. It has been extremely difficult to recruit African American males into the program.

Write-in responses measuring career intent were coded into four categories. Health professional and science professional were two broader categories, and within those categories were the subcategories of doctor and researcher. Preliminary findings suggest that the TEACH Research students had sustained interest and higher intent to enter research careers than student in the control group.

In 2013, TEACH Research was awarded another NIGMS grant to continue the program and further engage program participants and their peers. Though TEACH Spreading Teen Research Inspired Videos to Engage Schoolmates (STRIVES), TEACH Research students research, create, and launch a viral social media campaign that encourages their peers to consider a career in clinical research. Expert staff and faculty guide students as they conduct focus groups, shoot video, edit footage, and launch a successful campaign. The aim of the study is to test the effectiveness of a novel peer-to-peer social media marketing campaign to spread video vignettes created by teens to inspire other teens to consider careers in clinical research. While few students may consider a career in research due to lack of knowledge or access to role models in their immediate family or school network, peer online social networks represent a potential way of reaching underserved minority students, thereby "priming the pump" for pipeline programs by boosting students' baseline interest in research careers.

In one video, students talk about health issues that affect their communities and personal experiences and how these issues can be changed by clinical health research. They discuss the need for diversity in research to inform these problems. "In the past, we've heard students say that research careers are boring, ungratifying, thankless, and don't pay well," said Samantha Ngooi, project manager of TEACH Research and STRIVES. These negative percep-

tions were the driving force for TEACH students' creation of an infographic to burst the myths about clinical research careers.

Overall, TEACH Research provides a chance to increase clinical health research workforce diversity. Students and faculty buy into the program because they are aware of the lack of diversity in health care. Participants' families get to know the reasons why it is important for their children to be a part of the program, and students have the chance to enter a pipeline geared toward diversifying success. Preliminary results suggest that pipeline programs based on aligned ambition may be effective for sustaining career interest and cultivating intentions toward research careers. The main focus is to preserve interest and cultivate intentions while seeking innovative ways to build initial interest in clinical research careers.

UNDERGRADUATE RESEARCH EXPERIENCES: A LONGITUDINAL ASSESSMENT[1]

To diversify the STEM workforce, funding has been targeted at underrepresented minority undergraduates, postdoctoral students, and early faculty members in the biomedical sciences. But what effect have these dollars had, asked Paul R. Hernandez, assistant professor in educational psychology at West Virginia University. Hernandez's main program of research has focused on the roles of motivation and social influences on the academic persistence of underrepresented minority groups in STEM fields. In particular, he is interested in the situational and personal factors that maximize or inhibit human potential.

Participating in undergraduate research experiences (UREs) is almost universally accepted as an effective educational tool for increasing interest in STEM careers, but to date the efficacy of this approach has not been well established empirically. Furthermore, much of the research relies on self-reports, interviews, and retrospective accounts of satisfaction rather than empirically validated gains in knowledge and understanding of longitudinal persistence. Programs often rely on participants' memories of things that happened many years before, and limited longitudinal evidence assessing the effect of UREs on persistence is threatened by reliance on self-reported intentions to persist rather than actual behavior. In addition, longitudinal studies often fail to differentiate between types or levels of involvement in UREs—whether it is course-based research, extracurricular research, leading a project, or supporting a project.

Other methodological issues can also arise, Hernandez pointed out. Programs can fail to control for the duration of the UREs or not disentangle the direction of causality. Does the URE cause persistence or do persistence intentions cause participation in UREs? A common complaint directed against these programs is that "the rich get richer because they're going to go on and be successful anyway," said Hernandez. Studies are invalid without a control

group. Often individual programs have inadequate sample sizes. A program with only 20 to 50 students cannot produce quantifiable statistical significance in terms of gains relative to hypothetical results that would have happened without the program. Long-term evaluations often are not within the funding scope or mission of a particular program, and a program may provide no context to assess a hypothesized mechanism.

Hernandez wanted to determine the results of a diversity intervention following proper methodologies. "What happens if you do have a control group, what happens if you do follow students over a long period of time, and what happens when you look at the programmatic and the psychological mechanisms of change?" he asked. Since 2005 he has worked with a team on a prospective, propensity score–matched, longitudinal panel study to determine the effectiveness of the RISE program funded by NIGMS. Students in RISE were propensity-score matched with non-RISE students based on such factors as gender, age, ethnicity, major, GPA, educational progress, research interest, language barriers, and first-generation status. Students in RISE are given access to a variety of supplementary resources, including stipends, seminars, funding to go to conferences to present, tutors, additional instruction, and tuitions. Previous research has shown that the RISE program is effective at retaining the interest of underrepresented minority students in STEM careers and their persistence in STEM fields. However, the work did not distinguish between the types of UREs, and insufficient time had passed to connect UREs to STEM persistence post-graduation.

The study engaged undergraduates, primarily juniors being served by the RISE program, and compared them with similar students. Participants were followed through undergraduate tenure to graduation, graduate school, and careers. The program considered the program goals of RISE, which include the support of well-integrated developmental activities, academic preparation, development of research training and professional skills, and reduction of the gap in completion of PhD degrees between underrepresented and non-underrepresented students.

The study recruited students from 25 RISE campuses and 25 matched campus. The RISE program enrolls the best people at that campus, so finding a match can be difficult, Hernandez noted. Data were collected on the same group of participants twice a year over the course of a decade, with 72 percent of participants female, 50 percent African American, 40 percent Hispanic/Latino, 11 percent self-reported, and 1 percent Native American. These statistics do not reflect the makeup of biomedical majors in general but do reflect the makeup of the RISE program. Most of these students were in the biomedical and natural sciences and to a lesser degree in the behavioral sciences, social sciences, mathematics, and engineering.

An open-ended survey question in 2014 about current occupations revealed that many RISE participants were still engaged in scientific endeavors or were studying science in school. All open-ended responses were sorted into three categories based on current careers: STEM, medical, or other. Sixty-four percent of the propensity score–matched controls were not in STEM; 52 percent of RISE participants were not in STEM; and 36 percent of non-RISE

participants were actively engaged and committed to being in STEM versus 48 percent of RISE students. RISE students were twice as likely to continue to be in a STEM field nine years after initial enrollment.

Students still enrolled in an institution were questioned in their first, second, third, and fourth years. Results revealed that RISE students are engaged in research activities far more than are their propensity school–matched controls. Students in RISE benefited from being part of a community of scholars and being engaged more often and to a greater degree with different kinds of research experiences compared with non-RISE students. Student-designed research projects also appear to benefit RISE students, although this aspect does not serve a mediation role, perhaps due to power issues.

Strong causal inferences revealed that minority training programs, specifically RISE, had a strong effect on who stays in STEM, Hernandez concluded. He was hesitant to discuss broader implications, since more research needs to be done before reaching hard conclusions. However, it appears that broadening access to specific kinds of research experiences and engaging students in team-based communities can affect future career decisions.

THE ROLE OF UNDERGRADUATE STEM RESEARCH EXPERIENCES IN ACADEMIC SUCCESS

Over the past several decades, the proportion of STEM majors among the overall undergraduate population has fallen substantially. One key factor in this decline is the failure of entering STEM students to complete their undergraduate degrees. Nationwide, six-year completion rates in STEM majors are less than 40 percent, with particularly troubling early STEM departure rates among women and underrepresented minority students.

Research has pointed to the utility of early research experiences in promoting STEM persistence among all undergraduates, and especially underrepresented minority students, said Marc Levis-Fitzgerald, director of the Center for Educational Assessment at University of California, Los Angeles (UCLA). Furthermore, large public universities, considering their size and activities, are arguably the best positioned among institution types to address these disparities. But strategies need to be scalable, effective, and sustainable for diverse and sizable student bodies.

Two separate large-scale programs were designed to promote STEM academic success and retention at UCLA, in part by emphasizing undergraduate research experiences. The first study uses multiple comparisons of matched samples to identify the effects of a two-year academic support program for underrepresented lower-division students in the Life and Physical Sciences. The Program for Excellence in Education and Research in the Sciences (PEERS) program was founded in 2003 by faculty and has since been institutionalized at UCLA. A large population of the students in the program are underrepresented minority students and/or high "life challenge prospective" students in the physical science majors. Life challenge scores are program calculations that take into account students' high school characteristics, parental education level, and family income level.

Approximately 115 students are invited into the PEERS program during the summer between their senior year in high school and their freshman year at UCLA, and about 80 students enroll annually. The majority of participants are first-generation college students and ethnic or racial minority students. PEERS was designed to be a multi-faceted comprehensive program. Students participate in Pathway to Success seminars, have access to academic counseling and tutoring services on campus, engage in collaborative learning workshops, attend faculty research talks, are given information and fed into research opportunities, and engage in social activities that help develop a sense of community and belonging within and between cohorts. PEERS has three program goals: increase student GPA, increase the total number of science courses completed during the first two years, and increase persistence in science and mathematics majors.

Data from the program come primarily from registrar data. Program record surveys, student interview data, workshop evaluations, and data from the UCLA senior survey are also collected. In the research described by Levis-Fitzgerald, the treatment group included 147 students who had participated in PEERS and matriculated at UCLA in 2009 or 2010. A control group consisted of all entering life or physical science students who would have been eligible to participate in PEERS based on their life challenge scores, SAT scores, and underrepresented minority status. Some of these students were included in the original invitations to participate in the program but decided not to accept the offer.

The study examined the outcome of cumulative GPA after the first two years of UCLA, controlling for such factors as high school GPA and SAT mathematics score. PEERS participation was a positive predictor of the number of science courses that students completed within their first two years. On average, PEERS students completed about 13.8 science courses during their freshmen and sophomore years of college versus 11.2 courses for the control group and 12.3 for the SAT mathematics control group. Students need to complete 24 science courses in total throughout their four years.

In looking at STEM persistence, the program wanted to determine whether students re-enrolled as STEM majors and went into upper division STEM courses when they became juniors. Results showed that PEERS students were 2.5 times as likely as their control group counterparts to persist into their third year as a STEM major. "These results suggest that positive outcomes are not necessarily driven by self-selection," said Hannah Whang Sayson, senior research analyst at UCLA's Center for Educational Assessment.

Although PEERS offers a range of opportunities to participants, it remains unclear whether certain components are more beneficial than others. It may turn out that all of its different components are necessary, which raise issues of scalability. Future studies aim to isolate and study individual programmatic elements to break down the program's success.

The second study at UCLA draws on survey data and direct assessment of student learning to examine the effects of different types of research experiences embedded into the curriculum of upper-division life sciences courses. The Competency-Based Research Laboratory Curriculum (CRLC) was de-

signed to provide in-depth research opportunities for students in two specific life sciences departments at UCLA—Microbiology, Immunology, and Molecular Genetics and Molecular, Cell, and Developmental Biology. Once students are done with their core lower division requirements, they can choose from two different types of research curricula, designed to be different but parallel two-quarter research experiences.

Path one immerses students in scientific discovery experiences through team research. In Course-based Undergraduate Research Experiences, teams that usually consist of three to four students work together on a research project, with four different topics to accommodate the diverse interests of students. In path two, Apprentice-Based Research Experiences, students must have already been working in a faculty lab. They apply with the faculty mentor to enter the curriculum, where they conduct an independent research project with guidance from the faculty member. Ten student learning outcomes are at the core of the program, including such aims as improving oral and written communication skills, demonstrating knowledge of disciplinary concepts and their relationship to biological systems, and understanding the process of scientific research.

Several data sources were used to determine the program's effectiveness. One was the entry and exit surveys created in collaboration with CRLC leadership. The entry survey was administered during the first week of each course, and the exit survey was given in the last week of the course. A rubric-based content analysis using embedded student assessments was designed to provide direct evidence of learning. Open- and closed-ended questions also were included in the entry and exit surveys.

Data were collected between 2010 and 2014 from more than 1,000 students who completed the curriculum. Path one students included more fourth- or fifth-year students. The path two group were more likely to be third-year students with a slightly higher average GPA.

Regardless of the path, students had significantly higher interest in biology at the end of the research experiences. Path two students had significantly higher mean scores than their counterparts in path one at the beginning of the program, but over the course of the 20-week curriculum, path one students began to experience significant learning gains, which closed the gap between both paths in terms of skills and knowledge. These results indicate that students do not necessarily have to work an extra five to ten hours a week and volunteer in a faculty lab to reap the same benefits. These findings may be particularly beneficial for non-traditional students who commute in Los Angeles traffic, work full time, or have family responsibilities, Levis-Fitzgerald concluded.

ENGAGING FIRST- AND SECOND-YEAR STUDENTS IN THE COMMUNITY OF RESEARCH

Johnson C. Smith University (JCSU) is a private liberal arts institution located in Charlotte, North Carolina, with approximately 1,500 students, including about 300 in the STEM college. The university offers degrees in

biology, chemistry, mathematics, computer engineering, computer science, information systems, and information systems engineering. Approximately five mathematics gateway courses are offered at JCSU. Calculus one serves as the STEM gateway course and gives students adequate preparation to take courses like physics and engineering one. However, most of the students entering the institution do not place into calculus one but into the university's algebra course.

Students can feel deflated when they place into remedial mathematics courses, noted Dawn McNair, mathematics professor at JCSU. When McNair examined the National Survey of Student Engagement, she saw that increased engagement with students early on had a compensatory effect on grades and on the likelihood that students would return to college for a second year. She realized that if JCSU increased reflective learning and students felt that what they were learning was associated with their future, they would be more likely to come to class, feel more challenged, and recognize that they are on a pathway directly linked to their career aspirations.

JCSU began implementing educational processes to provide a boost to lower achieving students upon starting college. These processes allowed students to catch up to the students entering JCSU with higher levels of preparedness. The intervention at JCSU focused on two objectives: student connection to mathematical learning, and student ability to organize that learning into meaningful concepts. To facilitate these goals, the program developed an orientation course for freshmen STEM majors and seminars for sophomores, juniors, and seniors. Additionally, the program required students to complete a capstone experience.

The intervention at JCSU also aimed to provide students with more deliberate preparation for research by fostering a "community of research." Through partnerships with other institutions of higher education that provide graduate programs, JCSU created avenues for students to pursue research early in their academic careers. As a result of implementing research into the community, an increasing number of students in the STEM college achieved a 2.5 or higher GPA. STEM enrollment increased to a little over 300 students, and the STEM college had an increased percentage of the institution's graduates.

Before the program, many students did not know that STEM professional conferences existed, whereas after the intervention 46 percent more students participated in a STEM field trip and 45 percent more students attended a STEM conference. The result was a dramatic increase in students who presented at a conference or who co-authored a publication with a faculty member. More students also completed research internships in STEM fields, which translated into greater success in the classroom.

The intervention employed several models to instigate success, including a minigrant program, research interest groups, faculty and student teams, the CRUISE program (see below), and the Smith Institute for Applied Research. Faculty apply for competitive minigrants that must include two students, usually in their freshmen or sophomore year, and that require faculty members to provide students with the opportunity to disseminate research

through publications, presentations, or conferences. Research interest groups are primarily housed in seminar courses, particularly during freshmen or sophomore year. These groups build teamwork while addressing how to do scientific research and how to conduct proper literature reviews.

The Collaborative Research for Undergraduates in Science and Engineering (CRUISE) program leverages existing partnerships to provide students with additional research experiences. During meetings with external advisory committees, participants are asked if they would consider holding a few slots for freshmen or sophomore students interested in doing research at their institutions or industries. These partners include the Discovery Place Science Museum, the Wake Forest School of Medicine, and the East Carolina University School of Medicine. JCSU absorbs some of the cost of admitted students, who primarily apply after their freshmen year. Generally, four to six students are funded for the CRUISE program each summer, with the average cost per student ranging from $4,000 to $5,000.

The final component of the intervention at JCSU, the Smith Institute for Applied Research, is an institution-wide research component for all students funded under Title III. The Smith Institute provides seed money to faculty and mentored research.

Parents have offered an unexpected challenge to the CRUISE program, McNair observed. Because many of the students at JCSU are first generation, parents are apprehensive about sending their students elsewhere for the summer, and some have a difficult time believing that their child will be housed and paid for research. The program has started to host sessions to discuss these issues with parents and earn their trust and support.

A STUDENT-CENTERED ENTREPRENEURIAL RESEARCH DEVELOPMENT PROGRAM

Research programs for undergraduate students have been found to enhance self-efficacy, science self-identity, and the completion of advanced graduate degrees for minority students, noted Avis Jackson, a postdoctoral research associate at Morgan State University. These research programs traditionally have used the master-apprentice pedagogic model, in which the master imparts knowledge and skills to a less informed passive learner endeavoring to acquire the master's knowledge, skills, and perspectives. This model features a one-to-one supervisor-to-learner interaction while ensuring that learners are acclimated to procedures. However, at the undergraduate level, undergraduates can surrender their creativity and innovative ideas by working on their mentors' research, and the resources to support this kind of research can be limited.

Part of the Building Infrastructure Leading to Diversity (BUILD) program, A Student-Centered Entrepreneurial Development (ASCEND) model to increase diversity in biomedical research at Morgan State University (MSU) was designed to translate the key attributes of an entrepreneur to an undergraduate research training model. These include an achievement orientation; an internal locus of control; expectations of greater success, freedom, and personal responsibility; and a willingness to learn information and skills in-

process and to creatively solve and simplify problems, including access to resources. The ASCEND training model commences with an eight-week Summer Research Institute, designed to train the students to think like a scientist. Using active learning techniques, a diverse disciplinary team of instructors encourages and supports students to discover solutions and creatively problem solve while operating in interdisciplinary groups. Students meet potential mentors through mini-symposia, visits to labs, and conversing with faculty and graduate students. Students adopt groups around shared research topics, with each group formulating specific research questions, culminating in mini-grant proposals that are presented to an audience of faculty from MSU and partner institutions. Faculty rate projects for scientific significance, innovation, and approach, with eight high-ranking projects selected for further development.

The first cohort of 29 students, predominantly female and rising sophomores and including 15 biology and 7 sociobehavioral majors, enjoyed 100 percent retention. A majority were Pell grant recipients. Results of pre-post measures of self-efficacy and science identity revealed that both were high at entry and higher at the end of the program. For example, "belongingness" and "attitude to research" increased significantly, with medium effect size.

DIVERSIFYING THE SCIENTIFIC WORKFORCE TO INCLUDE DEAF/HARD-OF-HEARING INDIVIDUALS

The unique characteristics of deaf and hard-of-hearing individuals contribute to these individuals being significantly underrepresented in scientific research fields, noted Scott Smith, a research associate professor at the National Technical Institute for the Deaf (NTID) at the Rochester Institute of Technology. Depending on such factors as family and educational background, deaf and hard-of-hearing children grow up using many variable communication strategies, including American Sign Language, English-based signing systems, speechreading, speaking, and writing. As a result, they have variable English language development, with some deaf and hard-of-hearing adolescents being able to read and write English very well while many other deaf and hard-of-hearing adolescents' command of English lags behind their hearing peers.

In addition to their English language challenges, deaf and hard-of-hearing children experience inconsistent access to information in learning environments, especially informal and incidental information. For example, the "dinner table syndrome" describes the typical experiences of deaf and hard-of-hearing children growing up at the family dinner table, where they typically will not be involved with conversations among family members at the table. As a result, these children can grow up into adults who might have some gaps in their fund of information because they were not able to overhear daily conversations that typically hearing children absorb every day, even when they might not be paying direct attention. These gaps can lead to significant challenges for deaf and hard-of-hearing young adults who might have weak "soft skills" such as problem-solving and negotiating skills. These

barriers interfere with many deaf and hard-of-hearing people's abilities to become scientists and professionals in general.

Furthermore, while growing up, many deaf and hard-of-hearing children will be exposed to a prevalent social stigma that sees deafness as a disability. Many people have diminished career awareness and expectations for deaf and hard-of-hearing people in general, and they will not expose deaf and hard-of-hearing children to career possibilities that might appear impossible or too difficult for them. This is especially true for careers in STEM fields. As Smith said, more exposure to successful deaf and hard-of-hearing people is essential to overcome the negative effects of the pervasive social stigma that perceives deafness as a disability.

The impact of these unique challenges and barriers can be seen in measures of educational attainment. When compared to hearing people, deaf and hard-of-hearing people tend to achieve comparable levels as their hearing peers through high school and college. However, beyond the bachelor's degree level, deaf and hard-of-hearing students show a significant decrease in the percentages obtaining master's, professional, and doctoral degrees. A similar trend can be observed in educational attainment for individuals employed in the health care industry. Significantly more deaf and hard-of-hearing people have degrees below the bachelor's level, while many more hearing people earn degrees beyond that level. Deaf and hard-of-hearing people represent about 1.1 percent of the general population, but in fields related to NIH research, only 0.4 percent of all doctorate recipients are deaf and hard-of-hearing individuals, Smith reported.

The National Task Force on Health Care Careers for the Deaf and Hard-of-Hearing Community, which was spearheaded by NTID, concluded in 2010 that many deaf and hard-of-hearing individuals experience academic challenges, poor career guidance, and low expectations that result in their lack of desire and ability to pursue advanced degrees and careers as research scientists. The task force's recommendations led to two NIH-funded training programs: the Rochester Bridges to the Doctorate Program for Deaf and Hard-of-Hearing Students, which supports 15 master's degree students over a five-year grant cycle to prepare them for doctoral training in NIH-related disciplines, and the Rochester Partnership to Advance Research and Academic Careers in Deaf Scholars, which supports nine postdoctoral fellows to promote their career advancement within academic settings.

A major recommended initiative is establishment of a National Hub of Excellence for deaf and hard-of-hearing individuals pursuing biomedical and behavioral research and clinical careers. The hub could support the academic development, professional training, and career advancement of deaf and hard-of-hearing individuals pursuing biomedical fields, with individuals who are at the end of their career pathway becoming mentors and advisers to those in the middle or at the beginning. The hub also could collaborate with other training programs throughout the country and act as a national education outreach and technical assistance resource. It could provide a mechanism for collaboration with institutions throughout the country that are preparing deaf and hard-of-hearing research scientists and a catalyst for multidisciplinary programs of research that focus on deaf and hard-of-hearing participants

representing gender, racial and ethnic diversity. As a center of expertise and practice, it could disseminate best practices after having implemented and evaluated them and serve as a national outreach and technical assistance resource. The hub could address and help resolve disparities faced by deaf and hard-of-hearing individuals in accessing and successfully navigating education and career development programs so that they can have productive careers as research scientists in NIH-related disciplines.

"To achieve a diverse workforce, we need to bring together all the various factors that will assure success," said Smith. A national hub could foster this success by bringing together learners, teachers, and institutional leaders to pursue enhanced curricula, innovative instructional strategies, change-oriented administrative policies, and state-of-the art technology.

7

Graduate School and Beyond

While many of the same considerations surround interventions used with STEM graduate education as with undergraduate students, the two populations differ. Graduate students have made a much more substantial commitment to a field. Virtually all are eventually involved in research, though master's students may receive their degrees without deep research involvement. They generally view themselves and their education in different ways than do undergraduates, which creates both challenges for graduate-level interventions and new openings for helping underrepresented minorities succeed.

THE TUSKEGEE ALLIANCE TO FORGE PATHWAYS TO ACADEMIC CAREERS IN STEM

NSF funds the Alliances for Graduate Education and the Professoriate (AGEP) program to encourage colleges, universities, and other stakeholders to form alliances and propose models that can increase persistence among underrepresented minority (URM) students in STEM fields and encourage them to pursue careers in the STEM professoriate. In the last several years, NSF has funded nine alliances with doctoral-granting institutions. In turn, these alliances create innovative administrative strategies, infrastructures, and partnerships with non–doctoral-granting institutions, including many minority-serving institutions, to enhance recruitment, retention, and advancement.

In 2014 NSF funded an AGEP program in Alabama entitled the Tuskegee Alliance to Forge Pathways to Academic Careers in STEM (T-PAC). The Tuskegee Alliance is composed of two HBCUs—Tuskegee University and Alabama State University—and a predominantly white institution, Auburn University. The project was designed to develop, implement, study, and evaluate a model

of STEM education focused on underrepresented minority students who are U.S. citizens across the three partner institutions. T-PAC's goal is to eliminate barriers and engage underrepresented minority STEM graduate students in strategic interventions and practices that will result in their completion of STEM doctoral programs and transition them into STEM faculty.

Melody Russell, associate professor of science education at Auburn University and one of the principal investigators of T-PAC, said that the program was designed to investigate factors that impact career selection and perceived self-efficacy for URM STEM graduate students. In addition, the program examines how persistence, interest, motivations, and expectations influence students' science identities as well as their STEM identities. Multiple interventions were part of the project: online mentoring using social media platforms, online tutorials on STEM content, online comprehensive examination preparation, online graduate courses, a literature search and technical writing activity, research experiences in STEM at host alliance institutions, a STEM research exchange program, online graduate school proposal development, an online teaching experience, and future faculty programs. The T-PAC program consists of 18 NSF T-PAC scholars who participate in the program activities/ interventions to promote their professional development and better prepare them for STEM faculty careers. Specifically, scholars engage in various online platforms designed to promote communication and collaboration as well as allow T-PAC scholars to share their successes and engage in scholarly activities with STEM faculty across the three collaborating institutions. Moreover, a STEM research experience allows T-PAC scholars the opportunity to visit the research labs across the collaborating institutions where they have a chance to meet with STEM professors in the various departments.

The T-PAC activities/interventions have been examined in light of the following three research questions:

1. What factors impact STEM URMs who are U.S. citizens' decision to pursue careers as STEM faculty at Historically Black Colleges and Universities (HBCUs) and Traditionally White Institutions (TWIs)?
2. What factors determine STEM identity development for URM STEM U.S. citizen graduate students?
3. Does STEM identity impact career choice and academic outcomes for URM U.S. citizens in graduate programs across STEM disciplines?

This project also investigates the role STEM identity may play in career selection for URM STEM graduate students, Russell pointed out. The T-PAC program proposes a STEM identity model based on the role perceived self-efficacy, positive academic self-concept, levels of motivation, and persistence play in persistence and cancer selection in STEM. Moreover, the program examines the relationship between self-efficacy, motivation, and STEM identity relative to STEM graduate students' career selection.

Russell leads a research team that has collected qualitative and quantitative data to determine the ways in which the aforementioned factors influenced underrepresented minority students' STEM identities, drawing a participant pool from all three institutions. The first phase of data collection

included quantitative data analysis of 109 participants assigned to one of several groups based on various factors: minority status, underrepresented minority versus non-underrepresented, current experience, and course work versus independent research versus writing of thesis or dissertation.

The data revealed that only two of seven factors yielded statistical effects. The first factor influencing student identity was self-confidence. From course work to research to writing, underrepresented minority students exhibited lower self-confidence and academic potential across all primary activities than did their majority peers. While underrepresented minority students perceived courses and exams as less challenging as they progressed through the STEM pipeline, confidence in their capacity to perform well on examinations was still lower than among their peers.

The second influence was student self-evaluation. Generally, students had more positive self-evaluation as they progressed through the program. At the research stage, underrepresented minority students had more positive self-evaluation than at the course work or writing stage, unlike the other students, who consistently perceived their performance throughout. Underrepresented minority students perceived teacher standards as reasonable regardless of the activity, while majority students perceived them as higher during course work than any other stage. While underrepresented minority students did not perceive their academic capacity as lower or the demands of the program as higher, they used external indicators of their capacity, rather than their levels of self-confidence, to self-evaluate. The second phase of the research includes a qualitative data collection methods (individual/semi-structured and focus group interviews) for URM STEM graduate students across the three institutions.

Thus far, the T-PAC program has had a positive impact on T-PAC scholars based on the external evaluator's report, Russell concluded, and is moving toward achieving its goals. In the future, the T-PAC program would like to involve more URM STEM graduate students as T-PAC scholars and recruit more faculty mentors, to enhance its mentorship program, and provide more access to resources that prepare graduate students for STEM faculty careers.

THE IMPLEMENTATION OF A STEM PRE-PROFESSIONAL WORKSHOP SERIES[1]

Morgan State University is one of only four Carnegie-classified doctoral research institutions in Maryland, with an enrollment of 7,725 students. Currently, 45 academic programs lead to bachelor's degrees and 39 academic programs lead to master's and doctoral degrees. STEM majors are housed in one of the three colleges or schools. Electrical engineering majors, civil engineering, and industrial engineering are housed in the School of Engineering; psychology majors are housed in the College of Liberal Arts; and biology,

---

[1]Contributors to this work include Anita M. Wells, associate professor, Department of Psychology, Morgan State University; Dawn McNair, associate professor, Department of Mathematics, Johnson C. Smith University; and Clytrice Watson, interim dean, College of Mathematics, Natural Sciences, and Technology, Delaware State University.

chemistry, mathematics, and physics majors are housed in the School of Computer, Mathematical, and Natural Sciences.

When students enroll at Morgan State, they are required to take a placement exam: 54 percent of entering students are placed into developmental mathematics and 52 percent are placed into developmental reading, while 47 percent of incoming STEM majors are placed into developmental mathematics and 53 percent are placed into developmental reading. As at other HBCUs, STEM majors at Morgan State are required to successfully complete calculus or a comparable math course before they can matriculate through the remainder of their major's courses. Students who are unable to pass these courses in a timely manner can become discouraged, resulting in them switching to a non-STEM major. Despite these difficulties, 37 percent of MSU STEM majors report on exit surveys that they plan to pursue STEM graduate degrees following graduation. The data demonstrate that Morgan State produces competitive STEM majors who aspire to join the STEM workforce,

Very little scientific literature details effective ways to prepare undergraduates for the STEM graduate school application process, said Amber Hodges, associate professor in the Department of Psychology. Moreover, the research that does exist suggests that while students are aware of the primary criteria required to attend or apply to graduate school, they may not be aware of the secondary criteria required such as letters of reference, personal statements, and other co-curricular activities.

Therefore, to promote graduate school readiness, Hodges developed and implemented a STEM Pre-Professional Workshop series to help students successfully navigate the STEM internship and graduate school application process. This unfunded program supports a three-tiered process that includes robust retention efforts and several federally funded student research training programs.

STEM Pre-Professional Workshops at Morgan State University are held monthly. Topics include pursuing research internships and graduate programs, crafting a personal statement, networking and marketing oneself, and asking for letters of recommendation. Generally, 20 to 30 students attend each workshop. STEM faculty and directors of research programs encourage students to attend, and the workshop series is open to all students. The workshops are not targeted specifically toward freshmen, although underclassmen are encouraged to attend, since early exposure facilitates successful STEM program applications.

Students who previously participated in the workshop series reported they had an enhanced understanding of graduate school culture, readiness, and the cultural shifts in transitioning from an HBCU to a predominantly white institution. Many reported that attending the workshops provided the tools needed to successfully apply and be accepted into STEM internships. Recently, the program has used formal assessments to evaluate the overall workshop series effectiveness, with the first assessment administered before the workshop series and the second administered following the workshop series. Assessments were also administered to measure STEM efficacy, STEM persistence, and STEM career aspirations of workshop participants. Addi-

tionally, a pretest and posttest were given before and after each workshop, respectively, to determine the effectiveness of individual sessions.

Demographic information collected from the participants showed that almost 80 percent of students attending the workshops have GPAs between 3.0 and 4.0. One-third of the students who regularly attended the workshops also actively participate in some type of research experience or program. Finally, while some participants have already had some professional development, they still reported that the particular workshop series is beneficial to their success.

Overall workshop pretest data showed that prior to the workshop series the mean STEM efficacy reported by participants was 4.4 on a scale of 1 to 5, meaning that students had a strong sense of STEM efficacy before participating in the workshop series. However, STEM career aspirations averaged 3.8. This lower score may be partially due to biology and chemistry majors who are still deciding between pursuing a PhD or MD. STEM persistence averaged 4.2.

Participants were presented with four statements on each workshop content pretest and posttest and were asked to indicate agreement or disagreement with the statements by responding between 1 and 4. Scores for each pretest and posttest were summed and ranged between 4 and 16. Students who attended the workshop entitled "How to Identify and Select STEM Internships and Graduate Programs" averaged a score of 15.22 on the pretest for this workshop, indicating students generally were confident in selecting STEM internships and graduate schools. However, after participating in the workshop, students' response average increased to 17.58, revealing that they gained confidence and skills through the session.

Students who attended the second workshop, entitled "How to Craft a Personal Statement," averaged an overall score of 12.13 on the pretest, suggesting that students were neutral and unsure whether they had the proper skills. By the end of the workshop, students averaged 16.53 on the posttest, which demonstrated that students felt they gained the tools and knowledge to succeed.

The next steps for the program will be to collect data for two more workshops in the academic year. Then the posttest will be distributed for the overall workshop series, and those data will be compared with the data received on the pretest. Hodges expects to see increased STEM efficacy, STEM career aspirations, and STEM persistence, increased knowledge and understanding of STEM graduate school readiness content, and a positive correlation between students who attended the workshop series and those who successfully apply to STEM graduate programs and internships.

THE CALIFORNIA AGEP-T ALLIANCE

The California Alliance for Graduate Education and the Professoriate, which consists of the University of California, Berkeley; the University of California, Los Angeles; Stanford University; and the California Institute of Technology, was established to ensure that much larger numbers of underrepresented minority PhD students from alliance institutions aspire to and populate the ranks of the postdoctoral population, the faculty at competitive

research and teaching institutions, the federally funded national laboratories, and scientific think tanks. The alliance is specifically focused on increasing diversity in academic fields with the greatest national underrepresentation of minorities: the mathematical, physical, and computer sciences and engineering. These fields are "the very toughest nuts to crack, if you will, in terms of diversity," said Mark Richards, professor of earth and planetary science at UC Berkeley and principal investigator of the California Alliance.

The California alliance produces a disproportionate number of graduate students who go on to be faculty at leading institutions. However, the numbers of underrepresented minority students remain disproportionately low. While the California alliance is responsible for educating about 10 percent of PhD students across the country in mathematics, statistics, physics, astronomy, chemistry, earth science, computer science, and engineering, only 8 percent of underrepresented minority PhD students at the four institutions are in STEM fields.

The alliance hopes to accomplish five major goals:

1. Create an unprecedented community of practice across the four alliance institutions that includes graduate students, postdoctoral fellows, faculty, and key administrators.
2. Engage faculty as mentors to advance underrepresented minority students' careers across the four institutions.
3. Set new standards for professional development.
4. Promote the advancement of underrepresented minority students to faculty and postdoctoral ranks in STEM through new partnerships and using new tools.
5. Conduct research that leverages the architecture of the alliance to identify factors related to underrepresented minority students' success and professional ascension within STEM.

The program has five major components: retreats, a postdoctoral program, a mentor-matching program, a professional development matrix program, and institutional research. For example, retreats have facilitated many mentoring relationships and collaboration among faculty and students at various institutions. The mentor-matching program allows advanced graduate students close to graduation to visit another mentor's group for a week or two and get to know the students and the work. So far the Alliance has made 25 matches, mainly in engineering and the physical sciences. One student who traveled from UCLA to Berkeley was asked to return and is now publishing a paper with another student.

Through the California Alliance, the four institutions advertise postdoctoral positions specifically targeted at underrepresented minority students. Any applicant is considered by all four institutions. The first year of the program attracted a large applicant pool from which ten students were awarded postdoctoral positions. While NSF only supplied funding for ten two-year postdoctoral positions over the entire duration of the project, the institutions found additional donors to fund more students. No administrator can say, "Oh, we would like to have more underrepresented postdocs if we could just find highly qualified underrepresented candidates," said Richards. A

thorough search reveals many promising candidates so long as the resources can be found to support them.

Rodolfo Mendoza-Denton and Colette Patt at UC Berkeley led an institutional research project to assess the effectiveness of the nine interventions. On a 45-minute online survey that solicited 972 responses, men felt better than women about aspects of the program, with a gender gap of between 15 and 20 percent. White men were doing particularly well on measures of status while women were about 20 percent lower in their self-reports. Asian Pacific Island and Asian women were the least happy of the graduate students. However, underrepresented minority students, as a whole, did not differ much in their feelings and attitudes about being graduate students compared with their majority counterparts.

The next major project will be to survey the professional development portfolios for all four institutions and create a bulleted matrix to learn what each institution is doing and how they can learn from each other. The results will be a comprehensive web-base resource that is envisioned as a tree, with the branches of the tree representing different career paths for STEM PhDs. Students can click on a branch to explore different programs and pathways and to find more information.

THE CIC PROFESSORIAL ADVANCEMENT INITIATIVE

The Committee on Institutional Cooperation (CIC) is an academic consortium founded in 1958 that includes the University of Chicago, the University of Illinois, Indiana University, the University of Iowa, the University of Maryland, the University of Michigan, Michigan State University, the University of Minnesota, the University of Nebraska–Lincoln, Northwestern University, Ohio State University, Pennsylvania State University, Purdue University, Rutgers University, and the University of Wisconsin–Madison. Through its AGEP alliance, the CIC hopes to cultivate a mentoring-based professorial advancement initiative for underrepresented minority postdoctoral fellows and train a new generation of exceptionally well prepared scholars. The consortium produces about 15 percent of the PhDs currently in the United States each year in 147 areas of study.

Currently in its third year of AGEP funding, the CIC project focuses on underrepresented minority postdoctoral fellows mentoring. In addition, the consortium is working to educate faculty and faculty research committees about university hiring, training, and educational research. "We do it through a community of peers," said Aman Yadav, associate professor in the Educational Psychology and Educational Technology Program at Michigan State University. "We meet together to address common issues and share best practices." The program aims to find ways to reduce subtle bias in a sustainable process that will last beyond the four-and-a-half years of AGEP funding.

CIC's main activities involve small group mentoring. Currently, 61 postdocs across 11 schools are involved, 56 CIC faculty serve as mentors and 218 faculty have had training and have participated in diversity workshops for faculty hiring committees. The consortium has a job posting booth for mentors not only from within CIC but also from other institutions. Weekly calls with

students allow continuous feedback about everything from research to teaching. The team is also working on developing interactive professional development webinars as well as workshops for postdocs. Face-to-face workshops and training programs are conducted for faculty and committee members. In diversity training workshops, faculty members watch video case studies with hypothetical scenarios on unconscious bias. A discussion with the 20 to 40 faculty members in attendance around the videos is led by a training team.

Extensive qualitative interviews have been conducted within the CIC to understand what kind of professional development experiences, webinars, and workshops need to be provided to enhance faculty diversity. Three major concepts emerged from these interviews: students' experiences as underrepresented minorities in STEM fields, the challenges that they thought existed for them in entering academia, and the support that they felt they had received throughout the process. Students described how few other students were like them in STEM fields so that they always had to prove that they belonged. They discussed having different experiences than their peers and juggling different priorities. Most were the first in their family to pursue a PhD, and their family members found it difficult to understand why they had to work on the weekends or were unable to travel. Some discussed the challenges of mentoring and how collaborating with undergraduate students can be exhausting when trying to develop their own work. Nevertheless, participants felt that they were well supported in the program and that they received useful feedback from mentors and collaborators in their postdoc positions.

On a separate survey designed to assess science self-efficacy, science identity, general belonging, and a discipline-specific sense of belonging, results indicated that participants' lowest efficacy was in their abilities to develop theories, analyze data, and write reports about research results. Participants were more concerned with obtaining a faculty position than gaining experience. Among these postdocs, only 15 percent felt very confident about their future career, 30 percent felt confident, and 55 percent felt somewhat confident. The majority of participants emphasized the importance of two key skills: having independent research plans, and professional involvement. Professional development skills included the writing of grants, manuscripts, and high-profile publications.

In response to these concerns, the CIC invited a journal editor to talk about the process of writing and how to get published. In addition, 50 to 60 postdocs have come to Chicago to participate in grant-writing workshops.

In 2015, CIC institutions hired 52 underrepresented minority faculty in STEM fields, twice the number hired in prior years. The CIC also has begun to work with community colleges around the Midwest to enlarge the network of collaboration. The more the consortium can understand the issues minority students' face, Yadav concluded, the better prepared it will be to create a supportive pathway reflective of a diverse population.

PROMISE AGEP

PROMISE AGEP consists of 14 colleges, universities, and regional education centers in the University of Maryland system, four community colleges,

and a Hispanic serving institution in Puerto Rico that has been an NSF Model Institution of Excellence. The program received AGEP funding in November 2002, and programs began in 2003. Between 2002 and 2008, the program went through a series of different funding streams, with a focus on increasing the enrollment, retention, and graduation rates of underrepresented minority students.

Initially, two sets of studies were conducted by two research teams. A team from the College of Education at the University of Maryland, College Park, examined in-depth case studies to analyze micro-affirmations and micro-aggressions and their roles in student success. A second team, which surfaced from the administrative department, included Renetta Tull, who was co-principal investigator for PROMISE AGEP and Associate Vice Provost for Graduate Student Development and Postdoctoral Affairs at the University of Maryland Baltimore County (UMBC). This team examined how Seymour Sarason's psychological sense of community (PSOC) played out in the university setting. Sarason's theory identifies four contrasts that influence a person's feelings of belonging: membership or influence, reinforcement and integration, fulfillment of needs, and shared emotional connection. These factors became the backbone of PROMISE AGEP.[2]

The program focuses on professional development and does not include fellowships for graduate students. All students who attend the program are provided with professional development, although the data are disaggregated based on racial groups, ethnic groups, gender, and discipline. The program also provides many services outside of traditional academic seminars and academic departments. Approximately 42 events are held per year at various universities and in such spaces as retreat sites or hotels. These events include a Dissertation House, where students work with each other and with a coach on their dissertations, and a Summer Success Institute, which is a two-day session in the summer where different mentors return to empower students. Both these programs have been replicated and scaled at institutions in the United States and Latin America.

PROMISE AGEP also features a rotating postdoctoral fellowship and professors in training program. Students can attend holistic workshops on developing financial literacy, psychological well-being, and career–life balance. Each of these programs employs the four primary aspects of PSOC to foster a sense of community and belonging among participants.

At the end of each session, the 60 to 200 students are given a survey that includes the following questions:

- Was this a good investment of time?
- Would you recommend this to other graduate students?
- Does this event provide or promote a sense of community?
- Are you receiving this information from other sources?
- Did you learn anything new from this event?
- Do you feel mentored by faculty or staff who attended this event?

---

[2]McMillan & Chavis (1986).

STEM identity in research is connected to performance and recognition, Tull noted. Mentoring and collaborative projects give students opportunities to be recognized as scientists. One group of students working on their dissertations said, "We want to have #teamgetitdone as our hashtag for our dissertation so that we can all work together." They made shirts, and the hashtag became a symbol of their team effort. Every year at the end of commencement, a member of the staff holds the PROMISE flag and waves it while standing in front of the Administration Building. Students are invited to have their picture taken with the flag, and many are enthusiastic about this visual symbol of united involvement. Even if students take a break from their studies, the program invites them to stay involved in the campus community.

Through these and other collaborative and interactive measures, PROMISE AGEP has contributed to influencing policy and institutional change around STEM recruitment and retention through the academic pathway to tenured faculty.

A HACKING INTERVENTION FOR
GRADUATE STUDENT RETENTION

Tull went on to note that mentoring seminars for graduate students often employ lecture or panel formats to disperse information. PROMISE AGEP, the NSF-sponsored Alliances for Graduate Education and the Professoriate in the University System of Maryland, decided to take a new approach. Each August, PROMISE holds an annual conference for graduate and postdoctoral students called the Summer Success Institute. A diverse group of mentors, residents, and faculty attend national development workshops and seminars during the one- to two-day event. Students often refer to the event as the graduate school pep rally, and it has been held for more than ten years. The Summer Success Institute is always held before the semester starts to promote incoming student success.

In 2015 PROMISE developed an intervention for the Summer Success Institute that used a crowdsourcing method to mentor underrepresented graduate students in STEM fields. #ThinkBigDiversity wrapped a mentoring workshop into a technology hacking-inspired, design-thinking package that borrowed elements from hackathons in computer science fields. Computer science hackathons are multiday events where a problem is posed and small groups meet to discuss solutions. Sometimes these teams might be trying to develop an app; sometimes they might be working to tackle a social issue. These events are dynamic, interactive, and exciting. Everyone has laptops, and collective knowledge is used to find a solution. PROMISE AGEP used this approach to foster faculty mentoring, peer mentoring, and self-efficacy. The intervention's structure was based on theoretical frameworks that included the psychological sense of community, alternative or third spaces, STEM identity, and cultural capital.

Crowdsourcing determined the target audience—in this case, graduate students and postdoctoral fellows. Individuals were broken into three groups: incoming students with no graduate school experience who were about to matriculate in one week, continuing graduate students ranging from one year of graduate study to PhD candidates, and postdoctoral fellows and alumni.

The postdoctoral fellows group also included members from various university and corporate senior-level administrative ranks. These groups were sent to separate rooms, where they tweeted possible solutions for graduate student retention. Faculty, administrators, or independent STEM professional development consultants acted as guiding mentors in the groups.

Participants were instructed to use the twitter hashtag #ThinkBigDiversity in responding to questions asked during the event. The hashtag was a spinoff from computer scientists who have a concept called "Big Think." All were asked to consider how social media can be used to engage students in the issue of graduate student retention. Participants were encouraged to think about different questions that could be generated from challenge areas. "There's a problem and people come and give their ideas to this problem to come up with some kind of solution," said Tull. Mentors gave advice to students in real time, and students work together to put their thoughts on Twitter. Between July 1, 2015, and November 1, 2015, #ThinkBigDiversity generated 913 tweets. This time period encompassed publicity prior to the one-day event, responses that were tweeted during the event, and STEM diversity-based comments that continued after the event.

The study particularly examined 66 tweets contributed by the first group of incoming students. Tweets were analyzed using qualitative content analysis to make inferences from the text. A coding schema was developed where categories were independently defined and grouped and inter-rater reliability was ensured. The 66 tweets were broken into three categories based on subject matter: time management, isolation and family expectations, and obligations to community. "Time is your currency. You are the ones who decide on whom, what, where, and when you spend it," Tull said. These decisions are not easy, especially when students face them without external advice and support. The tweets generated possible solutions to these problems, which were broken into themes, including mindful engagement in face-to-face activities, developing accountability systems, and joining organizations with diverse members and similar interests.

The event used a software package called Tint Up that allows users to view a whole screen full of different tweets with the same hashtag at the same time. External mentors joined online to answer questions. As part of this online community, students fulfilled the membership requirement of Seymour Sarason's psychological sense of community.

#ThinkBigDiversity helped reduce isolation and foster opportunities for students to ask candid questions, receive individual mentoring, and develop accountability, Tull concluded. Students' cultural capital was valued as they communicated such ideas as personal sharing and aspirations. The program helped reinforce the importance of engaged development and long-term goals as key aspects of STEM identity.

DEVELOPING SAFE SPACES DURING A COACHING INTERVENTION

Activities that facilitate intergroup dialogue and the development of safe spaces can increase persistence among graduate students by validating their

experiential reality, thus fostering a sense of belonging and promoting inclusion. But safe spaces can be difficult to create. An ideal safe space is a place where anyone can relax and fully express oneself without fear of being judged or challenged on account of one's identity. However, few studies have been conducted to determine the best facilitation styles to create a more productive, accepting environment. A team at Northwestern University decided to tackle this question by designing an objective study to qualitatively determine coach facilitation styles associated with safe space indicators during a difficult conversation on race in science.

Four years ago, the team developed a coaching group model to supplement traditional research mentoring. A group of 100 biomedical PhD students were divided into coaching groups. Each coaching group was randomly assigned to have an equal number of men, women, underrepresented minorities, and non-underrepresented minorities. A senior faculty coach in the biomedical sciences led each group. Students and coaches were not affiliated with the same academic institutions, and the coaches received specific social science theory training before leading the students. These academic career coaches were not mentors and were not responsible for evaluation or associated with student research. "In this way, they are able to provide independent unbiased advice, and they can also leverage the support from students in their coaching groups," said Veronica Womack, a social psychologist with the Scientific Career Research and Development Group led by Rick McGee at Northwestern University.

For three years the groups met in person once a year. In between meetings, the coaches led virtual sessions. Virtual engagement was conducted through emails or conference calls. Members were encouraged to maintain contact with their groups as well as the coaches. During the second of the three annual meetings, an African American male social scientist with expertise in critical race theory held a session on systematic and interpersonal factors that affect the experiences of Black and Hispanic students. Systemic factors include institutional racism, where the institution targets and discriminates against a certain group based on race, and interpersonal factors, where individuals interact with others in discriminatory ways. The lecturer described race as "biologically false and socially real." He told students that they do themselves a disservice by not explicitly talking about discrimination. Science is a socially constructed system. Thus, factors of race play a major role in the scientific world.

Transcripts were created from the group discussions and from interviews with the coaches who led the discussions. These in-depth annual interviews were conducted with coaches six months prior to the academy meeting. A lead researcher read the transcripts to determine coach facilitation and safe space factors. Several indicators helped identify coach facilitation strategies, including the approach to building group relationships, the type of virtual group engagement, and group facilitation strategies during discussion. Coaches' tactics to develop a safe space were also broken down into indicators: coach-generated multiracial discussion on racial diversity or race-related experiences, student-shared anecdotes, and discussion among students. The researcher noted whether the content of the anecdotes and discussions were

race related. The occurrence of both sets of indicators were tallied for each coaching group, and the data were assessed to detect patterns between coach facilitation and the construction of a safe space.

Results revealed that the coaches' approaches to building group relationships and virtual group engagement were not associated with safe space indicators. However, the two coaches who did not generate a multiracial discussion on race-related experiences had the only discussions in which an underrepresented minority student did not share a race-related anecdote. These coaches talked about their personal experiences with otherness before soliciting the experiences of students.

The five coaching groups that had student-to-student, race-related dialogue each had a coach that built off students' responses by sharing an example or statement that reinforced and acknowledged a student's position. For instance, during the discussion, an African American female said, "People think certain groups aren't intellectually capable of contributing and are there due to affirmative action. I think in the back of our minds we have thoughts about how people are or should be, and then maybe there's an exception to the rule. . . . I don't usually talk about these things. It makes me very uncomfortable because I don't talk a lot." The coach responded by acknowledging the importance of the student's perspective, emphasizing that the group's discussion was a different environment where everyone was encouraged to be open and honest with one another. Then he asked her to continue to talk, and she opened up to the group about more of her experiences.

The study found that coaches' comfort with generating a student-focused discussion on race following a difficult conversation was a better predictor of safe space development than coaches' strategies to build group relationships or their mode of communication prior to discussion. This means that different approaches can be used to establish positive group dynamics and engage in difficult conversations. However, the study revealed that certain strategies can be used to help students feel more comfortable in a space. For example, focusing on students' experiences and affirmation of those experiences help students feel validated and valued.

Interviews were conducted six months after the meeting to ask students whether their participation had caused them to reinterpret their experiences in terms of gender, race, or social economic status. One student responded, "This year I tried to make an effort, whenever there was an issue of race and gender, to not just keep it in that particular race or gender but to bring it to everyone at the student level. Because change can only happen if everyone is thinking about it. It can't work if it is confined just to one group."

ARE MASTER'S DEGREE PROGRAMS A GOOD INVESTMENT?

Underrepresented minority students are often unable to afford the high costs of PhD programs. Since 1992, San Francisco State University (SFSU) and California State University, Los Angeles (CSULA), have received funds from NIH to support master's students in their training and workforce development programs with the goal of preparing them for PhDs in the biomedical and behavioral sciences. The costs of these programs have proved worth-

while. Over 550 students have received master's level funding for at least a year, and among these 418 have entered PhD programs, 216 of whom have received their PhDs and 159 of whom are currently in pursuit of their PhDs. Of the 418 students who entered PhD programs, 181 (43.3 percent) had undergraduate GPAs below 3.0. The program's 90 percent completion rate is a significant improvement over the national rate of 59 percent. But why were these students so successful, asked Frank Bayliss, professor at SFSU and director of the Student Enrichment Opportunities Office at SFUS.

Both institutions collected data regarding students' backgrounds and academic history to determine the answer. The data suggested that most of the students came from disadvantaged situations compared with most students who receive PhDs in science. These students tended to have low socioeconomic status, less than stellar undergraduate performance, and no immediate family with PhDs. But, by fully funding these students, they are able to focus on their studies and are given the opportunity to succeed, Bayliss said.

The master's programs at SFSU and CSULA and their mentorship structure, research opportunities, and connections to the two institutions create an environment of critical mass for underrepresented students. Students who enter the master's program in preparation for their PhDs often have different backgrounds than those entering for a terminal degree. Some have no research experience; some have no idea what to focus on. In the intervention, students have the chance to tighten up and narrow their focus through course work and experience. "They need to be in a graduate program with a lot of rigor, and a lot of high performing students," said Bayliss. If all the students in the program entered with GPAs below 3.0, the program would not work; context is key.

Students enrolled in the program meet weekly with a senior faculty member for the duration of the two-year program. They are encouraged to go to scientific meetings, be disciplined in their studies, and work toward publication. While writing their thesis prospective, students are required to take a rigorous scientific writing course. Recruiters are faculty in STEM disciplines, often on admissions committees. During a three-hour afternoon period, students meet with recruiters for fifteen minutes each to gain critical connections and information. Mentoring reaches beyond the individual to the program level.

Between 1980–89 and 1990–99, of the 650-MS master's students at SFSU, only 25 were underrepresented minority students. After NSF and NIH funding, the number of underrepresented minority students rose to 59, representing a marked improvement. Between 2009 and 2013, over 40 percent were underrepresented minorities, with an average of 16 master's thesis students going for doctorates each year. In 2013, 28 of the 54 master's students were minorities (and 22 were underrepresented minority students), a majority minority graduating class. Seventy percent of the students admitted into the program were first generation, 43 percent had a GPA below 3.0, and 68 percent had a GRE composite score less than the 50th percentile, with a 46 percentile average overall. These admittance statistics were below normal admission thresholds. However, many other criteria factored into the admissions process, including letters of recommendation, research experience, and

publications. Students come from a wide variety of undergraduate institutions, including the California State University and the University of California systems and some HBCUs.

To determine whether low-scoring students fared as well as their peers, 35 students in the program with an undergraduate GPA of 3.0 or higher were compared with 35 of those with an undergraduate GPA below 3.0. The PhD completion rates were identical between groups, and completion rates are expected to continue and even improve in the years to come. "I see a lot of PhD programs talk about holistic admissions," said Bayliss. "They are looking at people beyond their GREs and beyond their GPAs and trying to look at them as a whole. We've been doing this for 30 years, and it works."

According to the National Science Foundation, the average time in the United States from a BS to a PhD degree in the life sciences is 6.9 years. Among the students entering the intervention with a GPA lower than 3.0 at SFSU and CSULA, the time from BS to MS to PHD averaged 6.7 years, and they have 0.8 more publications than their PhD peers. On average, students in the program completed their master's degrees with high GPAs. These students are going on to attend high-caliber institutions like Stanford, Harvard, the University of Washington, and Berkeley, where the PhD GPAs were higher than at their master's institutions. Students are going into postdoctoral fellowships, career positions, biotechnology firms, various industries, and faculty positions.

The success of these programs has important consequences for NIH and other funding agencies that wish to increase the representation of students from underrepresented minority backgrounds in doctoral-level careers, particularly because many of these students would not conventionally be seen as ready for a doctoral program immediately upon graduation from an undergraduate institution, Bayliss concluded. Though the RO1 grant to study the programs has ended, the studies continue, funded in large part by the existing MBRS RISE program. Resources need to be gathered and programs like the ones at SFSU and CSULA need to be expanded tenfold, said Bayliss. Otherwise, large numbers of students with the potential to succeed are being overlooked.

OVERLOAD AND BURNOUT: THE CONTRIBUTION OF MENTORING

Burnout is a type of psychological stress characterized by exhaustion, lack of enthusiasm or motivation, feelings of ineffectiveness, and possible dimensions of frustration or cynicism that result in reduced efficacy within work, said Shine Chang, professor in the Department of Epidemiology and director of the Cancer Prevention Research Training Center at the University of Texas MD Anderson Cancer Center. Many responsibilities shouldered by faculty in academia, including mentoring, are required for career success. However, overwhelming responsibilities threaten success when a faculty member burns out. The role in faculty overload and burnout of mentoring has not been previously evaluated but has ramifications for interventions to improve mentoring quality and faculty performance and satisfaction, observed Chang.

The Maslach Burnout Inventory developed in 1981 by Christina Maslach and Susan Jackson is the gold standard for measuring burnout. It incorporates 22 measures of burnout, including emotional exhaustion, depersonalization, and personal accomplishment.

However, when one of Chang's colleagues did a literature review on burnout, he found no research that focused on higher education academic faculty. People who were doing this kind of research focused on service sector professions like teachers, health care providers, and social workers. Some research from the 1980s seemed to suggest that older age and higher rank may be associated with less risk of burnout. But Chang realized that more research was needed to fill in the gaps because the contemporary landscape has changed.

Chang formulated a number of research questions to address in her study on burnout:

- What is the impact of overload and burnout on the quality of mentoring?
- Do overload and burnout influence the quality of mentoring in science and communication skills development?
- Do mentoring responsibilities influence the development of overload and burnout among the faculty themselves?
- Does self-efficacy in mentoring, mentoring in general, mentoring in research, and mentoring in scientific communication skills associate with an increased risk of overload and burnout?"

Overload was indicated by a mean score greater than three from a six-item version of Reilly's Role Overload Scale scored on a five-point Likert scale, with one corresponding to strongly disagree and 5 corresponding to strongly agree. Items included, "I have more things to do and I don't really have the time and energy to do them," "I need more hours," "I can't ever seem to catch up," "I never seem to have time for myself," "I can't meet everyone's expectations," and "I seem to have more commitments to overcome than other people."

Self-efficacy measures included five questions on a scale from one to five, from not at all confident to very confident. Participants rated themselves on being able to give good guidance and instructions, successfully teach, give strong scientific presentations, and ensure that trainees talk effectively about their research in conversations. Two questions involved self-efficacy in research, tutoring, or mentoring.

Altogether, 146 faculty mentors participated in the study, 56 percent of them women and 12 percent underrepresented minority faculty. More people worked in the basic sciences than in the clinical sciences, and the mean age of the group was 45 years old.

Over a third of the participants felt burned out, and 86 percent reported overload. Only one person reported being burned out but not being overloaded. The more postdocs a person mentored, the less likely they were to feel overload. In contrast, the more doctoral students a person mentored, the

more likely he or she was to record high overload. Additionally, participants with higher research self-efficacy were less likely to experience burnout. Junior colleagues were significantly more likely to experience overload. The study found no differences in gender, race, or mentor experience in overload and burnout.

In the future, the study aims to conduct more longitudinal data analysis asking the same questions. Initial findings suggest that graduate students may require more nurturing than postdoctoral fellows, which might explain some of the relationships between mentoring, burnout, and overload for faculty. Faculty self-efficacy in meeting the unique needs of trainees at different ranks may influence faculty well-being, with critical implications for how they manage and choose responsibilities, including the types of trainees to mentor. Although a lack of influence in analysis of the years of mentoring on overload and burnout implies that experience gained over time does not reduce risk, the analysis did not account for the potential benefit from teaching faculty mentoring skills, which has also been demonstrated to have value.

THE NEXUS BETWEEN AFRICAN AMERICAN DOCTORAL STUDENTS' SOCIALIZATION TOWARD AND PERSISTENCE IN STEM

For a span of ten years, the Alliance for the Advancement for African Americans in Computing (A4RC) has aimed to graduate African Americans in computing fields through the doctoral level. One of the main components of the program is to partner students from historically black colleges and universities (HBCUs) with research one institutions. Students have the opportunity to participate in undergraduate research experiences in the laboratory while collaborating with faculty from these institutions.

One of the main focuses of the project, in addition to the research experience, was to allow undergraduates to enter the socialization process. Students at research one institutions often have the opportunity to create a bridge to a graduate degree or graduate learning at that institution. Relatively few STEM doctoral recipients stay in academia, which creates a lack of diversity at the faculty level and could play a role in minority attrition rates. This lack of representation from diverse backgrounds, particularly among African Americans, can stifle growth and innovation, said LaVar Charleston, assistant director and senior research associate at Wei LAB, University of Wisconsin–Madison.

In many of his studies, Charleston has found that self-efficacy is a mobile construct. Most of the students who do not persist in graduate degree attainment, particularly in STEM fields, have earned undergraduate STEM degrees. In each educational stage, self-efficacy needs to be reestablished. The research literature suggests that faculty, as a distinct reference group to college students, help shape students' perception of college through advanced engagement and interactions. For African American students, interactions with faculty might be an even larger predictor of persistence in STEM fields and future plans after graduation, as their opportunities for developing social

connections with professionals in STEM fields are limited. As underrepresented minority students, African Americans are more likely to experience discrimination, feelings of isolation, and low expectations. Having individuals who are professionals in a field believe in them and their abilities is critical to future development, providing them with more exposure to research opportunities, information about graduate school, social capital in academia, application strategies related to research statements, curriculum vitae writing, and even interviewing strategies.

A recent study at the University of Wisconsin–Madison investigated whether increased interactions with STEM faculty in college affects African American students' persistence toward graduate study, particularly within the computing sciences. Study hypotheses predicted that interactions with faculty members would help African American students ameliorate the negative stereotype about scientists and that interactions with faculty members would promote African American students' willingness to pursue graduate study in STEM fields.

Two theories informed the theoretical framework in thinking about the socialization process for African Americans in the computing sciences. The first was Tinto's model of student integration, which deals with the importance of a student's engagement and understanding of the scholarly culture at a particular institution. Social integration, engagement in communal elements of institutions, and peer connections can reduce feelings of isolation. Many African American students lack a sense of belonging at institutions of higher learning. By engaging in undergraduate research experiences, African American students can create a greater sense of belonging, thereby improving graduate school persistence.

A4RC aimed to help students develop from an early stage the mindset of considering graduate education. The partnership between HBCUs and research one institutions allowed students to interact in both institutions on research teams. Students spent summers as part of research laboratories and participated in year-round programs at their host institutions. One-quarter of the program population was senior doctoral students, and 75 percent were first-, second-, or third-year doctoral students; 40 percent of the students attended HBCUs, and 60 percent attended predominantly white institutions.

Regression analysis revealed that a statistically significant factor around stereotypes was context and professors. Students who spent time in research opportunities had the chance to talk with individuals who had excelled in graduate school. These conversations were able to break down some of the barriers and myths about what it means to be in graduate school, how similar and dissimilar it is to undergraduate education, and the time spent on meaningful topics. In this context, the key opportunity was the chance to talk to advisors about the role that computer science can play in helping disenfranchised populations. On the surface, participants entered the program carrying many stereotypes of computer science. Through the program, students learned the vast possibilities offered by the field.

One interesting potential implication from the study is that having a mentor who can talk a student through challenges, share understandings, and

discuss the challenges of learning, research techniques, practices, and being new to a field can increase resiliency and persistence. "If institutions don't displace the ownership to themselves, then that is left upon the individuals to try to understand how they navigate an ecosystem that is largely homogenous," said Jerlando Jackson, Vilas Distinguished Professor of Higher Education and chief research scientist at the University of Wisconsin–Madison.

In the future, the researchers aim to analyze the differences in roles and outcomes to determine standard practices that best address this type of work. The challenge is to build productive faculty-student interactions across race and gender.

EXPLORING VALUE-CONGRUENT MENTORING AND GOAL SETTING

Successful mentoring relationships are those that are sufficiently aligned in several key areas, said Natasha Berryman, program manager at the Morgan School of Medicine. Mentors can be transformational leaders, collaborate with mentees to produce desired professional outcomes, and promote positive changes in mentees for the purpose of professional development, and mentees who have these types of mentors report higher motivation and career expectations for themselves.

Transformational leaders positively impact the development of self-concordance goals. "These types of goals are those that align with and are rooted in the authentic self," said Berryman. "They mesh with who we are, how we perceive ourselves, and ultimately what we want our future to look like in the long term."

The Exploring Value-Congruent Mentoring and Goal Setting Among Underrepresented Scientists project has used the degree to which mentors are transformational leaders as a point of departure for study of the mentoring relationship. The project has been interested in determining whether mentees are experiencing these types of relationships as they move along educational and career paths. It frames exploratory research with the following statement in mind: "Value-congruent mentoring is a transformational mentoring relationship in which the mentee–mentor pair is aligned on intended professional outcomes."

This statement leads to many interesting questions about characterization, self-concordance, and stereotype threat, Berryman observed. For example, stereotype threat can have a bearing on both the development of this relationship and how goals are set within it. As another example, mentors may perceive their mentees as having different career expectations than the mentees have for themselves, and vice versa.

The study explored two hypotheses: first, that value congruence varies by underrepresented minority status; second, that underrepresented minorities in these kinds of mentoring relations are more likely to set self-concordance goals than those who are not. The 550-person sample, drawn from Ruth L. Kirschtein National Research Service Award recipients from 1985 to 2010, attempted to oversample underrepresented minorities.

In addition to collecting CVs, participants were administered a survey with a series of professional development questions that asked about their current status, feelings, and goals regarding professional pursuits. Those finishing their PhDs were asked about career preferences to operationalize the idea of congruency in the mentor–mentee relationship. Participants' overwhelming response was that they sought tenure-track research-intensive positions. Dissertation advisors were loosely characterized as mentors, although this characterization may or may not be accurate.

Among participants who said they wanted a research tenure track career, results showed that 13 percent of mentors provided no advice at all. However, many more underrepresented minorities received no advice from mentors. Additionally, those minority students who wanted to pursue tenure track research careers were often advised by their mentors to pursue other avenues. Underrepresented minorities either were not receiving advice, or the advice they were getting was not consistent with the goals they had for themselves.

However, in the sample, minorities were much less likely to report that research was their primary interest above all other activities, despite their desire to pursue tenure track research careers. "Going back to self-concordance goals, if you are pursuing this type of research career, but research isn't your thing, why are you pursuing this?" Berryman asked. Perhaps, there is a misalignment in goals that these students are developing for themselves, and also in the way that mentors are discussing these goals with them.

Overall, the study found that 73 percent of mentoring relationships in sample were value congruent. However, 78 percent of non-underrepresented mentees were aligned with their mentors on intended professional outcomes, while only 53 percent of underrepresented minority mentees were aligned. Evaluators found that underrepresented minorities were less likely to set self-concordant goals compared with their non-underrepresented counterparts, even when in a value-congruent mentoring relationship.

The next phase of the study is to identify those people who say they strongly prefer research over other career responsibilities and determine how their goals align with those of their mentors. Of those minorities who say they want a research career, maybe they did not actually want to go into a scientific career, and somehow their mentors knew how to advise them in that other direction.

In the future, Berryman added, evaluators need to find out how and why minorities are falling through the gaps and not getting any professional advice. In relationships where mentors and mentees are congruent on preferred career choices, evaluators need to identify what is the motivation of the individual scientist. Mentees need to be questioned about motivations, science identity, and response to the challenge of not getting any advice from mentors.

8

Professional and Institutional Perspectives

This last chapter of the summary report for the 2016 Understanding Interventions conference looks at issues that arose in considering professional, institutional, and governmental perspectives. In its focus on retention in the computing sciences and linguistic analysis of grant proposal reviews, it demonstrates once again the great breadth and specificity of the subjects encompassed within the Understanding Interventions movement.

FACTORS THAT INFLUENCE WOMEN'S ATTRITION FROM ASTRONOMY AND PHYSICS

The Longitudinal Study of Astronomy Graduate Students followed a cohort of people who were graduate students in astronomy and astrophysics during 2006–08 in an effort to understand the gender differences in persistence and attrition for these fields. The first survey was conducted during 2007–09 and the second during 2012–13, when many of the respondents had finished graduate school and were in the workforce. Rachel Ivie, director of the Statistical Center at the American Institute of Physics, headed the project in cooperation with the American Astronomical Society.

The study resulted from the Women in Astronomy Conference in 2003, which noted that 60 percent of the younger members of the Astronomical Society at that time were women. The main question behind the study was: "Would women have higher rates of attrition from astronomy and physics than men?" Ivie and her team hypothesized that women would be more likely to work outside astronomy and physics, with the effect of being female occurring independently of other factors.

The longitudinal study included everyone in graduate school in 2006–07. At the time of the second survey, of about 800 respondents, 83 percent had

PhDs. For respondents who had completed their PhDs and were not post-doctoral fellows, the study tested effects of four possible sources of attrition from physics and astronomy: imposter syndrome, mentoring and advising during graduate school, work–family balance, and being female. Imposter syndrome, for example, measures how well people feel they fit into their fields. "Someone who has the imposter syndrome feels like they just got their degree through sheer luck; no one noticed how stupid they were," said Ivie. "They just showed up and kept doing things and suddenly they got a PhD. But someday somebody is going to find out that they don't really belong." On a measure of this factor included in the first survey, women reported higher levels of imposter syndrome than did men.

The study also discovered a "two-body problem." Women are more likely to have a spouse or partner who is also in astronomy, and the same is true in physics. With a dual career situation, it is difficult to predict the location of two people in the future and whether they will wind up in the same place.

The study determined three measures of the two-body problem for people who have been to astronomy and astrophysics graduate school. It asked: Have you ever relocated for a spouse or partner? Have you ever maintained different residence from family in order to work or study? Have you limited your own career options for someone else? Men were just as likely to respond positively to the third question as women. However, chances of having a two-body problem are greatly increased for women compared to men, the survey found.

The study also asked questions on advisor relationships. To the question, "Did you have a mentor other than your advisor in graduate school?" women were more likely to respond positively; 60 percent had a mentor other than an advisor. Results showed that advisors equally encouraged men and women to excel in research. However, advisors were more likely to encourage men in their career goals, give men adequate input, and discuss ideas with men.

The study controlled for such variables as being male or female, time since degree, being a postdoctoral fellow, having a mentor other than an advisor, advisor relationships, the imposter score, and the two-body problem. It then asked whether women, independently of all of these things, were more likely to leave the field than men.

The answer to that question, according to the study, is that women were not more likely to leave the field just because of gender, Ivie reported. Rather, several factors had a direct effect on working in and out of the field. First, among respondents who were not currently postdocs at the time of the second survey, participants who had completed a postdoc were much more likely to work in the field. Second, participants who changed advisors were more likely to work outside astronomy and physics. Third, participants were three times more likely to work outside of the field if they had relocated for a spouse or partner. Thus, women were more likely to work outside of the field because they were more likely to experience the two-body problem, less likely to have a positive rapport with their advisors, and more likely to change advisors.

The research team decided to unpack the advisor measure to see which variables were affecting outcomes. Results showed that women were more

likely to leave the field of astronomy and physics because of unsatisfactory advising, which also made them more likely to change advisors. "How can we train advisors to be better advisors?" Ivie asked. She was surprised to find that the advisor relationship was still significant for so long after leaving school and asked how professional societies could work to improve advisor relationships.

The third survey will retroactively ask participants open-ended questions about why they changed advisors and the role of mentors in their academic careers. Additional questions about advisors will include whether they engaged in writing grant proposals, advocated for them, and helped them develop professional relationships.

UNDERGRADUATE RESEARCH IN THE E-SCIENCE ERA

Computer science is currently the least diverse field in science, with diversity decreasing over the years in contrast to science as a whole. However, as computational and e-science continue to expand and develop, these fields will provide tremendous possibilities for equal opportunities to do data-driven research, said Lior Shamir, associate professor at Lawrence Technological University. The growing availability of publicly available scientific databases in different disciplines, combined with the availability of data analysis tools, allows undergraduate students to make authentic scientific discoveries while using virtual resources and without the need for highly expensive research facilities or materials. These opportunities are especially important for smaller undergraduate institutions—including community colleges, liberal arts colleges, and HBCUs—where students do not necessarily have abundant opportunities for authentic research experiences.

There are two models for student research. The first is a student research model, where students work independently on self-guided projects. The second is a research assistant model, where students join a laboratory and participate in authentic research. This model provides more guidance and support, but students no longer own the research; rather, the research and agenda are driven by the faculty.

Lawrence Technological College has developed several interventions to attempt to engage students from all disciplines in computational research. In the program, projects are based on students' own agenda and interests so that students lead and own their research. Faculty members serve as research assistants to help students make authentic research discoveries in their particular fields of interest. This model for research allows students to express their own identity, culture, and personality through their research. For example, a student interested in marine biology analyzed a database of whale sounds and discovered that whales have different accents based on their geographical location. Another student interested in astronomy analyzed an astronomical database and was able to replicate the orbit sequence of meteorites. An amateur painter at the college collected paintings to determine how computers match similar artists and created a network that grouped paintings by colors. A student interested in music analyzed popular music through a database and created an algorithm to find the similarities between different albums of

popular music. His final program could sort artists' albums in chronological order, and his discoveries were featured in *Scientific American*.

One of the main goals of the program at the institution is to allow non-computer science majors to familiarize themselves with computer science and understand its utility as a means of accessing knowledge. Computer science can be fun and help students understand art, music, and sports, said Franco Delogu, assistant professor at LTU. The challenge is to apply computer science to non-computer courses with non-computer science faculty and students in their first year of college. To do this, e-science has been integrated into courses in art history, biology, and psychology, in part to attract students to computer science who are historically underrepresented in the field, especially minorities and women.

To assess the effectiveness of these programs, a pre- and post-survey were given to students in experimental and control classes, with focus groups being used to gather additional feedback. Grades, majors, and retention rates were submitted to an external evaluator and used to determine the program's success. The data suggest that some students in the program are somewhat overwhelmed and scared by the complexity of the task. To combat this problem, the pace of the program and expository methods can be adjusted, Delogu said. However, contrasting data reveal that many students are enthusiastic and passionate about the course. Students have been inspired to create exciting and innovative projects through the program.

Ultimately, the program is a work in progress that will continue to improve. As scientific databases increase, data-enabled science can provide equal-opportunity research to large numbers of students while allowing them to follow their own research directions and without the commitment of major financial resources or special research instruments.

GUIDED ONLINE GROUP DISCUSSIONS TO RETAIN STUDENTS IN COMPUTING MAJORS

While computing jobs are among the fastest growing and highest paying occupations in the United States, few women and minorities are benefiting from these opportunities. Meanwhile, a lack of diversity in computing means that valuable perspectives from a significant proportion of the population are missed.

A program at Illinois State University aims to not just retain but recruit students into computing majors to broaden diversity in the field. To accomplish this task, the program has asked a number of research questions: Can colleges create learning environments that optimize their strengths and minimize their weaknesses? Technology has changed the Net Generation, but how has it changed? Are there cognitive differences between the Net Generation and Generation X?

The majority of students currently in high school and college were born between 1980 and 2000, a cohort often labeled as Millennials or the Net Generation. Members of this group have different characteristics than do their teachers, said Anu Gokhale, professor and coordinator in the Department of Technology at Illinois State University. Students in the Net generation are

good at programming but not necessarily good developers or builders of technology. Their attention span has declined to 11 minutes from an earlier average of 20 minutes, according to research. Online communication is often not only the preferred but often the only way in which members of this group interact with one another. This age group prefers multitasking, nonlinear access to information, and active rather than passive learning. They have a low tolerance for lectures and rely heavily on communication technologies to access information in addition to carrying out social and professional interactions. While the Net Generation is highly driven to succeed, people in this age group prefer to work on teams to produce concrete results.

These findings imply a new type of learning community that better suits the unique characteristics of the Net Generation, said Gokhale. Rather than having face-to-face meetings, Illinois State University has established online learning communities that fit student culture and solidly reflect the social interactions of Millennials. The NSF-funded project is designed to use online learning communities to enhance student awareness of computing-related applications in real life and associated majors. Special emphasis is placed on involving women and minority groups to improve diversity in the workforce. The program provides opportunities for peer mentoring and peer tutoring to enhance student learning in computing-related courses. All types of learners can thrive in an online community. Students who may be shy, slow-learners, or slow-thinkers have the opportunity to form responses in their own time. Students can share their work with their peers and receive feedback and comments. This interactive community serves as a powerful promoter of creative and intuitive thinking.

The program addresses two domains: the cognitive domain and the affective domain. The affective domain addresses a student's feelings toward the work. When a student enjoys or feels alienated by a class, these feelings fall into the affective domain. The program involves freshmen enrolled in Math 123, a finite mathematics course required by multiple majors at the university that also fulfills the mathematics requirement for most computing-related majors. This course was chosen in an attempt to develop more positive attitudes of students toward the subject matter in a beginning programming course.

The approach includes online learning communities and weekly face-to-face seminars with professionals who are in the field. These presenters are faculty or external professionals who teach students about methodology and computing. The goal is to humanize the computing sciences by giving students a better sense of the range of available possibilities. Professionals are trained beforehand and tell students their life stories with pictures, videos, and demos. A four-member blogging team posts computing-related content twice a week on Sunday and Wednesday nights for 15 weeks each semester. The blog is posted on WordPress where other students have the chance to react, comment, and ask questions. Students receive credit for posting in the online community and take quizzes that are based on the blog. The last question always addresses students' enjoyment of the blog.

Online tutoring provides networking, support structure, and research design. Women and minority junior and senior computing majors are engaged as facilitators of learning communities to serve as role models and mentors

for first- and second-year students who have the potential to succeed in a computing major. Facilitators themselves gain valuable leadership skills and a sense of responsibility, pride, and accomplishment.

A nonequivalent pretest-posttest control-group design was used to measure students' attitudes toward computing and motivation. A scale was developed and validated, and its reliability was tested to measure attitudes. This research suggests that perceptions of students, educators, and other stakeholders play a large role in discouraging women and minorities from pursuing computing-related majors and participating in technical occupations. Students involved in the online learning communities maintained more positive attitudes toward the field and also maintained a strong belief that these fields are appropriate for women and minorities. The more positive a student's attitude toward STEM, the more positive their attitudes were toward participation of women in STEM. When compared to the control group, students in the experimental group performed better on critical thinking items on the same test. In addition, the retention rate increased by 25 percent for women and minorities.

The study at ISU shows that online learning methods do not alienate majority white males while proving effective in retaining women and minority students.

REVIEWER INTERACTIONS DURING NIH
STUDY SECTION MEETINGS

The ability to secure independent research funding is critical for career advancement in academic science. NIH is the largest funding source for academic biomedical research, spending over $30 billion in 2014 alone, with 80 percent of funded research awarded though competitive grants. For academic scientists in biomedical fields, the ability to secure NIH funding is a benchmark for long-term career success. This is particularly true of NIH Research Project Grants (RO1), which are unmatched by any other awards for securing promotion and tenure. However, funding disparities that correlate with applicant gender and race present a critical problem for recruitment and retention of underrepresented minority groups within the biomedical sciences.

The first step in solving this problem is to identify how reviewers' biases are introduced and reproduced through the various stages of the NIH review process. Joshua Raclaw, a postdoctoral researcher at the Center for Women's Health Research and an honorary fellow in the Department of Sociology, and Elizabeth Pier, professor of educational psychology at the University of Wisconsin–Madison, are part of team of socio-linguists and discourse analysts who created a study as part of an NIH transformative RO1 grant to examine the linguistic and interactional processes during NIH review panel meetings, also known as study sections. During these meetings, groups of expert peer reviewers collaboratively arrive at final impact scores that are used in determining final funding recommendations.

The study focused on how changes in reviewers' scores can be motivated by the actions of other review panelists. They discovered one particular prac-

tice that effected immediate public changes in the assigned scores for a grant. The use of laughter during a genre of communication called score calibration talk provided the opportunity for one or more participants to directly influence the final score assigned to the application, which may in turn influence larger group-wide shifts in final score assignments.

The NIH review process is a multistage process. The first stage consists of independent review of grant proposal applications. A small group of reviewers, typically three, are assigned to review the application. They are responsible for writing a critique that assesses the overall impact of the grant application as well as its strengths and weaknesses in five areas: significance of proposal, innovation, quality of investigators, methodological approach, and quality of the environment where the research would take place. The written critique is assigned an overall preliminary impact score as well as preliminary scores for the five criteria.

In the second stage of peer review, reviewers come together in study section meetings to determine the top 50 percent of proposals based on overall preliminary impact scores. During this process, assigned reviewers verbally report preliminary scores and then summarize the strengths and weaknesses from their critiques for the panel as a whole. The chairperson of the meeting then opens the panel up to discussion. At the conclusion of the discussion, the assigned reviewers are asked to announce their scores, which they are able to change based on the discussion. At that point, the entire panel records their scores for the proposal, and the advisory council uses a composite of those scores to determine the final funding recommendation for the grant. However, panel members are only allowed to score within a one-point range of the highest and lowest scores given by assigned reviewers.

The study at the University of Wisconsin–Madison examined the language used during the collaborative phase of peer review to determine how bias may influence the review process. One reason for honing in on the second stage of the review is that there is a wide body of research looking at the inter-rater reliability in scoring practices of review panels for NIH and other funding agencies. Generally, research reveals poor inter-rater reliability, with large differences between how individuals and panels score the same grant proposal. Ambiguous review criteria may be an explanation for low reliability. Ambiguity in review criteria can impact the subjectivity of a reviewer's judgment, and that subjectivity can in turn facilitate reviewer bias.

NIH uses a reverse nine-point scale to score grant proposals, with one corresponding to exceptional and nine corresponding to poor. NIH instructs reviewers to consider a score of five as an average proposal. Reviewers use this nine-point scale for overall impact and for the five criteria. The system is explicitly ambiguous in how reviewers are expected to apply the scoring system. In the scoring system and procedure hand-out reference, NIH encourages reviewers to reflect their overall evaluation in their overall impact score and not use a numerical average of the individual criterion scores. Reviewers are prompted to weigh different criteria as they see fit in determining the overall score. They also are urged to spread scores among the applications in order to better discriminate the strong and the weak applications.

The study at UW identified a genre called "score calibration talk" as one source of variability in how different panels score the same proposals. "Score calibration talk" was identified as the means in which reviewers' address ambiguities in the scoring system during panel meetings by beginning to construct a local understanding among the reviewers of a given score. "We posit that it's the frequency of this sort of score calibration talk in our data that's reflecting the strong potential for subjectivity in the review process, and with that subjectivity, the introduction of possible bias," said Pier.

To examine these score calibration talks, the study constructed four study sections that were video recorded and transcribed. All methodological and design decisions were made in consultation with NIH's Center for Scientific Review. The study team worked closely with one recently retired scientific review officer who helped in the recruitment of participants, the recruitment of grant applications, and the assignment of chairpersons to each of the four meetings. The study sections consisted of experienced NIH reviewers who were recruited to come together in panel meetings and review NIH RO1 grant applications that were recently reviewed by NIH's National Cancer Institute. The chairperson was a senior scholar in the field. All four panels reviewed the same application. The recordings were three to four hours long. The team worked to ensure that the study sections emulated NIH norms and practices in every action. These study sections differed greatly from the mock study sections produced by NIH, videos of which are available on the Center for Scientific Review (CSR) website so new reviewers can see what a review panel looks like. During the mock study sections, reviewers calmly judged the application with no laughter, teasing, score calibration, or disagreements. In a debriefing survey, reviewers gave the study sections run by the University of Wisconsin a score of six or seven on a seven-point Likert scale in their strong resemblance to actual NIH review panels.

Data from the study sections were examined using a methodology from conversation analysis, which uses a qualitative inductive empirical approach to examine the structures of communicative social interaction. This type of analysis focuses on how speakers construct and allocate turns of talk, how they manage the introduction of agreement and disagreement, and how they engage in routine forms of social action that structure everyday social life.

A video recording from the first study section revealed how laughter and score calibration talk can motivate immediate score change. The excerpt begins as a secondary reviewer is delivering an overview of the application's strengths and weaknesses, a process that occurs early on in an application's review. The reviewer assigned a preliminary score of one to the application, a perfect score, and announces that he has no other concerns about the application, a statement signaling that the overview of the application is coming to a close. However, he then continues to list further weaknesses of the grant.

The chair interrupts the reviewer's progress review to affirm that the reviewer gave the grant a score of one, indicating that the reviewer's further articulation of weaknesses is problematic given the score that he has assigned to the grant. In overlap with the reviewer's affirmation of his given score, another panelist begins to laugh. Other participants join in, and it grows into an overlapping cascade of shared laughter. In the midst of the shared laughter,

the chair begins to describe what types of applications he believes merit the score of one. The reviewer who assigned the score of one briefly joins in the laughter and then announces that he will reduce the score.

In this case, score calibration talk is used by panelists not only to interrogate a reviewer's scoring practices but also to motivate an immediate change in score. "In each of the cases in our data where we do see this immediate score change announcement happen, it happens either immediately following or in the midst of laughter from other members of the review panel," said Raclaw. Although laughter is typically associated with humor and emotional closeness, studies of laughter in actual interactions show that laughter also is associated with the negotiation of delicate inter-personal actions such as complaints, teases, and improprieties. Nervous and embarrassed laughter is typically understood to reflect the emotional inner-state of the producer, and actions that occur unexpectedly often invite laughter. The unexpectedness of the chair's question may be what first motivated laughter in the conversation. As laughter across multiple panelists occurs, the laughter can be heard as a response to the threatening nature of the chair's question to the reviewer, which implicitly questions not only the appropriateness of the reviewer's score but his competence as a reviewer.

In a video excerpt from a different study section meeting, the chair produces a summary of the application's grant and weaknesses, after which he asks the three assigned reviewers to announce their final scores. Typically, this is followed by a vote from all panelists on final scores. The reviewers' preliminary scores in the application are two, two, and four. Before moving on to the final vote, the chair challenges the reviewers' final scores. He asserts that four is a pretty good score. In particular, he points to a specific aspect of the grant that, in his words, is "really bad." Another panelist voices agreement with the chair's assertion.

Then a panelist voices a teasing joke about the lenient scoring practices of the group, stating that, "I hope my grant will be discussed at this table." The joke receives immediate laughter and agreement from multiple participants. In response to the laughter, the third reviewer changes his final score from a four to a five. The first and second reviewers follow suit, changing their final scores to five. This excerpt illustrates that laughter in the midst of score calibration talk has the potential not only to influence scores of the three assigned reviewers but also to have larger scoring consequences for the scoring of the application. Because the final scoring procedures at NIH review panels are organized around the establishment of a score range set by the three assigned reviewers' final scores, if the assigned reviewers give final scores of one, two, and three, all other panelists must cast their final scores within the range of one to three. Panelists who wish to score one point outside this range may do so but must publicly announce to the group that they are scoring outside the established range. In effecting changes to the three reviewers' scores, the score range for the entire panel was altered.

In looking at the final score, two panelists go outside the range to assign the application a score of six. All other panelists, including the chair, assign the score of five. The final aggregate score for the application exhibits a signifi-

cant change based on a very public change associated with the use of laughter in score calibration talk.

Review panel discussions offer the opportunity for reviewers from diverse backgrounds to share their expertise in evaluating applications. However, panel discussions also can facilitate the entry of subjectivity into the review process. Score calibration talk opens up the scoring process to local negotiation and naming. In the study, scores only get worse through the peer review process. It seems that reviewers have an easier time talking about an application's weaknesses than about its strengths. These findings question the benefits of doing review panel meetings if score variance happens only in one direction.

The University of Wisconsin study aims to help reviewers engage in balanced, productive discussions. Gender balance and a supportive chair are necessary to ensure success. Laughter seems to be a detrimental factor to unbiased peer review. "When numerous speakers engage in laughter, it's an expression of sheer stance. If you are the target of that laughter, it's a sheer stance against the stands you've been expressing," Raclaw concluded. In the future, the research team aims to further examine the potential connections between scoring practices and reviewer bias in review panels, especially because review panels have been largely overlooked in research examining bias and fairness in the NIH review process.

A QUALITATIVE THEMATIC ANALYSIS OF NIH MENTORED CAREER DEVELOPMENT AWARD APPLICATION CRITIQUES

NIH Mentored Career Development (K) Awards bridge investigators from mentored to independent research. A smaller proportion of women than men succeed in the transition from K awards to RO1 grants. A qualitative study at the University of Wisconsin–Madison aimed to analyze reviewers' narrative critiques of K award applications and explore the thematic content of the feedback provided to male and female applicants in order to examine the relationship between the critique text and women's career advancement in academic medicine.

Men and women are at near parity in the early stages of the academic medical pipeline. However, beyond the assistant professor stage, women experience slower rates of promotion and higher rates of attrition, said Anna Kaatz, director of computational sciences at the University of Wisconsin–Madison's Center for Women's Health Research. This leaves women proportionally underrepresented in higher ranking and leadership positions.

In academic medicine, perhaps the most important determinant of advancement is the ability to secure funding for research. NIH funds the majority of research at academic medical centers throughout the United States, with specific award types associated with each career stage. The K award is most commonly held by assistant professors or junior faculty. They are three- to five-year awards that protect 75 percent of an individual's time to develop a program of research under the guidance of an experienced mentor. There are three general types of K awards: KO1s, for individuals with research doctor-

ates, KO8s, and K23s, for individuals with clinical doctorate degrees conducting laboratory-based or patient-oriented research, respectively.

The overarching goal of K awards is to launch an independent program of research and successful obtain an NIH RO1 grant, which is the gold standard for independent research programs and biomedicine. Women and men are just as likely to apply for K awards and are just as likely to succeed in obtaining them. But among K awardees, women are less likely to go on and apply for RO1 grants. Among those K awardees who do apply for RO1 grants, women are less successful than men at obtaining them.

When an application is submitted to the NIH, it is assigned to a study section that consist of about 30 experts in that field. Three reviewers assign scores and write critiques about the application. For K awards, if the application falls within the top half of the application scores in the study section, it moves on for further discussion in a review group meeting where all panelists contribute to the final score. Then the application is sent to the second stage of review where NIH staff and council members work together to make funding recommendations to the NIH institute and center directors who make the final funding decisions.

The study took an exploratory approach to gender disparities in biomedicine by looking at the critique text that NIH reviewers wrote for K award applications. The research question was: What type of feedback and advice do male and female scientists receive in critiques of their K award applications, and does that feedback differ from K awardees who go on to obtain a subsequent independent award compared to those who do not? Drawing from NIH's public access database, the study looked at a list of University of Wisconsin–Madison KO1, KO8, and K23 awardees between the fiscal years of 2005 and 2009, said Molly Carnes, professor of medicine, director of the Center for Women's Health Research, and co-director of the Women in Science and Engineering Leadership Institute at the University of Wisconsin–Madison. Three emails were sent to awardees inviting them to participate in the study by asking them to donate the summary statements containing their grant critiques. Seventy percent of the awardees participated—ten male awardees and eight female awardees. Approximately 40 percent of these participants were funded after revision, meaning that they submitted a K award application, did not receive funding, and then revised and resubmitted their application. These participants donated both their funded and unfunded summary statements to the study.

The analytic sample consisted of 88 critiques, 34 unfunded and 54 funded, from 27 K award proposals. To ensure unprejudiced analysis, the sex, institution, and research information of the applicant were removed. Evaluators were also blinded to the K award funding outcome. Codes assigned to categorize reviewers' remarks fell under the criteria sections within the K award grant critique: candidate, career development plan, mentoring plan, research plan, mentor comments, consultants, collaborators, and the environments and institutional commitment to the candidate.

The data revealed that funded summary statements had more positive remarks and praise from reviewers, while unfunded statements received more criticism and negative remarks. In the research plan section of the ap-

plication, two themes emerged: one concerning the technical, methodological, and design flaws of the proposal, and another where reviewers provided advice following criticism. Female applicants received concerns about low productivity and whether or not it would lead to their ability to complete their proposed research. More than that, reviewers questioned whether or not they would be a successful and independent investigator in the future. For instance, a woman's KO8 proposal was reviewed with particular concern because of the relative lack of peer review applications or other contributions to research. Reviewers stated that the application seemed to lack evidence for the candidate's promise as a future independent investigator other than very positive comments from prospective mentors.

With male applicants, reviewers took a more neutral stance on whether or not their low productivity would predict whether they would be successful as a future independent investigator. In one grant, despite a limited publication record, the review noted that the applicant shows some publication skills and should improve.

Within the research plans section of the application, reviewers were repeatedly concerned about technical, methodological, and design flaws in the proposal. Female applicants tended to receive criticisms targeted at their ability as an investigator rather than the research plan itself. Reviewers tended to target male applicants' proposals rather than the investigators themselves.

Only one female applicant, but all male applicants, received advice as to how to address concerns within the research plan for reviewers. One female's application was reviewed as quite superficial and confused. Reviewers reported that it was unclear what could be added to the study, and no feedback was provided for improvement. In a male KO1 grant critique, reviewers cited a general concern for the lack of integration of the research plan, suggesting that it could be more effective to present an example diagram.

Female applicants' proposals were often characterized as only moderately significant to their field. Often, reviewers saw their proposals as too ambitious. From two female KO8 and K23 grants, reviewers wrote that the issues being addressed were only moderately significant but nevertheless would provide a vehicle for excellent training and generation of some useful information. The research plan was considered excellent, but there was a concern that the project may be overly ambitious considering the two-year proposed timeline and the candidate's other training in clinical-related activities.

For male applicants, reviewers characterize their research as having a highly significant impact in the field that can help lead to a successful career as a future independent investigator. In a male KO8 grant, a reviewer wrote, "the field needs young physician scientists, particularly those working on this disease. The focus of work is important and doable and could lead to a lifetime of studies. It is highly expected that the proposed courses in research will not only further his training to become an independent physician scientist, but will allow him to make significant contributions in the field."

Of female K awardees in the study, 63 percent went on to receive an independent award, as compared with 70 percent of male K awardees. With female K awardees, those who received the most positive feedback compared with the other female investigators and those who received more stand-out

attributes within grant critiques such as "outstanding" and "exceptional" went on to receive independent awards. Female K awardees who did not have any productivity concerns mentioned in their grant critiques also went on to receive independent awards. Female principal investigators who were criticized in the critiques did not go on to obtain independent awards. In contrast, male K awardees who received a range of feedback were equally likely to go on and receive an independent award. A higher percentage of male principal investigators who revised their K awards prior to funding went on to obtain higher level awards.

The study provided three major takeaways. First, male and female K awardees appear to receive different feedback from NIH peer reviewers. Second, only female K awardees who were not exposed to critical feedback went on to obtain subsequent R-level or independent awards. Third, peer reviewers appear to assign different value to research proposed by male and female applicants. Differences may be potentially explained by differences in the quality of the applications that K awardees submitted. But in the study sample, K awardees were similarly qualified and had similar levels of background experience.

Two large studies have been designed to carry on this research. The first is a large quantitative text analysis of a national sample of K award application critiques. The purpose of the study is to see if quantitative results generalize in a national population. The study will examine the differences in critique text not only by gender but also by race and ethnicity. The second is a collaborative project with social and cognitive scientists. In psychology, research shows that in fields where women are stereotyped to have low competence, they will interpret negative feedback as objectively worse than how a man would interpret the same feedback. This interpretation can lead women to lose interest in research and quit. This finding will lead to the first experimental study testing the impact of NIH peer reviewers' feedback on K awardees' interest and decisions to apply for subsequent awards, including RO1 grants. The study aims to investigate the extent to which negative feedback has a lasting impact that pulls women who are highly committed to research careers out of the pipeline at the mentor peer development stage. In the future, these findings could be used to train reviewers in how to give constructive feedback.

Index