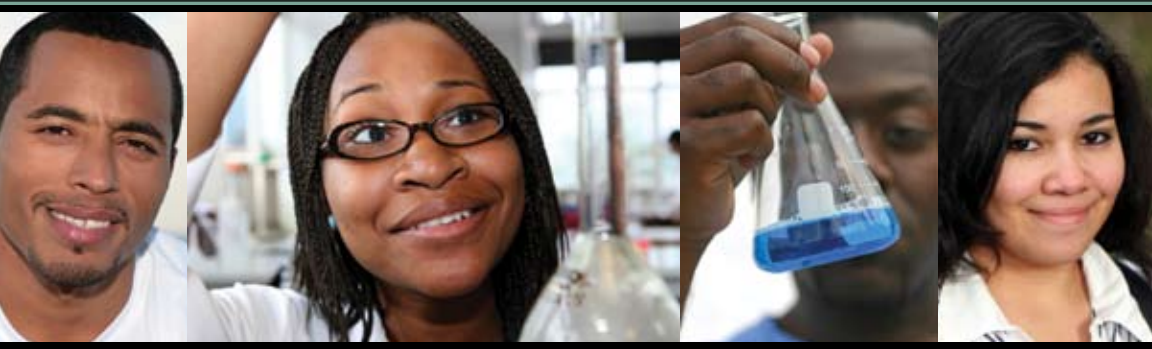
UNDERSTANDING INTERVENTIONS
THAT ENCOURAGE MINORITIES TO PURSUE RESEARCH CAREERS



BUILDING A COMMUNITY OF RESEARCH AND PRACTICE

Anthony L. DePass and Daryl E. Chubin, Editors

THE AMERICAN SOCIETY FOR CELL BIOLOGY

INTERVENTIONS RESEARCH DIVERSITY

UNDERSTANDING INTERVENTIONS
THAT ENCOURAGE MINORITIES TO PURSUE RESEARCH CAREERS

Building a Community of Research and Practice

SUMMARY OF A CONFERENCE
ATLANTA, GEORGIA, MAY 2–4, 2008

Anthony L. DePass and Daryl E. Chubin, Editors

American Society for Cell Biology
Bethesda, Maryland, USA

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PLANNING COMMITTEE FOR THE SECOND ANNUAL CONFERENCE ON UNDERSTANDING INTERVENTIONS THAT ENCOURAGE MINORITIES TO PURSUE RESEARCH CAREERS

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This conference was organized by the Minorities Affairs Committee of the American Society for Cell Biology (ASCB MAC). It is one of several activities aimed at broadening participation in research-related careers.

Organization of the conference was executed by a Planning Committee comprised of standing ASCB MAC members and ad hoc members from the broader research community.

This effort, as well as others organized by the ASCB MAC, was funded by a grant from the National Institute of General Medical Sciences' Minority Access to Research Careers program.

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Contents

Preface

For many years, programs have been supported that are designed to encourage minorities underrepresented in the sciences to pursue careers focused in science and technology areas. The National Institutes of Health, through its Division of Minority Opportunities in Research (MORE) within the Institute of General Medical Sciences (NIGMS), has led efforts in the biomedical areas. Programs typical of such efforts include the Minority Access to Research Careers (MARC) program, which seeks to "increase the number and competitiveness of underrepresented minorities engaged in biomedical research by strengthening the science curricula at minority-serving institutions and increasing the research training opportunities for students and faculty at these institutions."[1] Another major effort in this area is the Minority Biomedical Research Support (MBRS) program, which is aimed at "increasing the number of faculty, students, and investigators who are members of groups that are underrepresented in the biomedical sciences."[2] Other agencies, such as the National Science Foundation, have addressed the issue of underrepresentation through targeted summer research opportunities embedded in such programs as the Integrative Graduate Education and Research Traineeship (IGERT) program and the Alliances for Graduate Education and the Professoriate (AGEP) program.

There is no doubt that these programs have had an effect on the

[1] http://www.nigms.nih.gov/Minority/MARC/MARCDescription.htm
[2] http://www.nigms.nih.gov/Minority/MBRS/MBRSDescription.htm

numbers of minorities who have chosen to enter science-related careers, especially in biomedical areas. Though the numbers remain small (as described in chapter 1 of this report), they would undoubtedly have been smaller without the efforts of the dedicated and insightful individuals who have designed, implemented, and funded programs like the ones described in this volume. Furthermore, participation in science is not about sheer numbers alone. Programs to change the composition of the science workforce and the quality of the training that prepares graduates for a range of career opportunities are part of a much broader set of efforts to enhance diversity.

Despite their successes, a recurring problem has beset these programs. Many have not been based on conclusions drawn from research into how best to increase the participation of underrepresented minorities in the sciences. Instead, they have relied on intuitive approaches and "best practices" that might not be applicable across institutions and student populations. For example, a summer research program for undergraduates might make intuitive sense in that it introduces students to a research environment on a full-time basis for an extended period. Yet there may be no solid basis in research for concluding that such a program, in the form that it is implemented, has a greater effect than an alternative educational intervention. A particular summer research program might do more to reinforce the leanings of those students already committed to that career path without also drawing students unfamiliar or currently uninterested into research careers. A change in program design or an alternate intervention could have a greater desired impact on students' decisions to pursue research careers. Ironically, such programs often have been developed and implemented by scientists who would reject an approach that lacks empirical evidence in other aspects of their work.

In 2004, motivated by the lack of research-based evidence about the effectiveness of educational interventions, the MORE division issued a Request for Applications (RFA) on the "Efficacy of Interventions to Promote Research Careers." In its most recent revision, the RFA

> supports research that tests assumptions and hypotheses that undergird interventions intended to increase the interest, motivation, and preparedness for careers in biomedical and behavioral research, with a particular interest in interventions specifically designed to increase the number of students from underrepresented groups entering careers in these fields. The proposed research need not be restricted to underrepresented minority students. Comparative research that analyzes the experience of all groups in order to place that of underrepresented students in context and to learn whether and how interventions should be tailored to make more underrepresented students successful in biomedical careers may well be particularly illuminating and is, therefore, encouraged. This funding opportunity is not designed to support evaluation of an existing program;

> the purpose is to stimulate research on the underlying assumptions or hypotheses upon which they are built.[3]

The distinction between "evaluation" and "research" drawn in the RFA is crucial. Evaluations are important to assess whether a program meets its objectives, but they can be limited in providing a broader examination of an intervention. Consider the summer research program mentioned above. If such a program were evaluated, the evaluation could assess how well the program met its recruitment goals, whether students had a productive research experience (often based on the funding and publication achievements of the principal investigator), and the degree of satisfaction felt by students and mentors. But such an evaluation cannot determine the efficacy and appropriateness of a program compared to other interventions (in other words, the opportunities foreclosed by that program). Nor can it measure the broader benefits that a student or mentor might receive through participation in the program (for example, persistence in a career path or opting for other opportunities in or out of science). As a result, it has been very difficult to assess the effects of educational interventions on the long-term outcomes of participants. We take a snapshot that rarely extends beyond one to three years into the future and can only conjecture about impacts longitudinally. At best, we can narrow the list of alternative hypotheses, subject to caveats and limits in generalizability.

In 2007 the National Academies held a meeting requested by NIGMS focused largely on this issue of evaluations versus research in interventions meant to influence the participation of underrepresented minorities in science, technology, engineering, and mathematics (STEM) disciplines. That meeting had four broad goals: to demonstrate the need for hypothesis-based approaches that would inform the design, implementation, and evaluation of programs; to enable biomedical scientists to tap the expertise of colleagues in the economic, social, and behavioral sciences; to equip participants with some of the methodologies and tools relevant to the design, implementation, and evaluation of programs; and to foster a community of scholars whose work and expertise could be used in such pursuits. A summary of that meeting and additional information are available at http://dels.nas.edu/bls/more.

The 2007 meeting was successful in bringing together individuals who design and implement intervention programs with the educational researchers, psychologists, and others skilled in the study of human behaviors. But the meeting also highlighted several outstanding issues. While there is a growing research literature on the efficacy of educational

[3]http://www.nigms.nih.gov/Minority/Interventions.htm

interventions, it is dispersed across academic disciplines and often incorporates very different paradigms, methodologies, and views of how best to do research. Examples are legion of how the cultures of the life and physical sciences vary from the cultures of the social and behavioral sciences with regard to issues of qualitative sampling, the uses of ethnography, and requirements for strict control groups.

The Second Annual Conference on Understanding Interventions that Encourage Minorities to Pursue Research Careers brought together different groups of researchers and the program practitioners who rely on their research and marked a transition to an emphasis on the dissemination of interventions research. The conference was held in Atlanta on May 2-4, 2008, and was organized by the Minorities Affairs Committee of the American Society for Cell Biology (ASCB). This conference shared the goals of the first meeting, but it had two additional objectives: to recognize and develop a multidisciplinary community of scholars focused on educational interventions for underrepresented minorities, and to disseminate the research conducted by this community to a much broader audience of researchers and program practitioners. The 2008 conference reached out to scholars in the behavioral, social, and economic sciences by highlighting the design elements of programs that can be studied through research on processes and outcomes. Conference participants presented their research and participated in discussions that ranged well beyond their usual disciplinary concerns.

The message of the conference to those who develop and implement student-centered programs was simple: Analyze systematically what you are doing, just as you would approach a research problem. Be rigorous, hard-headed, and if necessary single-minded. Do not let your own convictions and rhetoric carry your programmatic efforts, because they will not suffice.

In addition to members of the ASCB's Minority Affairs Committee, the organizing committee for the 2008 conference included ad hoc members from several other scientific organizations, including the American Society of Plant Biologists, the American Association for the Advancement of Science, the National Academies, and the Consortium of Social Science Associations. Members of the organizing committee played key roles during the day-and-a-half of discussions. May of these individuals and groups also have been involved in the planning of the May 2009 Third Annual Conference on Understanding Interventions that Encourage Minorities to Pursue Research Careers.

The agenda for the 2008 conference is in Appendix A as well as on the web (http://www.understandinginterventions.org/PROGRAMBOOK.pdf). The website also contains abstracts for many of the talks delivered at the meeting and a full list of participants. The summary of the meeting

was written by Steve Olson using real-time transcripts generated by Hardeman Realtime, Inc. Jean Rosenberg and Wendy Sahli of the American Society for Plant Biology and Deborah McCall, ASCB's Senior Manager for Minorities Affairs, provided invaluable staff support.

Intervention programs can change the lives of young people, but they also offer an additional promise. Understanding and implementing the critical features of successful interventions can result in even greater success in future interventions. The understanding interventions conferences have been planned and conducted to realize that promise.

Anthony L. DePass, Chair, Planning Committee
Daryl E. Chubin, Vice-Chair, Planning Committee

1

The Continuing Challenge

Anthony DePass of Long Island University-Brooklyn and Daryl Chubin of the American Association for the Advancement of Science (AAAS) began the conference by briefly laying out the measured progress and continued challenges that characterize the effort to increase the number of underrepresented minorities in the biomedical and behavioral sciences. Minorities underrepresented in the sciences make up 31 percent of 18- to 24-year-olds in the United States, and the representation of minorities in the U.S. population is steadily growing (Figure 1). Yet minorities constitute progressively smaller percentages of the students earning bachelor's, master's, and doctoral degrees in the sciences (Figure 2). Understanding this phenomenon and the educational interventions that could mitigate this loss of talent at progressively higher levels of education was the principal driving force behind the conference.

The increasing percentage of minorities in the U.S. population has steadily been changing the population of elementary and secondary school students. Most of the growth of high school graduates over the next decade will come from minority populations, with Hispanics constituting the largest portion of that increase. This trend varies from region to region within the United States. The minority population in high schools is growing fastest in Nevada, Utah, Arizona, Texas, Georgia, and Florida. On the other end of the scale, Montana, Wyoming, the Dakotas, Kansas, Vermont, New Hampshire, and Louisiana are expected to have decreasing numbers of high school students, in the last case because of Hurricane Katrina. As Brian Bridges of the American Council on Education said

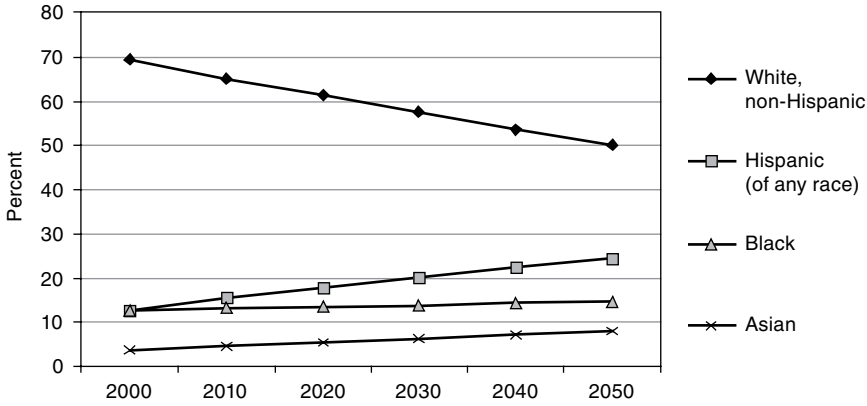


FIGURE 1 Non-Hispanic whites will continue to decline as a percentage of the U.S. population while the percentages of groups underrepresented in the sciences increase. SOURCE: Commission on Professionals in Science and Technology, with data from the U.S. Census Bureau.

later in the meeting, "Whites will continue to comprise the majority of all high school seniors, but a slow progression toward a majority minority population has definitely begun."

DEGREES EARNED BY UNDERREPRESENTED MINORITIES

The percentages of bachelor's, master's, and doctoral degrees earned by minorities underrepresented in the sciences have increased over the past three decades (Figures 3 and 4). At the bachelor's level, the percentage in the biological and agricultural sciences has gone from 6.4 percent

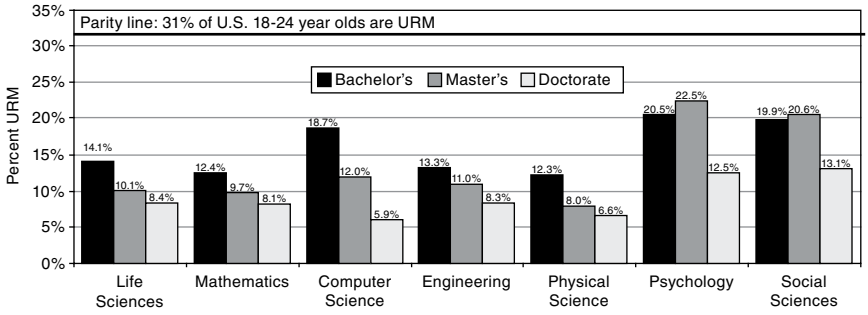
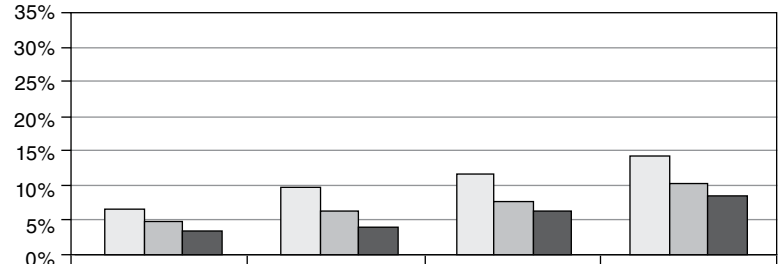


FIGURE 2 Degrees earned by underrepresented minorities (URM) in the sciences are well below the representation of this group in the U.S. population. SOURCE: Commission on Professionals in Science and Technology, 2005.

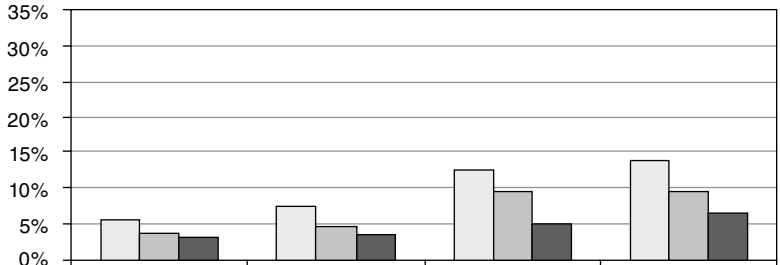


	1977	1987	1997	2005
Bachelor's	6.4%	9.7%	11.6%	14.1%
Master's	4.7%	6.3%	7.8%	10.1%
Doctorate	3.4%	4.0%	6.3%	8.6%

FIGURE 3 The percentages of degrees in the biological and agricultural sciences earned by underrepresented minorities have risen since 1977.

to 14.1 percent from 1977 to 2005 (the last year for which data were available at the time of the meeting) and from 5.6 percent to 14.0 percent in the physical sciences. At the doctorate level, the percentages have gone from 3.4 percent to 8.6 percent and 3.3 percent to 6.6 percent, respectively, over the same period. That represents real progress, DePass and Chubin said, and at least part of that progress can be attributed to educational programs put in place during that period.

However, these percentages are still far from the 31-percent level that would be required to reach parity with the representation of these groups in the 18- to 24-year-old U.S. population. At the doctorate level, the per-



	1977	1987	1997	2005
Bachelor's	5.6%	7.6%	12.7%	14.0%
Master's	3.9%	4.6%	9.5%	9.4%
Doctorate	3.3%	3.4%	4.9%	6.6%

FIGURE 4 The percentages of degrees in the physical sciences earned by underrepresented minorities have risen since 1977. These totals do not include the earth and geosciences.

centages are less than half the parity line in all fields but education (Figure 5). And the absolute numbers of students in these categories remain low. At 8.6 percent of the doctorates awarded in 2005 in the biological and agricultural sciences, underrepresented minorities represent just a few hundred Ph.D.'s per year.

The numbers of minorities in U.S. colleges and universities have been growing. Since 2005, minority students have constituted more than a quarter of all undergraduate enrollments, and the number is steadily increasing. Furthermore, minority students have the same levels of aspirations and interests in pursuing degrees in the sciences as non-minority students, said Bridges. But minority students leave science majors in larger numbers than do their non-minority peers. Many "need additional support," said Bridges, "because they come from academically unprepared backgrounds."

Females also are underrepresented among doctoral recipients in some fields, though not in all (Figure 6). In the life sciences, they are approximately at the parity line of 49 percent. But they earn fewer than 30 percent of Ph.D.'s in mathematics and the physical sciences, while they earn more than half of the Ph.D.'s in psychology, education, health, and the humanities.

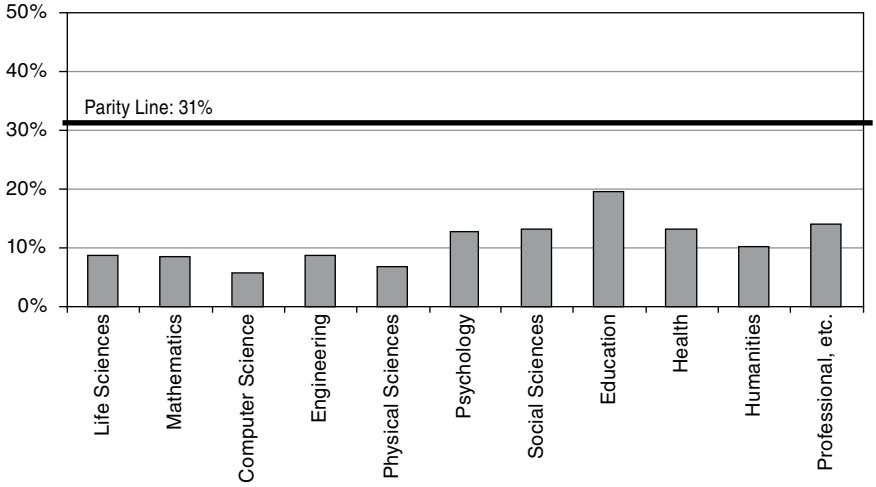


FIGURE 5 Among U.S. citizens and permanent residents, minorities underrepresented in the sciences earn fewer than 10 percent of the doctorate degrees in the life and physical sciences, and between 10 and 20 percent of the doctorate degrees in the social sciences, humanities, and professions. SOURCE: NSF Science and Engineering Doctorate Awards 2005.

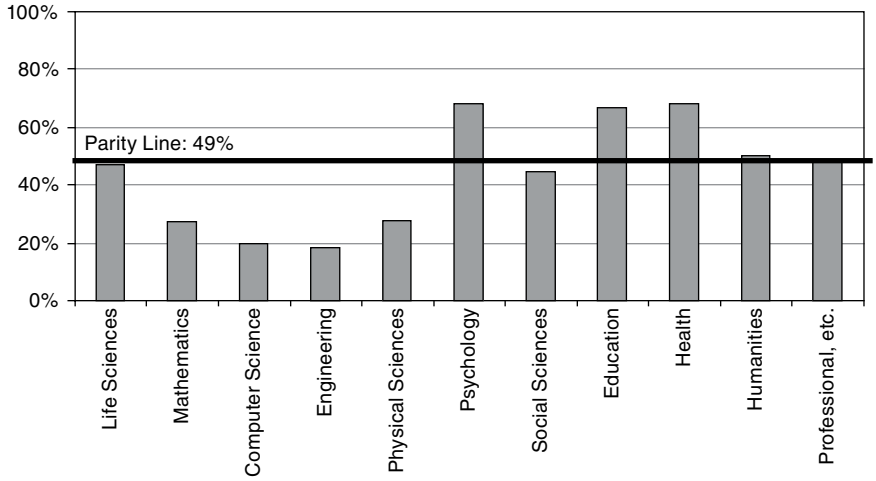


FIGURE 6 Females earn considerably fewer than half of the doctorate degrees awarded in mathematics and the physical sciences. SOURCE: NSF Science and Engineering Doctorate Awards 2005.

One reason that minorities are less likely to earn a Ph.D. than the members of other groups is that they emerge with a doctorate on average much more in debt than their non-minority peers, Chubin pointed out (Figure 7). The percentage of African-Americans who have more than $50,000 of debt after earning a Ph.D. is 27.7 percent, compared to just 1.5 percent for white doctoral recipients.

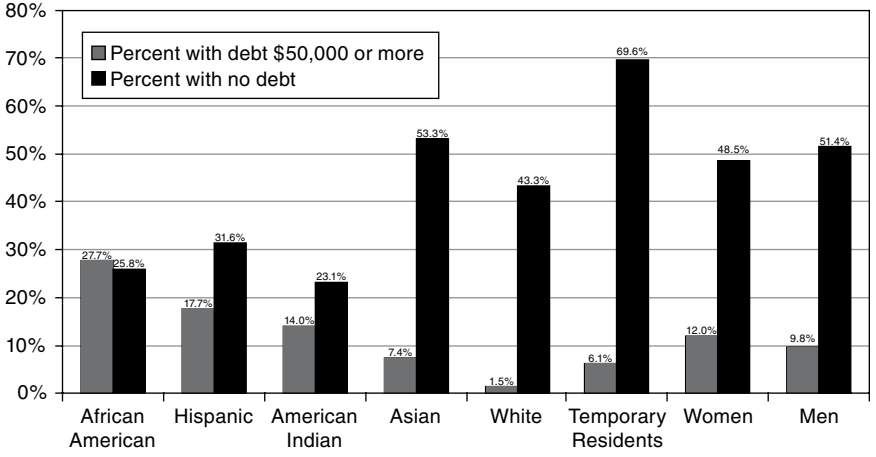
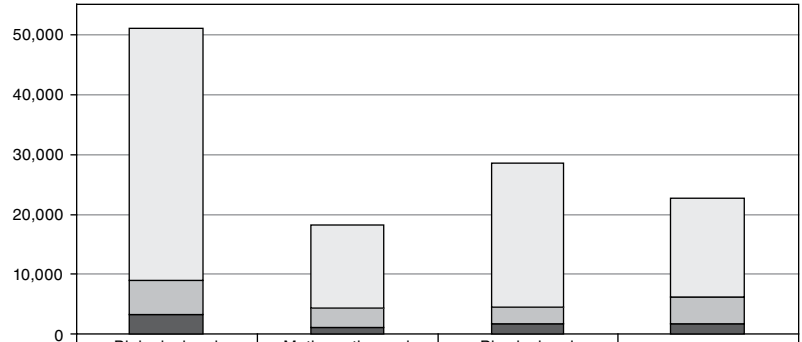


FIGURE 7 Underrepresented minorities have much higher levels of debt on average after earning a Ph.D. than do non-minorities.



	Biological and Agricultural Science	Mathematics and Computer Sciences	Physical and Earth Sciences	Engineering
Non-Minority	41,940	13,828	23,786	16,390
Asian/Pac. Isl.	5,849	3,269	2,925	4,378
URM	3,247	1,082	1,667	1,758

FIGURE 8 Minorities underrepresented in the sciences constitute less than 10 percent of all faculty in the sciences, mathematics, and engineering. SOURCE: NSF Survey of Doctorate Recipients 2003.

UNDERREPRESENTED MINORITIES IN COLLEGE AND UNIVERSITY FACULTIES

Underrepresented minorities and females also are severely underrepresented in college faculties (Figure 8). As Orlando Taylor of Howard University said, faculty establish the academic and intellectual climate of an institution, determine what is taught, serve as mentors, influence students' educational and career choices, serve as role models for young people, and advise government agencies on funding decisions. "A diverse faculty of men and women from the many cultures of our nation is essential—some say even a requirement—for producing a scientific workforce that is prepared to meet the demands of a global world."

Yet faculty diversity remains "more of a dream than a reality," Taylor observed. After 35 years of concerted effort, only 8 to 9 percent of the full-time science and engineering faculty in the United States are underrepresented minorities.

One key to encouraging minorities to enter academic careers is identifying the undergraduate institutions that feed those students into the academic pipeline, said Rhonda Sharpe from the University of Vermont. This varies from field to field and from one group to another. For example, African-Americans are well represented in foreign languages, but Hispanics are not. Asian-Americans are well represented in some academic

fields but not in all. Schools that do a good job with particular groups or in certain fields should be identified and supported.

Demographic "bulges" of minority students do exist at various places in the educational pipeline, Bridges pointed out. Undergraduate enrollments among minorities are up, as are graduate degrees in certain fields. But several bottlenecks at various points, including doctorate enrollment and faculty participation, continue to prevent the maximum participation of minorities at all levels of the academy.

Minority students need to be introduced both to graduate schools and to the idea of graduate school, Sharpe said. If they have opportunities for master's degrees, the idea of a doctorate becomes more imaginable. Members of these groups are susceptible to discouragement and need to be supported at all levels. And minority students need to be shown that faculty positions give them an opportunity to give back to their communities, which is an important goal for many of these students.

LEGAL CONSIDERATIONS FOR EDUCATIONAL INTERVENTIONS

Universities are very influenced by societal considerations, Chubin pointed out at the end of his introductory remarks. One of the most notable of these considerations is the legal environment in which all educational programs operate. Because programs targeted to particular groups have become difficult to defend legally, many programs have been dismantled, eliminated, reduced in scope, or opened to all students.

A 2004 report from the AAAS and the National Action Council for Minorities in Engineering (NACME) sought to give university administrators and faculty tools that can help them cope with actions that those opposed to affirmative action are now leveling against such programs.[1] These campaigns, which are focused at the state level, are particularly targeted to public institutions. "You may not be able to control the kinds of forces that are making your life more difficult," said Chubin. "You're going to have to negotiate them."

[1]Shirley M. Malcom, Daryl E. Chubin, and Jolene K. Jesse. (2004). *Standing Our Ground: A Guidebook for STEM Educators in the Post-Michigan Era*. Washington, D.C.: AAAS and NACME.

2

Disciplinary Perspectives

Different academic disciplines generally apply different methodologies to the evaluation of educational interventions. In the initial plenary session of the meeting, three distinguished social scientists provided broad overviews of the perspectives that economists, psychologists, and sociologists bring to the evaluation and implementation of intervention programs.

THE ECONOMIC PERSPECTIVE

Economists tend to be skeptical about programs that incorporate aspects of affirmative action, said Samuel Myers, Jr., of the University of Minnesota. Economists focus on calculating the costs and benefits of a particular program, even though the costs and benefits can be very difficult to measure in the absence of markets to assign monetary values to outcomes. Secondary data may be used to evaluate such outcomes, but the use of these data can raise additional difficulties.

Some economists also tend to be hostile to diversity programs, citing the model developed by economist Gary Becker that analyzes discrimination in economic terms. If the members of a group are qualified for a position but are denied opportunities to participate in the marketplace because of discrimination, then the marketplace should punish the individuals who discriminate. Essentially, the discriminating group should have to pay to distance itself from the group. Those people who do not discriminate will have higher profits, and the people with higher profits

will prosper while people with lower profits will fall behind economically. These economists tend to believe that the market will correct inequalities naturally in the long run. From this perspective, interventions represent an extra cost to produce an outcome that would have been achieved anyway. One solution to discrimination, therefore, is to make markets more competitive instead of intervening in markets.

Economists usually focus on the marginal costs and benefits of a program because they want to be able to calculate a program's net social benefits, or the benefits minus the costs. An example might be an agricultural analysis, where applications of water and fertilizer result in higher yields that produce a greater economic return. Another way to conduct economic costs-benefit analyses is to consider efficiency. Could the same outcome be obtained in a different way? For example, is the additional cost of producing Ph.D.'s in cell biology matched by the incremental benefits that are achieved? In such an analysis, redressing a prior wrong or blazing a path for future generations is not relevant; the only consideration is efficiency.

However, the calculation of benefits and costs relies largely on market evaluations, and for many educational interventions, no explicit market evaluation is immediately available, Myers pointed out. For example, economists might contend that the best market evaluation of an intervention program is the wages earned by underrepresented minorities who receive Ph.D.'s in cell biology. While not a perfect evaluation, they would say, it is more concrete than their degree of satisfaction with a program or a vague measure of improvement in their lives.

But the lack of a market to evaluate benefits does not mean that benefits do not exist. Some of the benefits associated with the production of new Ph.D.'s in the biological sciences go beyond what gets sold in the market. Also, benefits may include not just the benefits to an individual but to larger institutions. In other words, in addition to the personal benefits to the participants, there can be secondary or spillover benefits that need to be calculated. Economic methodologies therefore have a weakness in being unable to associate definite costs and benefits in many situations. Instead, said Myers, "you need to think very creatively about how to measure some of the nonmarket effects. . . . If you want to measure [things other than efficiency], like equity or responsiveness or adequacy, you should include that as well."

Economic analyses of diversity programs were developed largely to apply to discrimination between white and nonwhites in U.S. society, and specifically whites and African-Americans. But U.S. society is much more diverse than such an analysis would suggest and is becoming increasingly diverse. A relevant economic question is therefore whether diversity is economically beneficial or harmful. This question has been examined

largely by researchers looking at international development. Researchers have looked at countries where there are many ethnic groups and at countries where there are few ethnic groups. By comparing the diversity of ethnic groups in a country to economic growth, researchers have concluded that diversity may not necessarily be a good thing, because greater diversity tends to be associated with ethnic conflict, and ethnic conflict, if not mediated, can lead to inefficiencies.

However, other kinds of research have shown benefits of diversity. An example is research at universities showing that students benefit intellectually from being in dorms with diverse groups.

Affirmative action programs have not been ruled out by courts, Myers observed. But affirmative action programs have to be "narrowly tailored," which means that they need to be applied specifically to the groups that were discriminated against. They also are subject to "strict scrutiny," which means that because a program is racially focused, the standard of proof demonstrating that there has been racial discrimination is high.

One way to supersede these concerns is to open a program to everyone. But this raises the question of who benefits. Many race-based programs apply to every nonwhite group, so the benefits do not accrue just to the group for which the program might have been designed. In that case, the inability to tailor a program narrowly may undercut some of its objectives. The value of such a program "is a tough question, and you frequently get answers that you're not happy about," Myers said.

Another economic question is whether the benefits produced by an intervention program persist through time. The classic example is Head Start, where there is a benefit immediately and up until about the second grade. But as time goes on, there does not seem to be a difference between people who participated in the program and people who did not participate. Economic analyses try to look at the net benefits over time to calculate the value of a program.

Randomized experiments are difficult to do, for logistical and ethical reasons, in evaluating such programs. Researchers therefore have to rely on alternatives such as quasi-experimental designs. But there can be even more problems associated with quasi-experimental designs, such as the difficulty in finding a good match between a control group and a treatment group. Several techniques can be used to overcome that problem. For example, statistical techniques can be applied to data drawn from two groups of individuals, one consisting of individuals who meet a threshold for participation and another consisting of individuals who were close to a threshold. Another technique, interrupted time series design, can be used to assess whether a program resulted in a shift in outcomes.

Evaluations also raise many issues involving validity. As an example, Myers cited a voucher program in New York City that seeks to improve

the achievement of inner city students by giving them scholarships to attend private schools. Many thousands of students might want to participate, so a lottery is held to allocate the vouchers. But some of the people eligible for the program might not participate in the lottery, and this lack of participation might be associated with important outcome variables, like test scores. That is one form of potential selection bias. In addition, the people who participate might not accept the money. "It's an odd phenomenon, but it happens," said Myers. Some students might enter the program for one year and then drop out, resulting in another form of selection bias. There can be systematic differences between groups of parents and students who make different choices, and there is no way to get a perfectly random assignment. A technique called Heckman selection bias correction can help account for these things. But applying the techniques required lots of information about participants that can be used as background characteristics to control for differences between the groups.

Finally, there is a question of perceptions versus reality in economic analyses. Economists do not deal with perceptions, Myers observed. Many evaluations ask "what did you think" or "how do you feel." "Economists don't care about what you thought or how you felt; they care about what your wage was." The question that must be asked is what value subjective assessments like teacher evaluations have. Perceptions are likely to be different on the last day of a class as opposed to two years later, when graduates are in the job market. And there is a literature demonstrating that perceptions can vary for other reasons that have little to do with the actual outcome of a program.

One reason why it has historically been difficult to defend diversity programs is because the science of evaluating the programs has been in its infancy. Also, the people running the programs often were primarily engineers or cell biologists, who do their jobs well in terms of mentoring and training but do not necessarily have the knowledge base to evaluate programs. Furthermore, this problem is not limited to engineers and cell biologists. Evaluation of diversity programs is a concern throughout the STEM fields and throughout the federal government.

However, "there's science out there that's just emerging with respect to diversity," Myers said. The National Science Foundation's Committee on Equal Opportunity in Science and Engineering, on which Myers serves, has proposed that there be a more uniform set of evaluation criteria, and the committee has sent a report to Congress detailing its proposals.

Myers insisted that he is a defender of the programs being evaluated. "But in order to defend [these programs], I have to think like the antagonists."

"The short answer to the question of 'How do you defend your program?' is to design it well and to collect high-quality data," he said. That

way, practitioners can "anticipate some of the questions that economists are likely to raise."

THE PSYCHOLOGICAL PERSPECTIVE

Psychology is an extremely broad field, said Martin Chemers of the University of California, Santa Cruz. On one end it adjoins biology, physiology, and neuroscience. On the other end, it merges with anthropology. Rather than focus on a particular approach, Chemers presented a cross-disciplinary view of how psychologists think about and evaluate intervention programs.

Psychologists seek to measure cognitive processes like learning, memory, or decision making as well as thoughts, beliefs, moods, emotions, and physiological reactions that reveal how people are feeling. Most important, psychologists study behavior. "The thing that separates psychology from philosophy is the emphasis on the observation of actual behavior," Chemers said. "Things like performance, withdrawal from a program, staying in a major, or going to graduate school are things we would measure."

In making these measurements, psychologists seek an attribute that they call reliability. This is the extent to which a measurement of a construct yields the same score every time it is measured. If a measurement yields a different score from one time to another, then either the construct is not stable and unchanging or different things are being measured from one time to another.

One way to assess reliability is to consider the coherence among the items being measured. For example, if students are asked to rate their ability to do research, psychologists consider whether the answers to related questions coalesce and cohere. Reliability also is assessed through what is called test-retest reliability. A score taken at one time is compared with a score taken at another time, and the scores should not change unless there is reason to believe that the underlying construct has changed. In many cases, the thing being measured cannot be objectively assessed. In these cases, it may be necessary to have experts rate whether or not something has occurred, or the level at which it has occurred. Reliability then can be assessed by looking at how often two different raters working on the same measurement come up with the same score. If they do not arrive at the same score, the measure is not reliable. These three methods—internal consistency, test-retest reliability, and inter-rater agreement—are three crucial gauges of reliability, and they have not been sufficiently used in many past studies.

Once researchers know that a measure is reliable, the most important issue is whether it is valid. Validity implies that a measurement really measures the thing it was intended to measure. For example, say

psychologists have an operational definition of a construct called efficacy—people's belief in their ability to do something. Given a method used to measure efficacy, psychologists want to know whether the measurement truly reveals the construct of efficacy. If the measure correlates well with other measures of similar constructs, confidence in its validity is enhanced.

A danger is that a measure will be similar to everything. For example, if people are asked about their self-esteem, the measure frequently will correlate with everything else asked of a positive nature. The result is a response bias, in that people who say positive things about themselves will say positive things about all aspects of themselves.

Measures also should have divergent validity. They should not correlate with measures that are dissimilar or with constructs that are dissimilar.

One of the strongest measures of validity is that measures allow predictions to be made about constructs. So a measure of efficacy is especially valuable if it can predict commitment to a career, performance in classes, or decisions to go to graduate school.

Like economists, psychologists worry about threats to validity. Sometimes, research methodologies cannot rule out alternative explanations of an outcome. This is a difficult point for researchers in the natural sciences to understand, because they have a very different way of approaching controls in their work. In biology or chemistry, researchers can refine the object of a study to a pure and universal state, such as the behavior of a molecule. But the object of study in psychology is people, who cannot be refined into a pure state. They have many attributes, and psychologists do not want other attributes to interfere with the attribute they are seeking to measure.

One technique psychologists use to isolate attributes is a technique called counter-balancing. They seek to make all of the attributes that they are not interested in equal for the experimental group and a control group. For example, say students are going to take a test either in the morning or the afternoon. If all of the students in the experimental group take the test in the morning and all of the people in the control group take the test in the afternoon, a difference between their scores may be the result of the time when they took the tests. Therefore, some of the students in each group should take the test in the morning and some in the afternoon. Similarly, other influences can be controlled through counter-balancing.

The best way to balance the differences among people is through random assignment. If a group of people can be assigned randomly to an experimental or treatment group and a control group, the differences between them can balance out. But random assignment can be difficult and is not feasible with many programs, since practitioners can resist randomly assigning people to different groups.

Various statistical designs also can control or balance the differences between people. Many of the presentations later in the meeting, Chemers noted, will feature the use of these techniques.

Psychologists also are interested in questions of causality—what causes what. Three broad approaches can be taken. The individual can be studied, the situation can be studied, or the relationship between the individual and the situation can be studied.

A focus on the individual might look at the ways in which people differ to see if the differences are systematically related to an outcome. For example, is there a belief among individual students that can predict whether or not those students will remain in a STEM career?

The effects of situational variables on a student also can be measured. In other words, what aspects of an environment affect a person? For example, what parts of a program make individuals either benefit or not benefit from a program?

The final approach is to consider how a situation interacts with a person. For example, Chemers' research has looked at the effects of research experiences and mentoring on the psychological variables of self-efficacy and personal identity. In turn, he has sought to evaluate how a person's identity and self-efficacy affect outcome measures like performance in scientific reasoning tests, decisions to remain in a STEM major, or commitments to a STEM career.

SOCIOLOGICAL PERSPECTIVES

Sociology is also a very broad field, said Willie Pearson, Jr., of the Georgia Institute of Technology, with connections and overlaps to both economics and psychology. The difference is that sociology tends not to focus on individuals. Rather, it focuses on groups and organizations.

Research on the sociology of science has investigated many different groups, ranging from Nobel laureates to disciplinary groups like physicists. But only for about a quarter century has it focused on underrepresented minorities. And many of those studies have focused not on racial or ethnic minorities but on women, partly because women have been the subject of programs in gender studies.

Many sociologists of science have had an undergraduate or graduate degree in physics, chemistry, or some other natural science along with a degree in sociology. That's even more true in the sister field to the sociology of science, the history of science. In addition, researchers have not tended to be very diverse, and the research that has been done has reflected that lack of diversity.

Only in the 1970s did the first systematic studies of race and ethnicity on scientific and technical careers begin to appear. The research Pearson

did for his dissertation, for example, involved about 700 African-American scientists and about 1,200 non-African-American scientists, though not much research has been done since then that speaks to career patterns.

Despite the paucity of sociological research on intervention programs, work done on student populations in general has produced some important findings. One is the importance of the middle school years. During middle school, students who have an interest and ability in science and mathematics begin to form an identifiable group, and this group becomes a pool that moves forward. However, Pearson also noted that there are different pathways into science, and researchers need to explore these other pathways to get a complete picture of how students enter STEM fields and careers.

The literature also reveals the importance of teachers, mentors, and role models for nurturing and developing talent. For example, many students are attracted to science and mathematics early on by inspirational teachers. A teacher may be inspiring "for the sense of discovery, for love of knowledge, and for the sake of learning," said Pearson. However, teaching and mentoring is not always positive, particularly in those cases where a teacher or mentor has low expectations of a student. For example, some teachers and mentors may not want to grade papers or otherwise assess minority students too critically for fear of discouraging them. Instead, they give a student positive comments and inflated grades, which can cause great difficulties later when a student encounters a different teacher or mentor.

Mathematical proficiency is another subject that has been studied by sociologists. When they are young, students typically are very interested in both mathematics and science. But the longer they are in school, the smaller the percentage of students who remain interested in mathematics. This has an influence on career choices, because a lack of mathematical proficiency can have a substantial influence on a student's choice of major. Even within fields such as chemistry or the social sciences, students may shy away from more quantitative courses and careers because they are uncomfortable with the required mathematics.

In addition to investigating student populations as a whole, sociologists have begun focusing more attention on the experiences of underrepresented minorities in a variety of educational settings. For example, many minorities gain experience with science in segregated schools and organizations, such as historically black colleges and universities or other minority-serving institutions. For many years this was one of the few ways in which minority students could gain access to the scientific community.

Recently, more minorities have been graduating from non-minority institutions. At non-minority institutions, minorities may not have the

enrichment opportunities available to them previously, especially given a legal climate that makes race-based programs problematic from a policy perspective. Also, in previous years, students who graduated from minority-serving institutions had a tendency to return to them as faculty members. Today, minority students who attend non-minority institutions tend to become faculty at non-minority institutions, with the consequence that the minority-serving institutions are having trouble recruiting faculty members.

One controversial study looked at the participation of minority students in the top private and public universities. While more underrepresented minorities are participating in these programs, many of these students—and particularly African-American students—did not have grade point averages (GPAs) sufficient for them to be accepted into STEM graduate programs. As a result, the students' GPAs were a barrier for entry into further training.

Gender has many interactions with minority status. Much of the growth in participation in science and engineering at the undergraduate level for African-Americans and Latino groups has come from the greater involvement of women. Yet women can have a more difficult time becoming tenured faculty members, especially at the most competitive universities. In turn, their students see young faculty members who are not getting tenure despite being talented, which can send a negative message to them.

The sociological literature shows that having a critical mass of minorities in a program can make a big difference. When a minority is the only person from his or her group in a program, whether at the undergraduate, graduate, postdoctoral, or faculty level, that person's isolation can become a problem unless the person can be somehow integrated into the fabric of the scientific community. In addition, context matters, in that a large group of students who are spread out among many different departments may not be able to mitigate the "toxic environment" that many minority students face.

Sociological research has shown that pre-college and undergraduate preparation play major roles in subsequent educational achievement. But minorities tend to experience disparities at each stage of the educational ladder, and these disparities accumulate over time. For example, a disproportionate percentage of underrepresented minorities have not had the advanced mathematics or writing courses that can be critical in science. As a consequence, they can underperform on standardized tests that are used as measures for entry to certain types of programs.

Another problem is low expectations on the part of graduate advisers. For example, in their recommendations, an adviser may write "This is the best black student in the department," or "This is the best Latino student."

Sociological research also has looked at the so-called imposter syndrome, in which a student does not feel that he or she belongs in a position. Mentors from a graduate or undergraduate program can be especially important in helping students get through discouraging moments.

A related problem is what Pearson called "bare-bones" Ph.D.'s. For example, a minority student might take a postdoctoral position at a prestigious university, yet he or she might emerge from the experience with just one or two publications. "This does not make sense," he said. "How can you come from one of the best programs in the country, yet your CV is so thin? Something is happening there, and it's not good."

In general, the quality of the education experience in STEM is far from equitable. Students emerge from programs having very different experiences. Yet the enrichment experiences that students have in programs can be very important for their future educational and career choices and for such outcomes as promotion and tenure.

Many questions about intervention programs that involve sociological issues remain to be answered. At the same time, demonstrating that these programs are effective has become a critical issue. The number of programs has proliferated in recent years, yet increases in the number of underrepresented minorities have been marginal. It is important that the people conducting evaluations have skills in conducting systematic, critical, and rigorous evaluations, and evaluations need to be supported if they are to produce useful results.

INVOLVING INVESTIGATORS FROM MULTIPLE DISCIPLINES

During the question-and-answer session, the presenters were asked how program practitioners can involve evaluation experts from the different disciplines, especially when programs are small. Chemers replied that one approach is to forge alliances with other departments on a campus, because there may be situations where just a graduate student or a good statistician can meet a program's evaluation needs. Such alliances can help form a community of scholars that can be called on for help. Myers suggested exploring the possibility of an institutionalized evaluation component that can be applied to more than one program.

Pearson responded that a range of evaluators should be involved at the beginning of a program, not just when it is nearing its end. Several federal funding agencies support workshops for principal investigators, and these workshops could help a program practitioner find evaluators who have the skills needed to do a good job. For example, Chemers noted that he had recently received a grant to offer a series of workshops to teach principal investigators from the natural sciences and engineering the basics of the behavioral and social sciences.

3

Identifying the Active Ingredients of Successful Programs

Most interventions designed to increase the representation of minorities in the biomedical and behavioral sciences have multiple components, such as mentoring, research opportunities, academic support, and scholarship support. Each of these components of an intervention can have different effects on individual students and on groups of students. One of the goals of research on the efficacy of interventions is to isolate and quantify these effects so that the overall effectiveness of a program can be estimated.

PREDICTORS AND OUTCOMES IN THE MEYERHOFF SCHOLARS PROGRAM

The Meyerhoff Scholarship Program at the University of Maryland, Baltimore County (UMBC), has been one of the most successful programs in the country in encouraging minorities underrepresented in the sciences to enter Ph.D. programs. UMBC is a medium-sized research university on the southern outskirts of Baltimore headed by an African-American mathematician. Maryland has a large African-American population, especially surrounding Baltimore and Washington, D.C., and a specific mission of UMBC is to promote the success of underrepresented minorities in the sciences. The program began in 1988, and the first class of students consisted of 19 African-American males. The program soon expanded to include African-American women, and in 1996 the program was opened to all students who had an interest in the advancement of minorities in STEM

fields. To date, about 60 percent of the students in the program have been African-Americans.

The program is based on several key findings drawn from the research literature, said UMBC's Kenneth Maton. Students who are integrated academically and socially into an academic environment tend to be more successful. The program therefore has a six-week bridge program that students attend the summer before their first years, a sort of "boot camp," said Maton, that "gets them familiar with the university environment."

Building a sense of community is a major part of the program. Students are committed to helping each other, and students receive support from the faculty, from administrators, and from each other throughout the year. "There is a sense that there is a protective and nurturing and challenging environment in which the students are embedded," said Maton.

Knowledge and skill development also are emphasized. Academic tutoring is designed not to turn D's into C's but, rather, B's into A's. Students form study groups designed to provide both intellectual and social support. Summer research internships expose students to other parts of the United States and to other countries.

The program also draws from the research literature in providing sources of motivation for students. Meyerhoff scholars have to maintain a B average in a science major, so rigor and challenge are critical program values. Students are encouraged to get to know professors and work with the best students in class no matter what their ethnicity or race. Outside mentors and professionals in the Washington, D.C., and Baltimore areas provide support and an outside perspective for students. Program staff do intensive advising, with continued monitoring of the choices students are making and intense encouragement for students to stay focused. It is "very much a Cadillac of a program with lots of resources," said Maton. "It's very consistent with the theory of what needs to happen."

An evaluation program conducted by Maton and his colleagues has two primary goals: to examine the outcomes of the program, and to delineate factors that contribute to student success. Evaluators have gathered full outcome data for 390 African-American students after graduation. They have compared the data from these students with outcome data for students who were invited to attend the program but chose instead to attend a different university. The evaluators obtained informed consent from both groups of students, which included permission to obtain their transcripts and to follow their academic paths. Outcome measures include Ph.D.'s, M.D.'s, master's degrees in STEM fields, allied health degrees, students who do not continue in a STEM field, and other categories. "Thank goodness for the Internet—that helps following up—but it's a massive effort," Maton observed.

Meyerhoff scholars complete questionnaires both before they enter

the program and at different times during their time in the program. For example, while they are in the program, they are asked to rate the perceived helpfulness of each of the program's components on a 1 to 5 scale. These data are used in part to determine which program components are perceived as most important by students and also to predict program outcomes.

Among students who entered the Meyerhoff Scholarship Program between 1996 and 2003, 50.9 percent entered Ph.D. programs upon graduation, compared with 8.6 percent of the comparison students. Overall, 79.8 percent of the entering African-American Meyerhoff freshmen in these cohorts pursued STEM graduate education of some type (whether Ph.D., M.D., M.S., or allied health), in contrast to 49.1 percent of the comparison students. These differences remain substantial and statistically significant even when covariates such as SAT scores, high school GPA, gender, or intended major are taken into account.

The program components perceived by African-American Meyerhoff students as especially important include financial scholarship, being part of the Meyerhoff community, participation in the summer bridge group, summer research internships, and study groups. Students who reported greater benefit from mentors and from university administrators were especially likely to enter STEM Ph.D. programs when other variables were controlled.

The students who entered Ph.D. programs had significantly higher high school GPAs but did not differ in SAT scores from students who did not enter Ph.D. programs. Future Ph.D. students also indicated higher levels of precollege research excitement than did students who chose not to pursue a Ph.D. A higher percentage of males than females pursue education at the master's level. Another interesting finding is that students who have entered the program since 1995 have been more likely to continue to graduate school than students who entered the program before 1995.

The evaluation design has certain limits, Maton said. Students are not randomly assigned, which limits the strength of conclusions that can be drawn from the outcomes. Also, the current set of indicators explains only part of why some students choose to go into a Ph.D. program and others do not. "We need to capture the dynamic processes by which students make career choices," said Maton. Future plans call for new ways of analyzing predictors and outcomes for larger numbers of students, as well as looking at direct and indirect influences on students. The evaluators also want to do semester-by-semester tracking to follow students from the time they enter college using qualitative and quantitative methods to see which students stay on track for a Ph.D. and which ones go off track.

Later in the meeting, Matea Pender, a public policy graduate student at UMBC, presented data on a specific component of the Meyerhoff Schol-

arship Program: the summer research internships that many Meyerhoff scholars have after their first three undergraduate years either on campus or at other institutions, including private and government laboratories. The internships are not mandatory, but the Meyerhoff program helps students find and participate in these summer research experiences.

The project on which Pender participated looked specifically at whether summer research internships helped students enter Ph.D. programs following graduation. The project gathered data on 338 Meyerhoff scholars from 1991 to 2003. About one-third of this group, which is 82 percent African-American, entered Ph.D. or Ph.D./M.D. programs. After controlling for such variables as major, gender, parents' occupation and education, attitudes toward research, whether students expected to apply for and be accepted in graduate school, and whether students participated in research during the academic year, students who did summer internships after any of their four college years were more likely to enter Ph.D. programs than their counterparts. While an effect was observed for all four years, it was strongest for students who did internships after their sophomore year. A strong effect also was observed after the junior year when each cohort of students was examined separately. "We believe that the closer you get to a graduate school program, participation in summer research internships makes these students more aware of the opportunities they can pursue," said Pender. "They realize what research is about and start getting the feel of what is going to be happening in graduate school."

The study had some limitations. In some cases, data were not available for students who might have done summer research internships, though the careful record-keeping of the Meyerhoff program probably minimized the number of such students. The study is being expanded to focus on several additional control variables, such as the quality of the high schools students attended. While Pender and her colleagues focused mostly on the timing of the internships, another important question is whether the number of internships makes a difference, and Pender and her colleagues are now expanding their analysis of the data to examine this point.

THE EFFECTS OF ENRICHMENT ACTIVITIES

The Biology Undergraduate Scholars Program (BUSP) at the University of California, Davis, began in 1988—the same year as the Meyerhoff program—and is based on many of the same ideas. It has an academic enrichment component, with intensive supplemental instruction in the freshman year, academic and personal advising, a summer bridge program, and a research component. It does not select for high-achieving students and is open to any minority or disadvantaged student interested

in biology. Currently, the 55 to 65 new entrants to the program each year are 65 to 85 percent minorities underrepresented in the sciences.

According to Merna Villarejo of the University of California, Davis, program practitioners wanted to know whether "participation in these kinds of intervention programs both prepare minority students and encourage minority students to go on in the biomedical professions." To answer this question, evaluators tracked and surveyed participants using both a survey and in-depth interviews. For a control group, they compared students in the program both to underrepresented minorities interested in biology who did not participate in the program and to the larger European-American and Asian-American majority. Overall the program has studied almost 7,000 students who have come to the campus interested in biology.

Minority students at UC-Davis, whether in BUSP or not, have SAT scores that are about 75 points lower than those of the majority students. However, the two groups are fairly similar in graduation rates, which is about 82 percent at UC-Davis. Minority students who were not in the program had a slightly lower graduation rate, but the difference was not substantial.

The outcome results were quite different when looking at whether students decided to remain biology majors. Altogether, only about 45 percent of the students who came to UC-Davis saying that they wanted to major in biology stayed with the major. But far more BUSP students stayed with the major than among the minority students not in the program or the majority group. Furthermore, the BUSP students were twice as likely to stay in biology with a GPA greater than 3.0, which is considered the floor for acceptance into most graduate programs. In fact, they do as well as the majority group.

According to Villarejo, this is "important evidence of the program's overall efficacy, in that students started out with incoming characteristics much lower than the whites and Asians and are performing at the same level in science."

The researchers then performed a multivariate logistic regression analysis on the data to search for factors that correlate with success in the sciences. Most immediately, women graduate at higher rates and with higher GPA's than men. Asian-Americans do better than other groups, and Hispanics do worse, even when controlling for such factors as income, parental education, and high school test scores. African-Americans graduate at average rates overall. Low-income students are much less likely to graduate from college. But of the low-income students who do graduate, they were just as likely to stay in biology as the average students.

High school GPA is the strongest predictor of GPA in college, according to this analysis. "If you do well in high school, you're likely to do well in college," said Villarejo. SAT scores were not major contributors

to remaining in biology, but doing undergraduate research was a major contributor.

There is a very large correlation between doing undergraduate research and graduating in biology with a high GPA. However, Villarejo noted, correlation does not imply causation: "We don't know whether students who do undergraduate research have their biology interests reinforced, or whether those who already have the interest choose to do undergraduate research." Indeed, an ethnographic study done by Elaine Seymour and her colleagues suggests that undergraduate research experiences do not change participants' minds about going into research but instead clarify or reinforce their interest.[1]

The researchers sought out several hundred high-achieving alumni of the program, and 201 filled out a survey form (representing about a 70 percent response rate). The survey asked about the former students' values, career paths, experiences, goals, decision-making processes, and outcomes. The survey also asked about the components of the intervention program that contributed most to their success. The alumni were divided into research professionals, which includes both Ph.D.'s and technicians, clinical professionals, and other allied health professionals. About 70 percent of the respondents chose a career in the biomedical professions, with 66 percent of that group electing to become medical doctors.

According to the surveys, the most important component of the BUSP program was the supplemental instruction provided in basic chemistry, calculus, and biology. Research experiences were considered important by some, and advising was considered less important.

The rationale behind programs that emphasize undergraduate research is that when students engage in research, their appetite will be whetted to enter a career in biomedical research. Most of the survey participants had participated in undergraduate research, and their reports were mostly positive. Of the 38 respondents who entered a research career as either a researcher or technician, 80 percent reported that their undergraduate research experience was an impetus to stay in science, pursue a research career, and go to graduate school. For students who became medical doctors, only 36 percent said it had encouraged them to do more research, including continuing their interests in research through clinical research or academic medicine. And 40 percent of the students said that the experience convinced them that they did not want to do research. "That's not a bad thing to learn," said Villarejo. "We don't want people going on to graduate programs who can't stand being at the bench."

When asked about their perceptions of a career in biomedical re-

[1]Elaine Seymour, Anne-Barrie Hunter, Sandra L. Laursen, and Tracee Deantoni. (2004). Establishing the benefits of research experiences for undergraduates in the sciences: first findings from a three-year study. *Science Education*, 88(4):493–534.

search, the responses suggested that many former students in the BUSP program view being an academic researcher as "very unattractive," said Villarejo. They thought that researchers have trouble balancing work and family and have difficulty finding stable employment. They also thought other careers would offer greater financial rewards. Many respondents were concerned about having to move across the country to get a job, because staying close to family was a major consideration, especially for Hispanics. Even those former students who were getting Ph.D.'s expressed these concerns.

An interesting set of responses came from the technicians. Though they were very similar to the Ph.D.'s in their attitudes toward research, some said that they had very high college debt loads and that they needed to go to work to pay back loans. Another interesting group was the more than 20 allied health professionals, who were primarily dentists and doctors of pharmacy. All were women, and they were very qualified, even more so than the group that became M.D.'s. But they said that they wanted to know that they always could get a job and that their job would be family-friendly, so that they could leave work at the end of the workday. Time to degree, job availability and location, salary, perceived compatibility with parenting, and desire for recreation were driving factors for their choices.

Finally, the survey probed when Ph.D.'s decided that they wanted to do research. Of the 24 in the survey who eventually became biomedical Ph.D.'s, only five recognized research as their main interest when entering college. Eight had some interest but were also premed, and 11 were strictly premed. For many of these students, their undergraduate research experience was "truly transformative," said Villarejo. Doing research introduced them to something that, in some cases, they had never done before. The take-home message for program designers is that programs should "widen the pipeline," said Villarejo, because some first-year students have no experience with research but are well suited for it and are excited by it once they get the opportunity to participate. Even among pre-medical students, though the majority will go to medical school, some will be inspired by research experiences to switch into a research track.

WHAT MATTERS FOR UNDERREPRESENTED STUDENTS IN STEM

The Bill & Melinda Gates Millennium Scholarship program awards 1,000 college scholarships to entering first-year students and will do so through at least 2016. At that point, 20,000 African-American, Hispanic, Native American, Pacific Islander, and other minority students will have benefited from this program. The scholarships cover up to five years at the undergraduate level and five years at the graduate level. Students se-

lected for the program need to be minorities, eligible for a Pell grant, and a citizen or legal permanent resident; they also must have a minimum 3.3 GPA (though the average has been closer to 3.6). Students are judged on the basis of leadership abilities, community service, and extracurricular activities, with the program seeking students who have overcome hardship and are motivated, tenacious, and intellectually curious. Even with these strict criteria, "we have more than enough students who compete for these scholarships," said William Trent of the University of Illinois, Urbana-Champaign, who has studied the Gates Program and the Summer Research Opportunities Program. "The pool of potential high-performing but high-need students is much more substantial than we think."

The National Opinion Research Center at the University of Chicago has administered surveys to five cohorts of Gates Millennium Scholars so far. This is part of a longitudinal study that will follow the students for up to five years into the workplace, with approximately 90 percent of the scholars expected to complete a master's degree or above. A comparable group of students who did not receive the scholarship have also agreed to be surveyed. "This still does not relieve us of the self-selection bias, and we are doing things in our research to compensate for that," said Trent. Still, it is "an opportunity to learn quite a bit about a very unique pool of students."

The program provides a last-dollar scholarship, which means that very few of the students need to work to support themselves. "What we have learned is that the quality of financial aid is critical," said Trent. It influences both the choice of institution and the strenuousness of the major selected. Among the Gates Millennium Scholars, 87 percent attribute their choice of college to their financial assistance. Also, because students do not have to worry about covering the cost of their education, they have additional time to invest in their studies. The survey reveals that the scholars are able to study an average of four hours a week more than the students not in the program.

The scholars tend to attend more selective institutions than the non-scholars. This is important, said Trent, because selective institutions retain a higher percentage of their students irrespective of color. Comparatively fewer scholars attend minority-serving institutions, which is "not all good news," said Trent, "given the traditional role that minority-serving institutions have played in producing disproportionate numbers of underrepresented students going into STEM fields."

More Gates Millennium Scholars also choose STEM fields than is the case for all college students. In the initial cohort, more than 50 percent of the African-American students, about 50 percent of the Native Americans students, and just under 50 percent of the Hispanic students chose a STEM major.

Trent and his colleagues did a logistic regression analysis to identify

the factors that contribute to persistence in a STEM major. Not surprisingly, being male was a major factor. However, becoming a Gates Millennium Scholar was not a key predictor of persistence in a STEM major. What was important was academic engagement and noncognitive factors. SAT scores and AP exams taken also were factors, though successful Gates Millennium Scholars come from a wide variety of high schools, including majority black and majority Latino schools. "This finding is extremely important because of the numbers of students of color who are in school that don't offer AP courses," said Trent. "Preparation is huge in being able to compete effectively at the next level in these fields."

The other program that Trent described, the Summer Research Opportunities Program, is designed to engage underrepresented minorities in research experiments with faculty members to accelerate the students' socialization into a discipline and to foster the creation of a community of scholars among participants. Using a variety of instruments, including surveys, focus groups, interviews, and published documents, Trent and his colleagues found that 41 percent of the students involved in the program went into STEM fields over the years 1986 to 2003. A particularly interesting finding was that, among African-American and Latino women, spirituality and faith were major factors that they cited as sustaining their enrollment. In addition, more than 90 percent of students reported that academic engagement was a crucial factor. Other important factors were the opportunity to work with faculty, mentoring, and exposure to research and teaching in a research university.

"The things we do to provide academic engagement, opportunity, and exposure, to bring young people into these fields, can't be discounted," Trent concluded. "We continue to emphasize too much fixing the students and not enough fixing and repairing the context in which these young people are attempting to develop into today's and tomorrow's scientists."

During the question-and-answer period, Deborah Harmon Hines of the University of Massachusetts Medical School raised the issue of students who are not prepared for selective institutions. Her experience has been that many students who enter college with the same SAT scores and GPAs but coming from first-generation or economically disadvantaged families do not have the same social supports as other students and are at risk for dropping out. Greater vertical integration between colleges and the K-12 system could help prepare these students for college, she said. Trent noted that the same phenomenon had been seen in a presidential scholars award program instituted by the University of Illinois. "What historically white institutions, small and large, fail to realize is that race does matter. Many students do not easily acquire a safe space on campus in which to land and to grow." In response, the University of Illinois cre-

ated a set of activities designed to introduce students to the university before the first year began, followed by continuing academic supports. Other important factors are having a critical mass of other students in a racial or ethnic group and having gone to school with whites previously, Trent noted.

THE BENEFITS OF BEING IN A MINORITY TRAINING PROGRAM

One constraint on most educational interventions is that students cannot be randomly assigned to a treatment and a control group. One way around this constraint is to use longitudinal data from multiple programs to compare the features of programs that work. Longitudinal data enable evaluators to look at not only the features of programs but also some of the decision-making processes students go through over the course of their education.

Wesley Schultz of California State University, San Marcos, presented findings from a nationwide longitudinal study of more than 1,400 minority science students. About 400 of these students were supported by the RISE program, and about 100 were supported by the MARC program. The outcomes of students supported by minority research programs were compared to a matched set of students who had similar characteristics, including an intention to pursue a career in biomedical research, but who were not supported by a training program.

Schultz and his colleagues drew data from 25 RISE and MARC programs nationwide, with survey information being collected from students twice yearly. For each RISE or MARC student being studied, they found a similar student—"their twin, if you will"—who did not go through either program. They sought to balance the students in terms of such factors as major, GPA, age, parental education, and whether they spoke English as a first language. For some of the smaller campuses being studied, it was more difficult to find a matched student, so in those cases the researchers went to the campus and recruited comparison students. One complication in finding matching students is that their educations, too, may have been subsidized or supported but by organizations other than NIH. "There are lots of different programs out there," said Schultz. The evaluators therefore created another category of students who were supported through funding mechanisms other than RISE or MARC.

The majority of the students studied were African-American or Hispanic and females. All of the data were collected through a web interface using the best practices available from other longitudinal studies. The survey measured a wide variety of constructs, such as self-efficacy, identity as a scientist, educational accomplishments, publications, level of financial support, and prior experience with minority training programs.

Response rates have exceeded 70 percent, and the researchers have emphasized making sure that students stay in the panel.

Schultz reported data from five waves of surveys—the initial recruitment wave plus four follow-ups—which represents three years of data gathering. The data considered four outcome measures: a student's intention to become a scientist, baccalaureate graduation rates, applications to doctoral programs, and enrollment in doctoral programs.

One immediately noticeable aspect of the data, Schultz said, is that "there's a lot of movement in and out of these programs." The naïve view was that a student would enter a program, graduate, and then go on to a graduate program. However, 42 of the students who were in the matched control group moved into the RISE group. Fifteen moved from the MARC program to the RISE program. Of the students in RISE, 141 stayed in the program and 196 moved out. The movements were similar in the MARC program, with 22 moving from RISE to MARC, 20 consistently in MARC from the beginning, and 54 moving out of MARC. "This movement makes it difficult to evaluate the program," Schultz pointed out.

With three years of longitudinal data available, four key outcome variables are available: intention to pursue a research career, undergraduate graduation rates, applications to graduate programs, and admission into graduate programs. The results suggest that training programs can have a substantial effect on retaining minority science students and also on fostering their subsequent success as biomedical scientists. Of the students who were recruited into the panel as juniors or seniors, students in both MARC and RISE were significantly more likely to graduate than the matched controls. In applying to graduate school, 80 percent of the MARC panel did so, 64 percent of the RISE panel, and 49 percent of the matched controls. The same pattern appeared in the data of graduate school acceptance rates: the RISE students had higher rates than the controls, and the MARC students did significantly better than both.

Similarly, a substantial percentage of the RISE and MARC students enrolled in graduate school versus a small percentage of the matched controls who did so. The same pattern applied to medical school applications and enrollments, though there was no difference for master's programs. As Schultz concluded, "findings are encouraging and suggest that training programs like RISE can have a substantial effect on retaining minority science students, and on fostering their subsequent success as biomedical scientists."

EMPIRICAL VALIDATION OF A COMPREHENSIVE MULTIPLE INTERVENTIONS MODEL

Colleges, universities, and funding agencies could more effectively distribute resources to underrepresented minorities if they had better

answers to three questions, said Simeon Slovacek of California State University, Los Angeles. Can educational success be predicted based on academic and personal characteristics? Which interventions are most effective to foster educational success? And how does participation in scientific research affect students?

Slovacek and his colleagues set out to answer these questions by gathering data from students and program leaders at three institutions: California State University, Los Angeles; San Francisco State University; and New Mexico State University. All three programs prepare students for Ph.D. study, though only New Mexico offers Ph.D. programs in the biomedical sciences. All of the institutions have had enough success in preparing minorities as biomedical researchers that their intervention programs for these students have been repeatedly funded by the National Institutes of Health. All three universities have high science degree completion rates, and together they average a Ph.D. program placement rate of more than 80 percent.

The researchers used a mixed methods approach that relied on a variety of research instruments, including case studies, interviews with program directors, surveys of alumni, focus groups, and cohort analyses. Students were surveyed at least once a year about their experiences and attitudes toward the programs, as well as about the effectiveness of specific interventions. The research group also used an instrument called the Strong Interest Inventory® that has a strong reliability in gauging students' career aspirations. For example, the Strong Interest Inventory® proved to be a valuable way to differentiate between students who were interested in medicine and those who were more interested in research.

As measures of educational success, the researchers defined a progression that included interest in science in high school, declaration of an intention to major in a STEM subject, retention in the major, high GPAs, completion of a bachelor's in science, entry into a graduate program, completion of a Ph.D., and becoming a senior scientist. Ultimately, they focused on earning a Ph.D. as their main outcome variable.

More than 200 current or former students were involved in the research, plus a control group. Quantitative data were gathered from surveys, program records, institutional data, and other sources. Qualitative data came from in-depth interviews with program directors, faculty, and research advisers. This mixed method approach is particularly appropriate for descriptive and explanatory studies that seek to grasp the "how" and "why" of a program's components.

The research produced evidence that intervention programs help students succeed academically. Surveys showed that students found several things helpful in succeeding in their science courses, including research, mentoring, study groups, supplemental instruction, and advice from course completers. The number of years a student was funded by a

MORE program was a significant predictor of success, as was participation in student groups, having a faculty mentor, and receiving faculty assistance in applying to graduate school. Personal factors that were correlated with entry into a Ph.D. program included a student's academic background, credits earned in AP mathematics, and GPAs.

Some factors discouraged Ph.D. study. Having an outside job not at the university was one, along with issues with the university or family obligations. On this last point, Slovacek pointed out, when students are asked whether they are supported by their families, most answer yes, but the proper question to ask is whether students have to support their families.

Students who had multiple sources of funding were more successful, because if funding ran out from one source they could turn to another. Advocacy for students also turned out to be an important factor, because negotiating the university bureaucracy can be very difficult. "In my own college we have 28 forms that need to be filled out at some point," said Slovacek. "Each of these forms requires how many signatures? Not one, not two, but three signatures. Are they all in the same office? No. So just in one college, you have an incredible bureaucracy." Underrepresented minorities need advocates, whether faculty members or program staff, who can help them deal with such problems as oversubscribed classes, lost or held-up checks, and unprocessed or lost administrative forms.

The program variables associated with success included strong program leadership, the number of years that a person has been running a program, a focus on students, the ability to marshal resources, critical mass, and networks to the scientific community.

Slovacek drew several broad conclusions from his experiences. One is that having surveys come from program directors and mentors is more effective than having them come from evaluators. Second, requirements enforced by Institutional Review Boards that students be given the option of not identifying themselves on survey responses can make it very difficult to compare responses across surveys. "Use one questionnaire or survey if possible."

Finally, he said, "The outcome of any serious research can only be to make two questions grow where only one grew before."

Later, Alan Peterfreund from Peterfreund Associates presented data drawn from a specific part of the program. The question to be investigated was, What is the effect of paying students to conduct research—essentially buying their time for an intervention program?

Data were gathered from a questionnaire returned by 46 students supported by MORE programs at San Francisco State University (representing a 75 percent response rate). For a control group, the researchers administered the questionnaire to 97 students with characteristics similar to those in the MORE group.

More than half of the students in the MORE programs were spending more than ten hours per week in the lab. The MORE students also were more likely to have participated in research in a previous year. A "very significant point," according to Peterfreund, is that only about one-third of the MORE students had an outside job, whereas almost 80 percent of the other students had such a job, and the students in jobs reported that they were working 16 hours a week or more. "The MORE students, when we asked, told us that if they were not funded, they, too, would work outside jobs," said Peterfreund.

Analyzing the impact of the research experience is complicated by the fact that students have many different kinds of support. To analyze the effects in more detail, the evaluators divided the involvement in research into three levels: basic lab support, a more mid-level research called engaged participation, and research creation, which is equivalent to what a typical graduate student does in a lab. A greater percentage of the MORE students participated in the mid-level of research engagement. Students engaged in the higher levels of research reported that they were better able to succeed in class, partly because of the mentoring and assistance they receive from faculty members. "When students are engaged in research environments, they're starting to transform from thinking as a student to thinking as a scientist," said Peterfreund. "It's a mentored activity—a very important one. . . . Science starts making sense and has context."

The evaluators asked students about achieving goals in five broad areas: research participation, research communication, academic performance, time management, and engaging with role models. In four of those five areas, there was a statistically significant difference between the MORE students and other students. Also, the majority of MORE students strongly agree that research has increased their desire to pursue an advanced degree and has inspired them to think about careers in science. They also were more interested in obtaining Ph.D.'s than were the nonfunded students. "In summary," said Peterfreund, "students are more engaged in a more sophisticated level of research, with deeper participation and more communication opportunities, and we see an impact for the MORE students with respect to their academic performance and their self-perception as scientists."

Isolating research as a distinct component of an intervention program can be difficult. MORE students also engaged in other enrichment activities, such as research seminars, community support, and academic support. "To tease out one element is a challenge," said Peterfreund. Also, because the study looked at just one institution, the question of how widely applicable these results are remains open.

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Investigations Involving Particular Groups

Several of the presentations at the meeting looked at specific groups of students, whether distinguished by race and ethnicity, age, or gender. Narrowing the focus to particular groups in intervention studies has both advantages and disadvantages. Focusing on groups can remove some of the extraneous variables that can complicate the analysis of data drawn from more heterogeneous samples. However, the lack of comparison groups may leave researchers unable to investigate the factors that affect the group as a whole. The strengths and weaknesses of this approach need to be taken into account when designing a study and when interpreting its results.

AFRICAN-AMERICAN MALES

In recent years the status of African-American males has again become a topic of considerable discussion, said Jerlando F. L. Jackson of the University of Wisconsin-Madison. For example, the *Washington Post* recently ran a series of articles on African-American males that extended over much of a year, and other media stories have examined the experiences of African-American males in education. Many of these discussions have focused "primarily on the shortcomings of African-American males in education [and other areas], and have painted a doom-and-gloom picture," said Jackson. In general, the media provide few successful images of African-American males. "This negative imagery tends to victimize African-American males as a group." As is typical of stereotypes, the

views are imposed on the entire group, regardless of an individual's success. "Individuals within a group were seen as part of the group and not necessarily as individuals, thus connecting them back to the negative imagery." As a result, "the stigma of inferiority attached to the images follows the group, and in turn an individual, regardless of what domain of employment or education an individual may enter." A particular emphasis has been on social domains where intelligence is assessed, as is the case in education. The question is whether the heightened attention to African-American males will lead to further stereotyping or to public policy responses to address the issues affecting many members of this group.

In a 2006 article in the *New York Times*, Orlando Patterson wrote that cultural explanations need to be explored when considering the lives of African-American males. In this light, said Jackson, two contrasting questions could be addressed: "What's wrong with African-American males and their interaction with the American educational enterprise," or "What's wrong with the American educational enterprise and its interaction with African-American males."

One fact that has been lost in the attention given to African-American males is that *all* males in U.S. society face challenges. According to the *Washington Post*, for example, one-third of young men between the ages of 22 and 34 still live at home with their parents, regardless of race or ethnicity. "What is happening to boys in general in society is irrespective of race and ethnicity, which begs the question of the extent to which we have disentangled what we have observed in African-American males" from issues that can be attributed to gender, class, or other attributes.

A recent issue of *American Behavioral Scientist* entitled "Beyond Brown: New Approaches to Addressing Inequities in Education for African American Males," which Jackson co-edited, examined the experiences of African-American males from a variety of viewpoints, including historical, environmental, legal, educational, and social contexts. "We wanted to push beyond the discourse of *Brown v. Board of Education* and think about contemporary interventions that would work, and we wanted to move away from previous treatments of the topic in which isolated situations were observed."

Jackson described two articles in particular. The first, on special education, observed that "demographic variables such as race, ethnicity, and in many cases gender and class remain significant predictors of the types of educational experiences that will occur for students." The students who are placed in special education classes and programs at the highest rates tend to be black, male, and poor. As a result, the group most likely to be placed in special education is African-American males, and this is true in urban, rural, and suburban schools. According to the article, nearly 20,000 African-American males were inappropriately classified as mentally re-

tarded, which represents a 300 percent overclassification for this group. African-American males also are identified as seriously emotionally disturbed more than twice as often as for other groups.

The article also looked at how African-American males who are enrolled in special education use and perceive school counseling services. The study found that interactions with counselors were centered on academic and personal issues. In particular, the interactions were centered primarily on scheduling and academic planning. African-American males in special education demonstrated a hesitancy to disclose information about their personal and social circumstances and a resistance to use the full range of services available from counselors. "Many of the participants used language to link their hesitancies to notions that are related to slavery," said Jackson.

Another article in the issue, which was written by Jackson, looked at factors that may contribute to disparate representation of African-American males in the academic workforce. *Brown v. Board of Education* set in motion a social contract that promised to eradicate many inequities in education, since it was assumed that improvements in K-12 education would migrate into higher education. However, this has not occurred. African-American males in academia are still most likely to be hired in lower level positions at less prestigious institutions. Jackson's article set out to explore the factors that led to this underrepresentation. He looked at factors related to concepts of human capital and merit-based performance measures. Hiring practices in higher education typically rely on the application and CV, as well as whether an applicant has demonstrated that he or she can do the job being sought. Using data from the 1999 National Study of Post-Secondary Faculty done by the National Center for Education Statistics, Jackson looked at the five human capital variables in the database and at several merit-based variables, including publications, external funding, and participation on committees and other activities.

The study came to several key conclusions. Models containing the human capital and merit-based performance measures were able to explain the high observed representation of white males in the academic workforce. "The advice that is provided about going to good schools and developing the right experiences and doing well in work does manifest in statistically significant observations for white males in the model." However, the models were less successful in explaining the underrepresentation of African-American males. "There's something else explaining whether they'll get that job," said Jackson.

Two explanations should be considered, according to Jackson. One is that the model is excluding variables that are relevant to hiring decisions. In that case, it may be necessary to include qualitative variables such as a person's dialect or appearance that might be disadvantaging

African-American males in the hiring process. The other possibility is that the criteria and variables being used in the model are problematic for African-American males. That is, the lack of significant variables as predictors supports the low observed rate for African-American males in the academic workforce. "Human capital and merit-based performance do appear to be related to hiring practices but to differing degrees for various groups."

AFRICAN-AMERICAN WOMEN IN SCIENCE

There are more African-American women in science than African-American men. Though science is often seen as dominated by whites and males, "apparently no one told these young women," said Sandra Hanson of Catholic University, because they are "doing very well in science in terms of interest and involvement."

Hanson has applied what she calls a multicultural critical framework to the anomalous success of African-American women in science. She has used data from the National Education Longitudinal Study to quantify the experiences of African-American women in science. She also has arranged with the web survey firm Knowledge Networks to collect information from young African-American women to understand their achievements in science.

Instead of viewing gender as a characteristic of individuals produced by socialization, many scholars today apply a structural approach that sees gender as an organizational principle. For instance, a recent influential study of women in corporations did not focus on their socialization into certain attitudes about work. Instead, it looked at the work and job structures that created low attachment for both women and men in those kinds of jobs.

Yet even this structural approach does not go far enough in explaining the experiences of African-American women in science, Hanson said. First, it downplays their achievements by not accommodating the idea of agency. Structural approaches tend to be deterministic in implying that people with certain characteristics will act in particular ways. They do not acknowledge, said Hanson, "that these social structures, which were constructed, can also be reconstructed." Critical theorists, in contrast, balance agency and structure to acknowledge that individuals have a degree of free will and that structures can change. "Students aren't merely victims of educational structures," said Hanson. "They don't absorb all of the messages and don't obediently comply with the race and gender messages they are being given."

How do these African-American women manage to swim against the tide of the science education system? Hanson has found that African-

American communities and families make considerable investments in their daughters, creating strong personalities that tend not to be afraid of the science establishment. Critical theory suggests that gender and race relations are continually negotiated, and that hierarchies and structures are sometimes questioned and contested. These investments in daughters, which are not necessarily replicated in white communities, also have a historical context that goes back to slavery, Hanson said.

Understanding African-American women's experiences in science also requires acknowledging diversity in gender systems. Scholars tend to look at either gender or race but not at the intersection of the two. Also, research has had a middle class bias, in that it often extrapolates the experiences of white middle class women to all women.

But the experiences of African-American women in science can be quite different than for white women. For example, the National Education Longitudinal Study has data from hundreds of thousands of students who have been surveyed since 1988. These data show that, by eighth grade, young African-American women are more likely to be in advanced, enriched, and accelerated science courses than are their white female counterparts. They are more likely to look forward to science class than white women and are more likely to think that science will be useful in their futures. In tenth grade, they say that they work harder in science class than their white counterparts, and they are more likely to plan on having a science job at the age of 30. African-American women do not outperform their white counterparts in terms of GPAs or standardized test scores. But eight years after graduating from high school, they are more likely to report that they are in a science-related job.

Turning to her work with web surveys, Hanson explained that Knowledge Networks has developed a representative sample of households that have the technology to generate survey results. The firm was able to provide Hanson with a sample of 1,000 African-American and white women between the ages of 13 and 25. That sample allowed Hanson both to ask the women open-ended question and to use a technique that relies on vignettes to assess their perceptions. The four vignettes she has used feature an African-American woman talking about issues involving race, an African-American woman talking about issues involving gender, and two comparable vignettes that use white women. This technique is "good for measuring discrimination," Hanson said, "because people are hesitant to talk about discrimination when they are talking about themselves." Also, compared with survey questions, which do not have high reliability, the vignettes can be randomly assigned, producing experiments with greater validity.

After the vignette is viewed, respondents are asked whether this situation has ever happened to them, and then whether it has happened

to others. With a sample of African-American women, when the girl in the vignette was African-American and talked about race, 31 percent of respondents said it had happened to them, and 52 percent said it had happened to others. However, only 16 percent of African-American women said that gender issues had arisen with them. "These African-American women see race as a bigger factor in the classroom than gender," Hanson concluded. However, African-American women also saw gender as a factor in the classroom more often than did white women.

In another vignette, a woman in the vignette says that she likes science but does not feel comfortable in the classroom, even though she never mentions either race or gender. This vignette generated greater agreement among African-American respondents that something similar had happened to them. The respondents "did not want to be told it was race or gender. . . . They did not want someone else to bring up the race card or the gender card."

This technique offers great potential to explore the attitudes and experiences of minority women in science, Hanson said. It also points toward considerable "optimism in terms of seeing their interest and engagement and strength in science."

WOMEN OF COLOR IN ENGINEERING

Research-based activities can be used both to enhance the professional and personal lives of scientists and engineers and to explore the factors that influence their lives. Willie Pearson, Jr., delivered a presentation for Cheryl Leggon of the Georgia Institute of Technology, who was unable to attend the meeting, on a project focused on women of color in engineering. While results from the project were not available for the talk, Pearson described some of the methodological considerations that informed the study's design and implementation.

The project's goal was to understand the experience of minority women engineering faculty in a larger institutional and professional context while also providing them with professional development and enhanced socialization. Each woman was assigned a mentor who could work with them on career planning and implementing a research agenda, because even in highly regarded programs, Pearson said, "some do not have a clear vision of what their research program is going to be."

Another emphasis was the development of professional skills, including management skills, because researchers "discovered very early on from the literature that running a laboratory or a particular research team required skills that they were not necessarily taught in a graduate program." Managing a lab is akin to running a small business, according to Pearson. Simultaneously, faculty have to be writing proposals, ensuring

continuous funding, dealing with issues of time management, and managing the grants they have. Given the multiple roles that these women have to play, asked Pearson, "how do you organize these in a manner to be successful?"

Participants in the project were identified using the snowball technique. Contacts were made with individuals who then referred additional individuals to contact until sufficient numbers of people were enrolled in the study. Women who participated in the project committed to remaining involved for the duration of the project, attending an annual conference, and submitting certain information about themselves, such as their CVs. They also must have earned a Ph.D. in engineering and must be in tenure-track positions in a college or university. The first cohort was about 20 tenure-track women on the engineering faculty at a 19 different institutions.

The principal investigators on the project, which included an engineer and a sociologist, termed the project an "initiative," not an intervention, because they interpret "intervention" as implying that something needs to be corrected within a group or system, whereas "initiative" implies that the skills and success of the women involved in the project are being enhanced. They also wanted to reframe the issue of diversity in terms of race, ethnicity, and gender. These should not be treated as additive, the investigators said, but as synergistic, so that one person has multiple identities and statuses. Gender influences considerations of race and ethnicity, and race and ethnicity inevitably reflect on gender.

The study draws on literatures from the sociology or science, science and technology studies, and evaluation research. Much of the previous literature on women in science and engineering has not been desegregated by race, and many studies investigating race and ethnicity have not desegregated by gender. This can be "very problematic," said Pearson, since the experiences of males and females in, say, engineering can be quite different. For instance, African-American women have a higher rate of participating in engineering, and the reasons for this greater representation need to be explored. Experiences also can be different for African-American women, Chicano women, Native American women, and members of other groups, said Pearson.

STEM fields also need to be disaggregated, according to Pearson, because in engineering, for example, mechanical engineering can be different than electrical, computer, or biomedical engineering. More women nationally are concentrated in biomedical engineering and chemical engineering, so experiences in these different fields should be separated.

Finally, coordination between different policy actors is important. For example, programs of the federal government should reflect and harmonize with those of private foundations, and all programs should be insti-

tutionalized at the colleges and universities where women in science and engineering work. By the same token, the combined issues of race, ethnicity, and gender are issues around the world, and studies of these issues should reflect the international context in which they are embedded.

WOMEN AND MINORITIES IN ACADEMIC MEDICINE

Women and minorities are underrepresented in academic medicine just as they are in STEM fields, said Lori Bakken of the University of Wisconsin-Madison. Even though approximately 50 percent of medical school graduates are women, not enough of them are going into academic fields.

Several years ago, she and her colleagues did a study of research training programs on the University of Wisconsin-Madison campus. One component was a short course in clinical research that introduced postdoctoral fellows and some faculty to careers in clinical research. An evaluation found that the short course increased the confidence of both men and women in performing research, but confidence increased more in men than in women.

Recently, Bakken and her colleagues had a chance to revisit these results through a related study done at the University of Wisconsin-Madison and Howard University in Washington, D.C. They focused on three questions: Can the gap in improving research self-efficacy be replicated? Does an intervention targeted at promoting self-efficacy diminish or eliminate the gap? And is there a difference in research self-efficacy between white participants and participants of color?

A self-efficacy workshop similar to the previous one was done at both institutions, involving a pretest and a post-test before and after the intervention. The workshop was done at each institution with the same team of individuals, with two-way video conferencing ensuring that all participants had the same experiences. The intervention (which was modeled after a similar intervention by Kate Roy Sullivan and James R. Mahalik) targeted the four sources of self-efficacy identified by Albert Bandura: performance accomplishments, verbal persuasiveness, reducing anxiety levels, and role modeling.

The hypotheses were that the intervention would increase self-efficacy for women, that the self-efficacy intervention would decrease the gap between men and women, and that there was no difference in research self-efficacy according to race. These hypotheses were based on a distillation from the literature. For example, the last hypothesis was based on the idea that the African-American population had already been confronted with so many obstacles along their career paths that they would already have a strong base of self-efficacy.

The 58 participants in the study included 16 male controls, 21 female controls, and 21 women in the intervention group, with 36 white participants and 22 participants of color, primarily African-Americans. The result is that before and after the short course self-efficacy increased significantly for men and for women. However, the gap observed in the first study between men and women was not seen in this study.

Bakken suggested two possible reasons for the failure to replicate the earlier finding. One is that the instruments for assessing self-efficacy were refined for this study, resulting in a rigorous 92-item psychometric scale. The other possibility is that the short course was designed to balance the role modeling done by the speakers, with an equal representation of men and women and African-Americans, whites, and other ethnic groups, whereas this balancing was not done in the original study.

Bakken noted that the gain in self-efficacy for participants of color was higher in the follow-up study than for the white participants, though the reasons for this are not clear. The project is gathering longitudinal data by monitoring the participants for a year following the short course.

MIDDLE SCHOOL STUDENTS

A particularly important time for the development of attitudes toward science and STEM careers is during middle school. Also, an important transition in the teaching of science occurs during these years. During elementary school, the teaching of science is often experiential. Many elementary school science classes are inquiry-based and engage students in the process of speculation and discovery. But by the end of middle school that approach tends to get lost and science is taught as a body of facts. "It has always seemed ironic to me that we want to train scientists but we don't give them the opportunity to be scientists," said Nicole Crane of Cabrillo College. "There's a strong element of connectivity when you *do* something. When you do it, you can identify with it and you can see your own role in that process."

Crane and her colleagues studied a program called Sea Lab, a two-night residential program in which middle school students participate in a variety of scientific and social activities. The researchers analyzed data from more than 650 youth using both qualitative and quantitative methods, with responses to surveys and interviews being coded and analyzed statistically. The goals of the project were to determine how middle school students changed in their cognitive understanding of not just science in general but the process of science. The study also probed how they changed affectively—how their attitudes about science, science careers, and themselves changed.

One immediate result is that the students became much more spe-

cific in their understanding of science. When asked to list three things they knew about science at the beginning of the program and at the end, responses were much more likely to include particular scientific words and references to processes. In the post-program responses, students also were much more likely to mention the active parts of doing research, like forming a hypothesis or conducting experiments.

The researchers also probed students' affective responses. More participants were able to articulate the importance of science, how fun and exciting it was, and how much they "liked" it in post-camp surveys than they were in pre-camp surveys. "They became a lot more connected," said Crane.

The surveys revealed some important differences among groups. Among underrepresented minorities—which in the sample consisted largely of Latinos—the percentage who thought they were good at science rose much more after the program than it did among the majority population. Minorities were less likely than majority students to say that "science is hard" after the program, even though they were significantly more likely than majority students to say the science is hard before the program. "They thought that they were better at it and that it was less hard by the end of the program," said Crane. "These are interesting trends."

Overall, boys thought that science was harder after the program, while the girls gained a greater sense of their own efficacy in science. The program also had a stronger effect on fifth graders than it did on eighth graders.

Most of the students indicated that they expected to go to college—specifically, to a four-year college—and that they expected to study science in high school, with minority boys having the greatest change in these beliefs over the course of the program. The expectation of attending college is interesting, said Crane, since demographic data suggest that many of these youth will not pursue college or are more likely to attend a two-year college than a four-year college. The factors that affect college choice in these students are an important consideration in the design of programs aimed at recruitment and retention in the sciences and research.

In general, said Crane, there was "a statistically significant enhancement of attitudes toward science, and this was particularly true for race and often for gender." She urged the meeting participants to emphasize the importance of experiential education for all students in science. "We have to give students, starting at a young age and continuing through their years in school and college, these kinds of experiences so they know what it means to do research," Crane said. "Data support the important role of experiential opportunities in enhancing retention in the pipeline."

5

Theoretical Perspectives

Interventions that are informed by a particular theoretical perspective often are well suited to particular kinds of research assessments. In particular, several of the presentations at the conference focused on measures of the self-efficacy of participants in educational interventions and on social cognitive career-based theory.

SELF-EFFICACY AND IDENTITY

The University of California, Santa Cruz, has 12 undergraduate programs and 2 high school programs aimed at encouraging and supporting students to learn science and enter biomedical research careers. Because each of the programs has different components, analysis of the programs can help identify the components that are most effective, which has been the goal of the Assessing Scientific Inquiry and Leadership Skills (AScILS) project at the university.

The project focuses on two psychological mediators that are predicted to influence students' futures, said Martin Chemers of UC-Santa Cruz. "Science inquiry self-efficacy" refers to students' beliefs about their ability to perform successfully in scientific work. In general, self-efficacy is the belief in one's ability to accomplish a particular task in a specific domain.

"Identity as a scientist" refers to students' sense that the role of a scientist is compatible with their own personal identity—a factor that became apparent in the early years of the program. "In our early interviews,

students kept telling us things like, 'I don't know how I can be a scientist when there's nobody that looks like me who's a scientist,'" said Chemers. "We realized how critical this was and built the scales and included them."

The research, which has been conducted by an interdisciplinary team consisting of both natural and social scientists, is both quantitative and qualitative. It includes in-depth interviews with high school students, undergraduates, graduate students, faculty, and staff; retrospective surveys of students who have been in programs in the past; and longitudinal studies that measure the attitudes, perceptions, and performance of students as they come into a program, during the program, and when they leave. Many different types of research are necessary, Chemers noted. "No single method of research will overcome all the difficulties of these kinds of studies. But if you have enough overlapping approaches to research, enough different methodologies, and if you corroborate from one to the other, you can sometimes draw stronger conclusions."

Chemers specifically described two research projects: a retrospective study of graduates from the last five years, and a survey of members of the Society for Advancement of Chicanos and Native Americans in Science (SACNAS). The retrospective study targeted more than a thousand students who had participated in these programs in science and engineering between 1999 and 2004. Questionnaires asked students such questions as what they did during their undergraduate years, what were their perceptions and beliefs regarding science, and how were they involved with the scientific community. Researchers also surveyed a comparison group of science and engineering majors in the same time period who did not participate in the program, with an overrepresentation of underrepresented minority students. The result was 502 completed surveys, with 56 percent women.

A path analysis designed to identify significant relationships between survey responses and outcomes revealed few differences between minorities and the majority student population on the causal variables influencing outcomes. Research experience has a very strong effect on people's belief in their ability to do research. It also influences, though not quite as strongly, a person's identity as a scientist. Involvement in the scientific community—in particular, having an opportunity to network with other science students and scientific professionals—has a moderate impact on a student's beliefs. Mentoring also has an effect on commitment to STEM fields. "Students who have advisers who help them to be good students were more likely to stay in," said Chemers. "This is very close to the predicted hypothesis that we started with."

Academic support and financial support are not strong influences on the psychological mediators. Financial support is important to students,

but it does not distinguish students who are successful from students who are not successful. Academic support is negatively related to the mediators, perhaps because it is seen by students as a remedial process.

The second study Chemers described involved sending a questionnaire to a sample of undergraduates, graduate students, postdoctoral fellows, and faculty belonging to SACNAS. Of the 327 questionnaires that were returned, 74 percent were from undergraduates or very recent graduates. The findings were very similar. Research experiences predict self-efficacy, and lab experiences increase a person's sense of ability to work as a team member. Mentoring has positive effects on both efficacy and identity, and efficacy also predicts identity. "When you think you are good at something, you are much more likely to think that that's the thing for you," said Chemers.

The conclusion from these studies, said Chemers, is that identity is the most direct predictor of commitment, with research mentoring and community involvement predicting both self-efficacy and identity. More broadly, these studies reveal the importance of considering psychological factors as both measures and mediators of an intervention program's success.

THE USE OF SOCIAL COGNITIVE CAREER-BASED THEORY

Another organizing framework for the design and evaluation of research-based programs is the application of Social Cognitive Career Theory (SCCT). This set of concepts focuses on the interactions between an individual's behavior and environmental variables. This relationship is dynamic, in that it is constantly changing, and behavior and the environment continually interact with each other. The theory allows for the development of hypothesized pathways that explain educational and career development. The theory also can be adapted to reflect the circumstances of students underrepresented in the sciences.

Evaluations tend to move from perceptions to realities as programs progress, said Nicole Lewis of Duke University. When a program is just beginning, evaluators are limited to asking students about how they perceive the program, whether it has increased their interest in graduate school, and whether they think they would have access to opportunities without the program. "Most early studies focus on satisfaction," said Lewis. "How satisfied were you with different components of the program?" As time goes on, evaluations can assess more concrete outcomes, such as grades, retention in a program, or career choice.

Lewis and her colleagues used data gathered from surveys administered to students in the 1988-2006 cohorts of the Summer Pre-Graduate Research Experience at the University of North Carolina at Chapel Hill, which resulted in a sample of just more than 600 students. About 80 per-

cent of the students were African-American, with a female to male ratio of more than 2 to 1. Of the students who completed the program prior to 1999, 28 percent had already earned a Ph.D. degree, and another 16 percent were in the process of earning a Ph.D.

The research investigated the relationships among program outcomes and underrepresented students' plans to pursue graduate study. It found that the data fit a model designed to explain plans for graduate study by the participating students. It was observed that there were relationships among program satisfaction, increased knowledge of graduate school and of research, the perceived value of program participation, increased interest in graduate school, and plans for graduate study.

In addition, Lewis's analytic technique, structural equation modeling, permits assessment of the strength of the relationship between program components and outcomes. For example, the link between a relationship with a faculty research adviser and increased knowledge of research was highly variable from one student to another. This could be because faculty research advisers may be absent or less present in a lab during the summer, in which case a student may be under the direction of a postdoctoral fellow or graduate student; on the other hand, there may be situations where a faculty research adviser works closely with a student. Moreover, the link between gaining an increased knowledge of graduate school and research was positively related to participants' post-program interest in graduate school.

The success of the SCCT-based model in predicting students' interest in graduate school is "helpful for people developing new programs, improving programs, or replicating programs at different sites," said Lewis. The findings also suggest areas for future studies, including testing additional variables and investigating the differences in model predictive validity between subgroups of program participants based on factors such as gender, academic classification, and discipline of study.

LEARNING ACTIVITIES THAT AFFECT CHOICE OF MAJOR

What actually causes the underrepresentation of minorities in STEM, asked Terrell Strayhorn of the University of Tennessee, Knoxville. Interest in STEM begins very early, he pointed out, and many students of color often are not exposed early in their lives to the possibility of jobs related to science and technology. Yet research shows that such exposures are associated with choosing STEM majors in college.

The question also can be put in a more specific form: What are the probabilities that an individual with a given set of characteristics will make the transition from one stage to the next in a trajectory leading to a career in research? And how can these probabilities be changed?

Social cognitive career theory suggests that individuals' choices are

a function of their self-efficacy—their belief in their ability to accomplish a task. From this perspective, Strayhorn said, one way to change the probabilities is to increase individual self-efficacy, the belief that one can do science. And a powerful way to do that is to expose more minority students to opportunities to develop science-related skills.

Strayhorn used data from the College Student Experiences Questionnaire (CSEQ), which is a 191-item survey designed to measure the quality and quantity of students' involvement in college activities and their use of college facilities. The data used in the study were collected in the 2004-05 academic year and reflect a randomly selected, nationally representative sample. About 43 percent of the surveys are from first-year students, and about a quarter of the sample was planning to earn an undergraduate STEM degree. The data were drawn largely from four-year public institutions. The survey is not much used at private institutions, which includes many of the historically black colleges and universities, and it is not used extensively at community colleges.

Using a hierarchical logistic regression analysis, Strayhorn found strong support for his hypothesis that opportunities to learn STEM and exposure to research are associated with the choice of a STEM major. "If you know whether a student has engaged with a faculty member in research, or whether he or she did an experiment using the scientific method, knowing that information would tell you how likely it was for that student to choose a major in STEM," Strayhorn said. Other significant predictors of STEM choice as a major include age, gender, grades, explaining scientific concepts to peers, and reading articles about science not related to class.

In the sample, women were 45 percent less likely than men to choose a STEM major, and minorities were 61 percent less likely. First-generation college students also were less likely to choose a STEM major, probably, said Strayhorn, because of the students' lack of information or early exposure to science-related activities.

Strayhorn called attention to the observation that students who frequently explain scientific concepts to peers were more likely to choose a STEM major than those who did not. That observation is "closely tied to the theoretical framework that informed this study," in that students who explain science to their peers are likely to have a confidence that would make them more likely to major in STEM. By the same token, many of these students were probably already STEM majors.

The results have several other interesting implications, according to Strayhorn. "If we can expose students to reading about science outside of class, we may be able to strengthen the STEM pathway for students of color," though this hypothesis remains to be tested. Similarly, students who are conducting experiments using the scientific method, which they

are most likely doing in connection with courses they are taking, are being exposed to a career in science and technology, which increases their ties with STEM majors. This is also the premise behind precollege and other early-intervention programs, such as summer bridge and research experiences before college.

All of these activities "promote self-efficacy, which in turn is likely to increase the odds of choosing a STEM major." To broaden the pathways to STEM, institutions should expand these kinds of opportunities. "On my own campus," said Strayhorn, "I used these findings to tell the provost that we need a faculty mentoring program and a student research program." Furthermore, faculty should engage students in research, provide students with information, and "test whether or not a student feels confident about his or her ability to conduct research."

A SOCIAL COGNITIVE APPROACH TO RETAINING MINORITIES

Rather than referring to people as underrepresented minorities, Angela Byars-Winston of the University of Wisconsin-Madison suggested using the acronym ALANA, for African, Latino/a, Asian, and Native American. That term is "an affirmation of their ethnic heritage," not just a reference to numerical majorities or minorities.

Social cognitive career theory, which was proposed by Robert Lent, Steven Brown, and Gail Hackett, has three important constructs, Byars-Winston observed. One is what she called the "little-red-engine-that-could factor: I think I can, I think I can." Self-efficacy is domain specific, so that a person might feel high self-efficacy in public speaking but low self-efficacy in tennis. Specifically, academic self-efficacy consists of a person's confidence in his or her ability to succeed academically and complete a STEM degree.

The second major construct is the idea of cost-benefit analyses that inform decisions. Students weigh the benefits and costs of a possible course of action. They ask, Is a major worth it? If I complete this degree, what type of lifestyle will I have? What returns will I gain from my investment?

The third construct is the desired outcome or goal that a person is motivated to achieve. Some of the original research in social cognitive theory in the 1960s and 1970s showed that people's actions tend to be based more on what they believe to be the case than on what is objectively the case. Thirty years of research on this hypothesis in the context of academic and career outcomes have "absolutely validated" this theoretical framework, said Byars-Winston.

In her research, Byars-Winston has expanded the focus of social cognitive career theory to include what she calls the three C's of retention

factors: contextual, cognitive, and cultural factors. Contextual factors encompass "how students are experiencing and interpreting their environment in and out of the classroom, on the campus, within their STEM environments, and in the larger university or college." For example, in recent research, Byars-Winston and colleagues found that the biggest sources of support reported by premedical undergraduate students are parents.

Cognitive factors refer to students' perceptions of their confidence and ability to succeed academically and to cope with demands and challenges. "We often focus on building students' academic self-efficacy," said Byars-Winston, "but we don't talk as much about how confident are they to cope with challenges that they're going to encounter, like being the 'lonely only'"—that is, one of the few racial or ethnic minorities in a given context.

Finally, cultural factors include the effects associated with racial, ethnic, or gender membership. One such factor is ethnic identity, which can be seen as how important and how salient a person's ethnic group heritage is for him or her. Another very important factor is the comfort people feel with others from different ethnic groups. For example, many ALANA students attend predominantly white colleges and universities, and their "bicultural confidence skills" can have a major influence on their experiences.

Byars-Winston and her colleagues have used this theoretical framework to examine students' interest in STEM and their intentions to graduate with a STEM major. Based on previous research, they hypothesized that self-efficacy and outcome expectations predict interest and that those two variables combined with interest predict intentions to complete a STEM degree. They then tested the hypothesis using a sample drawn from the College of Engineering and the College of Agricultural and Life Sciences at the University of Wisconsin-Madison. In the fall of 2005 and 2006, several hundred ALANA students were surveyed, with males outnumbering females in the College of Engineering and the reverse in the College of Agricultural and Life Sciences. The survey instruments had been validated nationally, which gave the data high reliability and allowed new data to be compared with previous studies.

The data verified the first hypothesis, predicting about 30 percent of the variance in interest in science and mathematics. Surprisingly, outcome expectations had a greater influence on STEM interest than did self-efficacy, which "says something about the values orientation of our students." However, the data did not confirm the second hypothesis, because interest did not make a statistically significant contribution to predicting intentions. According to Byars-Winston, the finding emphasizes the role that socially valued work, community orientation, and a sense of service plays in students' commitment to a STEM degree. The researchers

have gathered additional data to explore more carefully the factors that contribute to an intention to major in STEM.

As expected from previous work, students were more confident in being academically successful in the short term and less confident farther into the future. And students who had positive outcome expectations and perceptions of the campus climate were more confident in their ability to cope with the demands of getting a STEM degree and were more positive about the benefits of getting such a degree.

Byars-Winston's research group also surveyed ALANA students about their ethnic identity and comfort level with other ethnic groups. Surprisingly, ethnic identity was not highly correlated with the outcome measures in the study. But comfort with others outside of their own ethnic group positively correlated with four outcome variables: academic self-efficacy, coping self-efficacy, outcome expectations, and perceived campus climates. "This issue brings up the role of bicultural competence and bicultural skills in academic outcomes that have been talked about a lot in the psychological literature," Byars-Winston said.

It is important for interventions to address students' perceptions of their academic ability and what they are expecting to get from a STEM degree, Byars-Winston concluded. Giving people research opportunities and mentoring opportunities is closely linked to needs and opportunities within a specific discipline. But it does not necessarily help students link their current experiences with their future goals and opportunities. "That's a career development issue."

It also is important to facilitate students' accurate self-perceptions. Students' self-efficacy can dip over the course of their college experience, and they can require assistance to remain confident in their ability to handle academic demands and challenges. In this respect, interventions need to address how to recover from failure, Byars-Winston said. How can students develop "bounceback plans"? How can they move forward even if their experiences are not all positive?

Byars-Winston's group also conducted in-depth interviews with a subset of students. They were able to identify clusters of themes, which they used to develop four stories that captured the trajectories, experiences, and critical incidents of many students pursuing STEM degrees. Using the information from the surveys and interviews, Byars-Winston and her colleagues developed a theory-driven, student-informed mentoring intervention that is delivered by engineering faculty trained by her research team. "What I've seen with many faculty is that they've been excited and committed to mentoring—and have no idea what to do when a student comes. We haven't given them a framework, we haven't given them literature that shows there's scholarship that undergirds interventions with students."

The interventions with students have been so successful that the dean

of the College of Engineering has formally adopted the program. The students meet just three times a semester, yet "we're having some incredible outcomes," Byars-Winston said. "Our students are experiencing more confidence. And [they're] increasing their STEM academic identity."

FOCUSING ON THE IMPORTANT ISSUES IN INTERVENTIONS

Interventions are usually targeted to narrowly defined groups, such as undergraduates or postdoctoral fellows. But interventions "will continue to be relatively unsuccessful until we deal with department bias" more broadly, said Anne MacLachlan from the University of California, Berkeley. "The implicit biases of faculty, no matter how friendly they think they are, nonetheless affect student participation."

At the same time, interventions can become relatively unfocused by striving to address "diversity" rather than the three large groups that are specifically disadvantaged—African-Americans, Mexican-Americans, and Native Americans. Supporting the members of these groups will be essential to ensure an adequate scientific workforce, producing an economically productive populace, reducing chronic health disparities, and addressing issues of social justice.

Identifying who is in the pipeline of science education reveals the magnitude of the problem. In biology, 63,892 undergraduate degrees were awarded in 2004. Even at this level, the number of degrees earned in biology is very different than the distribution of the U.S. population. And the figures are worse for California, where Mexican-Americans make up more than 30 percent of the population and yet earn only 5 to 6 percent of the bachelor's degrees awarded in the state.

The number of Ph.D.'s awarded to African-Americans, Mexican-Americans, and Native Americans reflects a further "remarkable falloff" from the undergraduate level, according to MacLachlan. At the graduate level, even though UC-Berkeley graduates the largest number of Ph.D.'s of any institution in the country, the numbers of underrepresented minorities in biology are "very tiny."

Both at the graduate and postdoctoral level, research has shown that students do not get enough training in many of the things they will be expected to do after receiving their degrees. In particular, graduate students of color face many issues that are not addressed in their departments. The worst one, MacLachlan said, is the problem of isolation. In research she and her colleagues conducted, which included interviews with 158 Ph.D.'s in science, mathematics, and engineering, Ph.D.'s of color all spoke about their sense of isolation. For example, isolation makes it much more difficult to deal with the "daily acts of microaggression" that underrepresented minorities face, such as colleagues saying, "Oh, you

speak really good English." Departments can do many things to minimize that isolation, but departments need to commit themselves to addressing the problem. And the norm in predominantly white departments is not to speak about ethnicity to a person of color. Yet ethnicity "is part of who they are," said MacLachlan. "You can't not address it. But it's this funny Victorian notion that you don't want to mention anything."

Departments also need to recognize that different groups face different issues. "It would be great if we could get rid of the term 'minorities' and come up with something that's less pejorative and doesn't lump people of different colors together," said MacLachlan, "because those who are not sensitive to color tend to treat all minorities in the same way, which is not very helpful." In addition, women have different issues than men, and women of color are in a "double bind that is not always recognized in departments."

Her study demonstrated that students of color have particular difficulties in their first year of graduate school. Some think that they are going to set the department on fire and are disappointed if they don't. Others doubt their capacity to be there or believe that they have to be twice as good as other students to get ahead. For many graduate students, said MacLachlan, "there is this unfortunate phenomenon of 'when am I going to be found out,' which persists, sadly, right through finishing the dissertation." Affirmative action has had a problematic effect in this regard, because a consequence of affirmative action is that the achievements of students are dismissed, even though they have the qualifications needed for entry into the program.

There are far more men than women in Ph.D. programs, yet both groups are dwarfed by the number of international students in these programs. "This country has elected to solve its issues about having a highly trained technical workforce by basically importing temporary visa holders instead of putting the energy into training its own people. I feel very very strongly about this. Where did we go off track? Why is it easier to hire a Russian mathematician than an American mathematician? And there are only so many [Americans] because of misguided policies for a great many years."

The problem of bias within departments is closely related to the much broader issue of the overall climate on campus. One of the greatest problems facing higher education today, MacLachlan argued, is making the campus climate friendly for women and persons of color. "This, too, has a lot to do with why there are so few faculty of color."

Among the many steps departments could take is much better advising of students of color. If some advisers and mentors do better with minority students and others do worse, incoming students should know that. Students also can be given suggestions about how to overcome

the isolation they are likely to feel. Improving education requires "improving the whole department, making it sensitive to its language and behavior."

PLANTING SEEDS AND BEARING FRUIT

Part of the rise in the numbers of underrepresented minorities in the sciences is deceptive, said Connie L. McNeely of George Mason University. Although Ph.D.'s awarded to underrepresented minorities have increased dramatically between 1973 and 2006—from 2,400 to 22,400—that number includes the social sciences and psychology. When those two fields are removed from the total, the number of underrepresented minorities receiving Ph.D.'s in the sciences has actually dwindled. In that respect, academia in most scientific fields continues to act as both a gender and a minorities sieve. At each step along the academic ladder, the percentages of women and minorities drop. Minorities enter college with the same rate of interest in majoring in STEM fields as mainstream students, but their degrees of persistence are lower. Even the reasons given by minority students for switching majors are the same as for majority students—typically linked to whether a student attends college full-time or part-time, whether a student works (and whether that work is on or off campus), parents' education, family income, and whether the student's educational background included a rigorous high school curriculum. However, each of these reasons is likely to apply more widely to minority than majority students. "The same factors can explain persistence across groups, but you need to control for who ends up where and in what category," McNeely said.

Many factors are cited in explaining educational problems, including poverty, social disorganization, institutionalized racism, cultural misadaptation, educational experiences, deficiencies in resources, and access to opportunities. All of these are important targets for public policies, McNeely said, but they cannot be treated in isolation. Education includes much more than instruction and has to be taken seriously as a social institution. The purposes of education also encompass, for example, socialization, certification, and sorting and selection. Each of these factors can affect individuals and their attainment in educational systems. For example, what is the content of a certification? Is it learning and competency in a field—or is it just spending enough time in a field to get a degree?

Cultural influences can have a powerful effect on educational outcomes. Researchers thus need to look at the institutional environment and at organizational cultures in assessing the factors that affect student achievement. Students need the cultural capital—the cumulative background, skills, attitudes, and confidence—to succeed educationally. They

need to come to college ready to learn, and not be in need of extensive remediation to achieve a college level of readiness. Students need to be supported all along the educational pathway so that they are prepared for college and for graduate school if they choose that route.

Popular movies provide some interesting and powerful illustrations of this point. Several popular movies have depicted minority students who overcome great obstacles to reach high levels of educational achievement. "They are so inspirational," said McNeely, "but they also make me angry. Maybe not angry as much as frustrated, because, based on true stories, what they show us is that, despite the lack of resources, despite the social pathologies that might attend their lives, these young students excel. . . . And these movies frustrate me; they lead me to say, 'You know what to do, so why isn't it being done?'"

Many of these movies also emphasize the critical role of teachers. Yet teaching, too, occurs within an institutional and social context that has a profound effect on educational outcomes, and this context needs to be studied and better understood if problems in the educational system are to be addressed.

The interventions being discussed at the meeting can be thought of as seeds that when planted and nurtured can bear wondrous fruit, McNeely said. They address such issues as motivation, commitment, mentoring, leadership, access, and opportunities. These interventions are aimed at "bringing about institutional and cultural changes in academia and the broader infrastructure that affect educational attainment," said McNeely.

Interventions must take into account that different disciplines and fields can have different practices, and these can affect the educational outcomes of students. "They are anecdotal, but I cannot tell you how many stories I have heard of minorities and women saying that they were passed over or denied opportunities—whether intentionally or unintentionally—for research participation, for working in certain labs, or for working on certain kinds of projects that would have helped them."

Also, collaboration and coordination are critical if the seeds are to take root. A wide variety of programs now exist that focus on different aspects of a young person's life. These programs need to be considered in terms of coordinated efforts to address the broader social issues that affect educational outcomes.

McNeely's recent work investigates the diffusion of policy innovations between and within institutions. "What are the channels and spheres of influence that determine whether changes can lead to effective institutional reform?" she asked. "Institutional inertia is still the rule, and current findings illustrate the difficulty in effecting real institutional change." McNeely has focused on the professoriate and on the pool of minority

and women graduate students who could become future faculty. Her research looks at not only individual experiences and outcomes but at the institutional and cultural infrastructure that affects outcomes from a longitudinal perspective, from the Civil Rights movement to the present. The policy environment is part and parcel of this infrastructure, and changes in policy can bring about changes in the academic profile.

6

Methodological Issues

CREATING CONTROL GROUPS

The Program for Excellence in Education and Research in the Sciences (PEERS) at the University of California, Los Angeles (UCLA), is an intensive program committed to promoting academic excellence and professional development for students dedicated to careers in the life or physical sciences or mathematics. The primary objective of the program is to increase the number of students who develop a strong foundation in the sciences and make teaching and research a part of their life's work. PEERS provides students with collaborative learning workshops, individualized counseling from both PEERS-specific counselors and departmental counselors, priority enrollment in introductory science classes, and a wide variety of social activities to help the students bond into a community. It is a two-year program with 65 students per class, with about two-thirds of them ethnic minorities and a greater proportion from socially and economically disadvantaged groups.

A major challenge for PEERS is developing control groups to evaluate the program, according to UCLA's Tama Hasson and Linda DeAngelo. For example, when designing a control group, the criteria for entering and continuing in a program need to be considered. Thus, if evaluators are measuring outcomes after the second year, they need a control group equivalent to the group that went through PEERS for the two-year period.

The evaluators of the PEERS program resolved this issue by matching the PEERS group against different groupings of other underrepresented

students who entered UCLA. The other groups were then further analyzed to eliminate variables that did not match with those of the PEERS group. This allowed the researchers to test specific variables because they could identify the components they wanted to examine. This was also important given the small size of the PEERS groups, which have about 40 underrepresented minorities out of 65 students each year.

Hasson cited two examples: Does the PEERS experience have an effect on retention in a science major? And do the collaborative learning workshops have an effect on student grades? For the first question, the control group was drawn from all of the other underrepresented students who entered UCLA in the same year as the PEERS cohort with a declared science major. For this question, said Hasson, "looking at every single underrepresented student is a valid control."

This control group is not appropriate for the second question, however. For the PEERS group, 95 percent of the students took two introductory science classes—mathematics and chemistry—while the percentage was much lower for underrepresented minorities with a declared science major. "Right away we have a problem," said Hasson. "We cannot use this group to compare grades in science classes," because the numbers and kinds of science classes they took were different. Instead, to answer this question, a new control group was constructed of students who took two science classes.

Similarly, the evaluators wanted to control for the experiences students had before they came to college. For example, the PEERS students had, with a few exceptions, mathematics SAT scores of 540 and above, whereas the control groups used to answer other questions had SAT scores that ranged much more widely. Therefore, the evaluators formed a control group consisting only of underrepresented minorities with mathematics SAT scores above 540. Also, when considering backgrounds, the evaluators decided that the PEERS group, on average, had a higher "life challenge quotient," when taking into account such issues as the quality of their high school, their parental income and education, and whether English is the primary language spoken at home.

With the use of appropriate control groups, the effects of the PEERS program became much clearer. For example none of the African-American students in PEERS failed a science class in their first quarter, whereas 46 percent of a comparable group of African-American students did. The average grade for the PEER students was half a grade higher in chemistry than for the appropriate control group. "At this level, PEERS is doing its job," said Hasson.

The bottom line, said Hasson, is that program evaluators need a very large pool from which to draw control groups. "It isn't until you start formulating your questions and dissecting what you want to learn that you

will be able to determine who will be in the final control." This requires extensive access to student records. Needed information includes not just ethnicity and mathematics SAT scores but life challenges, choice of major and changes in that choice over time, grades over time, and research records. Such information comes not only from enrollment and admissions records but from data gathered by departments and by college scholarship and honors offices.

Conducting this kind of research also requires various individual and institutional approvals, Hasson emphasized. In particular, research involving the kinds of control groups used at UCLA required human subject approvals from Institutional Review Boards and other bodies. "If you don't have experience in this area, you need to partner with someone who does," Hasson said. Also, research teams need individuals who can perform sophisticated statistical analyses, which also may require partnerships with people who have the necessary expertise.

THE CRITICAL INCIDENT TECHNIQUE IN INTERVENTIONS RESEARCH

One valuable method that can be used to develop interventions that broaden participation in research careers and to measure the impacts of those interventions is critical incident technique, said Roger Levine of the American Institute for Research. Since its development during World War II, it has been used in probably tens of thousands of studies; a 2001 bibliography on the technique produced by the American Psychological Association ran to 301 pages.

"So if it's such a widely used methodology," asked Levine, "why haven't you heard of it?" Mostly because it was developed and is still widely used in industrial organizational psychology, Levine said. But it also has found widespread use elsewhere in the social sciences.

Levine and his colleagues have used the technique to conduct several studies of underrepresented groups in STEM fields. They investigated African-Americans and Hispanics with above-average mathematics skills who entered college and did not choose STEM majors. They also studied members of the same groups who entered college with STEM majors and either stayed with the major or switched out. They looked at the barriers and facilitators to choosing and advancing in STEM careers for individuals with disabilities. They also examined the factors leading students to choose geoscience majors and geoscience careers.

The basic rationale behind critical incident technique is that, "if you want to find out why people do something like choosing a STEM major, ask them. But ask them about specific behaviors, or specific things that they did, or that other people did, that were responsible for either their

choice or their rejection of this career." This information is gathered through critical incident interviewing, which is a type of open-ended interviewing. The technique provides specific guidelines for organizing the results of the interviews, for writing up critical incidents, and for analyzing the data. As part of the analysis, evaluators develop a taxonomy or classification scheme that includes all of the identified factors that are responsible for the outcome of interest. The technique also includes methods to determine whether the taxonomy is reliable and comprehensive.

An advantage of the technique is that it is empirically grounded. It focuses on behaviors, which are susceptible to change. And no special equipment or advanced quantitative skills are needed to analyze critical incident data.

In the study of why underrepresented minorities did not choose STEM majors, the questions included items like the following: Why did you choose your major? What happened to make you feel this way? What are the positive and negative experiences that you have had with science, technology, engineering, or mathematics? Interviews with 19 faculty administrators and 35 students yielded nearly 2,000 critical incidents. For example, positive incidents might be: "The geometry class teacher made the course really fun." "We would see how things we were doing in class related to things we see in everyday life." An example of a barrier might be: "The math professors and TAs do not speak English very well." The 2,000 critical incidents were organized into categories, including people-related factors, course-related factors, teaching-related factors, career-related factors, media-related factors, extracurricular activity factors, and so on. Once the categories were identified, targeted strategies can be developed to deal with specific issues. Evaluators essentially "mine the data to identify specific positive and negative behaviors," said Levine.

In the second study, of African-Americans and Hispanics who enter college with an interest in majority in STEM, questions included: What did you decide to major in? Did you ever think of switching majors? Why or why not? The responses can be complex. For example: "The program at my school was really competitive. There were a lot of people in the program, and I was wondering if I was on the same playing field as them. This led to thinking about doing something else. I thought about it for a long time and decided this is what I really wanted to do, and also wanted to do for as long as I remember, so I stuck with it." Once the responses were organized into a taxonomy by factor, the people who stayed in a STEM major were compared with those who did not. "The greatest discrepancy was with accepting challenges," said Levine. "What is the message here? Try to develop resiliency. Prepare people for the challenges they are going to face."

Another factor distinguishing the "stayers" and the "leavers" was the

degree of professional and practical experiences they had at the college level, with most of the positive experiences related to internships. At the same time, the technique was able to reveal what students liked and did not like about their internships.

The approach was similar for the studies of individuals with disabilities and the students who choose careers in the geosciences. Critical incident interviewing uncovered the major factors that led students to make decisions. This information was used to develop information materials for people with disabilities—for example, to prepare them for difficult situations or provide them with strategies to solve problems. The study of the geosciences also identified factors that were unique to this group, such as appreciation of nature or the outdoors. This information can allow program designers to increase the probability of retaining someone in a STEM major or career.

7

Mentoring

Mentors can have a profound influence on minorities who are at a critical crossroads in their lives and struggling with self-identification, said Earnestine Psalmonds of the National Research Council. But even though an extensive research literature addresses mentoring, relatively little of this literature has looked at minorities in science and engineering, both across and within disciplines. The National Research Council is conducting a study on the science and engineering pipelines for underrepresented minorities, partly because that subject was not covered in the *Rising Above the Gathering Storm* report, and that study is looking at the effects of mentoring. Professional societies and other organizations with an interest in mentoring also could participate in this research, Pslamonds said, and help disseminate information about mentoring so that it better informs policy.

MENTORS AND MENTEES

The designers of intervention programs often assume that mentors who are similar to mentees produce better results, but is that known for sure, asked Mica Estrada-Hollenbeck from California State University, San Marco. Previous studies have had mixed results, finding that similarities make a difference in some cases but not others. But none of this research has been done with undergraduate minority science students, and comparisons of gender and ethnicity are rare.

The Science Study described earlier in the meeting by Wesley Schultz of California State University, San Marcos, provides one way to answer

these questions. One part of that study looked at how mentorship helps to explain the effectiveness of minority training programs. How do men and women respond to same or different gendered mentors? How do African-American and Latino science students respond to mentors of the same or different ethnicity?

The Science Study is a longitudinal study of minority science participants recruited primarily in the fall of 2005, with some additional students added in 2006. The panel comes from across the United States and includes students from 45 universities, 25 of which had RISE or MARC programs. All participants intended to pursue a career in science when they joined the panel. The researchers also recruited a matched sample of RISE and non-RISE participants who were similar to the sample in terms of ethnicity, grade, gender, major, GPA, intention to become a scientist, and other factors. "We tried to get two groups that looked very similar to each other and compare them as we go in time," said Estrada-Hollenbeck.

The majority of the participants in the study are African-American and Latino, with additional participants who are Asian-American, Hawaiian Pacific, and Native American. Data are gathered online through the web interface at www.thesciencestudy.com, which also provides information about the study. Students fill out a wide-ranging questionnaire regarding such issues as scientific identity, accomplishments (such as publishing and attending conferences), perceptions, financial support, and interactions with mentors.

Estrada-Hollenbeck and her colleagues looked specifically at participants who indicated that they have a mentor. They then explored the attributes of the mentor, including gender and ethnicity, and asked the students to complete a survey on aspects of the relationship. This information then was compared with the intention to pursue a science-related career.

Students supported by the RISE and MARC programs consistently show a significantly greater intent to pursue a science-related career than members of the control group. Furthermore, the difference increases with time. The data also indicate that the mentoring relationship contributed to the intention to pursue science-related careers. Mentoring accounts "for some of the reason but not all of the reason," said Estrada-Hollenbeck. "There's more of a story to be told. But it indicates that mentorship is important."

The data reveal an interesting gender effect in mentoring. When males have a male mentor, they are more likely to stay in the sciences than when they have a female mentor. Females also are more likely to stay in the sciences when they have male mentor than a female mentor.

To understand this interaction, the researchers looked at how par-

ticipants rate their mentors. The measures they used are satisfaction, psychosocial support, and instrumental support. Satisfaction was measured through such questions as whether a mentee can talk openly with a mentor and whether the mentor met expectations. Psychosocial support refers to such factors as whether the mentor has shared a history of his or her career and whether they conveyed feelings of respect to the mentee. And instrumental support refers to such factors as whether a mentor helped a mentee improve writing skills or explored career options with the mentee.

When measured along these dimensions, male and female mentees expressed equal satisfaction and equal psychosocial support with their male and female mentors. But males said that they received more instrumental support from female mentors than from male mentors, while female participants did not report much difference between the two.

For both male and female participants, the ethnicity of the mentor did not have an effect on their intention to stay in the sciences. Males have a higher intention to stay in the sciences than females, but this does not appear to be related to mentoring. However, the results are different when looking just at the ethnicity of students. Latinos tend to express a greater intention to stay in science than the members of other ethnic groups. And when Latinos have a mentor who is the same ethnicity, they have a higher intention to pursue a science-related career than when they had a mentor with a different ethnicity. Furthermore, this enhanced effect does not seem to be related to satisfaction, psychosocial support, or instrumental support.

In conclusion, said Estrada-Hollenbeck, "matching the gender and ethnicity of mentors and protégés for minority science students may not affect everyone exactly the same way." Also, Estrada-Hollenbeck pointed out, these data concern only students' intentions to remain in the sciences. Because the Science Study is a longitudinal survey, students will be tracked to the point where their intentions turn into behaviors. Within a few years, "we'll have the opportunity to see if the intention actually predicts whether they stay in the sciences or not."

MENTORS AND COACHES

Mentors and coaches have many things in common, said Richard McGee of Northwestern University. But they also have differences that shed light on how to improve mentoring.

Mentoring can be an expensive model, in terms of lost talent. "It's a great model when it works. But I've been in the business quite a while, and I don't think a year has gone by when I haven't heard hand-wringing about how to make mentors better."

Mentors are expected to be selfless, putting the mentee's needs first. By the end of the process, the student is expected to have grown substantially, sometimes even surpassing the mentor in some ways. Mentoring has to establish expectations, and the value of explicit individual development plans is becoming more commonly recognized.

But mentoring also takes time, especially in the early stages, and not all mentors are willing to put in the time that is needed. Mentors can have conflicts between spending time on mentoring and doing their own research. Mentors also can have conflicts between supporting a student and criticizing or correcting that student. Not all mentors are equally skilled at mentoring, but mentors are resistant to being trained to do it better. "The worst person to try to teach is someone who thinks they know how to do it," said McGee. Time also is needed to find a good match between a mentor and mentee, but time is not always available.

Uneven mentoring can be more detrimental to women and underrepresented groups than to majority groups, said McGee. "When mentoring is really good, it's really good. When mentoring is bad, it's a disaster."

Instead of asking mentors to do more, they could be allowed to do less. They could focus on what they do best, with the remainder of assistance for students provided in other ways. "I'm not in any way underplaying the value of mentors," said McGee. "To be honest, one of the greatest joys I've gotten in this business is mentoring. I have no problem with mentoring. I just have a problem with what we're asking it to do."

Other models may not be so prone to problems. Rather than letting natural selection reduce the number of students to those who will become researchers, a better approach may be to identify the skills that a student should acquire and look at the best ways to impart those skills, rather than just seeking to make mentors better all the time.

Coaching also involves working with an elaborate network of promising young people. Both students and athletes undergo a rigorous training program. But for athletes, by high school they start to have dedicated coaches and trainers, and by college they have professional coaching staffs. "From college on, athletes are seen as important investments with talent to develop, not experiments waiting to happen."

Rather than assuming that anyone can be a coach, the people who are best at coaching end up in those jobs. They are experts at combining individual and group training. The athlete still has to do the work and has to have the talent to rise to the top. But the coach provides great benefits to many people, not just to a few. "What if science had professional coaches along with mentors?" McGee asked.

Such coaches could be drawn from anywhere on a campus. If established professors choose to do less research or if they have trouble getting a grant, they could become coaches, which would also free up research

money for younger researchers. The coaches could be screened intensively. They also could work across departments, institutes, or schools.

The use of coaches for students and postdoctoral fellows would allow mentors to focus time and energy on the things they do best. A coach could not be an expert on the content or research in each field, but many aspects of the development process cut across all disciplines. Coaches could lead efforts to construct individual development plans. They could provide objective feedback to beginning researchers, instead of allowing young researchers to sink or swim. They could teach grant writing, reviewing, and mentoring skills. They also could provide information about where resources are available, both within an institution and outside. "As a learning model, this has incredible strengths over a typical mentoring model," said McGee. "A coach is never seen as too busy. They're not going to tell you, 'I'm too busy. I have a grant to write.' I'm here to be your coach. So you eliminate a lot of barriers."

McGee disagreed with the argument that such positions would be too expensive. Faculty mentors who no longer have grant support could be used in new ways. If even a couple of postdoctoral fellows were able to get grants that they would not have gotten because a mentor was too busy, the coach has paid for his or her time. According to one estimate, universities invest $2 million in a new faculty member before the typical faculty member gets tenure. If a coach can get one person through that process who would not have made it through otherwise, the salary of the coach is covered for many years to come.

Furthermore, coaches could have a substantial positive effect on the diversity of young researchers, McGee said. Each person who is about to complete a Ph.D. and take the next step in a professional career is an important event. A coach could make sure that such a person does not get lost. "If they make a career change decision and go off to industry, that's wonderful, but if [academia] is where they want to go, we can't afford the risk of not helping them get there." Coaches could be chosen for their ability to work across ethnicity and gender lines. They would receive training, so that they could get better at their jobs. They could link beginning researchers with additional mentors and role models. "They could eliminate this hesitation, which is well known in minorities and women, to go to someone who seems busy and highly successful, because I don't want to bother them." For coaches, that would be part of their jobs. Coaches also can monitor the mentoring that mentees are receiving and raise an alert when something in the relationship does not work.

Such a system would have to overcome certain obstacles, admitted McGee. Mentors would have to give up the notion that they have a right to "customize [mentees] in their own image." Such a system also would challenge the assumption that all research skills are best learned through mentoring, which may not be correct for some skills. Most important, it

would challenge the idea that beginning researchers should sink or swim, which is a view "held most strongly by those borne by water wings and life jackets," said McGee. "We have to question the premise of why a person needs to sink or swim, especially with the groups we're working with."

During the question-and-answer session, McGee speculated that the term "mentoring" may be part of the problem because it has become a catch-all for often ambiguous and unspecified expectations. Instead of a student asking someone to be a mentor, a student could say that he or she needs help learning a specific skill. "I might let go of the generic term mentor and break it down to bite-sized bits of what it is that you want to get from that person."

THE RESEARCH SELF-EFFICACY OF MENTEES

Many successful nurse researchers have had mentors, said Elise Lev of Rutgers University. However, their mentors can be drawn from many different fields, not just nursing. The "guided mastery" that mentees receive conveys relevant knowledge, influences career choices, provides opportunities for them to experience research with appropriate support, and is a critical factor in providing socialization to the role of scientist. Mentors teach mentees "unspoken cultural rules—how to play the game," said Lev.

However, the nature of the relationship between mentors and mentees has not been well studied. Exactly what mentors do is not well understood. It is not known exactly which factors influence the research self-efficacy of mentees. "The positive and negative processes of mentor relationships are not well studied."

Lev and her colleagues compared mentees' perceptions of their ability to do research (research self-efficacy) with their mentors' perceptions of the mentees' ability to do research. Misjudgment of efficacy appraisals can be problematic, she said. Misjudgments can lead to educational opportunities forsaken, careers not pursued, and risks not taken.

The mentors in her study were NIH-funded researchers who worked with an undergraduate or graduate mentee on a funded research study. A search of the NIH database produced potential participants, and a mass e-mail was sent to the identified researchers asking them to participate. The researchers who agreed to participate were directed to the study's website, where they provided informed consent and completed a survey instrument. The surveys were completed separately and confidentially by the mentors and the mentees. "The study website was available for four months," said Lev. "However, most responses occurred actually within the first 24 hours."

The survey included 92 items that assessed research self-efficacy, in-

cluding conceptualizing, designing, funding, organizing, and managing a study. Data were collected from 21 mentor-mentee pairs. The mentors were 12 females and 9 males from 34 to 59 years of age. The mentees were 15 females and 5 males, with one unidentified, from 19 to 50 years of age. The mentees spent from 1 to 40 hours a week with their mentors, with an average of 7 hours per week, and the participants were mostly white.

The mentors rated their mentees as significantly more self-confident than the mentees rated themselves. Though the consequences of this mismatch of perceptions are not fully known, the results may be an indication that "mentoring isn't always working," said Lev. Assisting mentors and mentees to develop realistic expectations of the relationship may benefit both parties, and training for mentors and mentees may make mentorship more rewarding to both mentors and mentees.

The study was limited by its small sample size, which limits the generalization of results, and the fact that the population may not be representative. In general, the recruitment approach taken in this Internet-based research study may not be optimal, Lev admitted, partly because the number of potential participants who actually received the mass e-mails is not known. "Sending individual letters to potential participants rather than a mass e-mail is recommended to ensure that the invitation would be received." In addition, study of underrepresented minorities is needed to determine if reports of self-efficacy are different among the members of this group. Investigation of not only confidence in one's ability to do research (research self-efficacy) but actual competence also needs to be carried out.

MENTORING AFRICAN-AMERICAN MEDICAL STUDENTS

Several studies have found that minorities have greater difficulty climbing the academic ladder toward positions in medical schools, and these difficulties are not caused by lack of ambition or talent, said Marc Nivet of the Josiah Macy, Jr., Foundation. These studies have suggested that the socialization process of academic medicine may be difficult for both minorities and women to navigate. In his research, Nivet studied this socialization process to determine "how faculty members from a variety of racial and ethnic backgrounds and gender perceive their institution's culture and whether it is compatible with their own sense of values."

In particular, Nivet looked at what minorities thought a career in academic medicine was going to be like when they were a medical student or resident. Focusing specifically on African-American medical students, he asked what prospective African-American medical school faculty members see as facilitators and as obstacles to careers in academic medicine. He also asked what can be done to increase representation of African-

Americans in the faculty pipeline and to enhance their experiences. It's "stunning" he said that researchers have tended not to ask this question of the people going through the pathway themselves. "We rarely ask those individuals the question of what would they do. What do they envision for a better pathway?"

Nivet conducted in-depth interviews with 21 African-American medical students who were chosen either because they were dual degree M.D.-Ph.D. or M.D.-M.P.H. students or because they had taken a year out of their medical training to do research, assuming that these students were most likely to be interested in a career in academic medicine. All were in their third year of medical training, they were roughly split between male and female, and the students were from a combination of more selective and less selective medical schools. He used the lens of anticipatory socialization as a framework for his questions, which posits that students go through stages in being exposed to and incorporating the norms of a field.

Medicine is less advanced than other areas of academia in making the implicit explicit, Nivet contended. The mentoring that is needed seems straightforward, yet medicine has not developed the kinds of programs that offer students exposure to potential professional roles. For example, students do not necessarily see dual-degree programs as a gateway to become faculty, particularly in the case of the M.D.-M.P.H. students. They see their goals as getting their degrees, not going on to careers in academic medicine.

Nivet also concluded from his interviews that the office of diversity affairs on campuses can play a much larger role than they do currently. These offices often are important vehicles to get students recruited into medical schools. In the interviews, students suggested that these offices could provide much more support to them in terms of becoming faculty members and advancing their careers.

An obstacle identified by the students was the misalignment of values in academic medicine between clinical care, research, and teaching. "If you think of it as a stool, teaching would be the short leg that keeps the stool from falling over," said Nivet. Yet the students, the majority of whom went into academic medicine because of an interest in teaching, said that "they realize that teaching is the short leg of the stool."

The students also questioned the commitment of academic medical centers to the surrounding communities. They report that they have witnessed behaviors that "are not aligned with why they went into academic medicine."

Students want more exposure to what an academic career is. Just having a faculty member sit in front of you is not enough, according to Nivet. For instance, these students know very little about the clinical educator

track that has come to parallel the clinical researcher track in recent years. "They don't know about this bifurcated system, and they don't know because it's implicit, it's not made explicit, when you're a medical student that there are these additional tracks."

Lifestyle concerns run across fields and students, according to the interviews. Both men and women said that they wanted to have families and did not want to be getting their first NIH grant in their 40s. "Lifestyle concerns are real."

Mentors do not just help students animate their careers. They also help students achieve personal goals. In the interviews, the students expressed the belief that the mentoring they had received was inadequate, at least in the formal mentoring conducted as part of their educational programs. They had built relationships "that they were proud of and got a lot from, but the formal mentoring programs were not working for these students." One of the primary reasons is that students thought the programs were "thrown together," in the sense that the relationships did not develop on their own. Instead, they said, they would receive an e-mail from a faculty member saying to come and visit with me. "They would go there and sit for ten minutes. The mentor would say, how are you doing, and the person would say, fine, even if he was not fine, and then he would go off." The students thought that mentors were more interested in fulfilling their mentoring requirements than in offering useful assistance.

An alternative idea offered by the students was the idea of collaborative mentoring, in which a single student has multiple mentors at the same time. In such a situation, mentors could come from across the institution. Mentoring assistance can even come from multiple institutions. For example, in one collaborative program, the University of Pennsylvania, Mt. Sinai School of Medicine, the University of Medicine and Dentistry of New Jersey, and Albert Einstein have summer workshops for junior faculty members focused on the nuts and bolts of working in an academic setting, such as writing grant proposals. As part of the program, the individuals in the program have come to know each other and have been able to share information about how the culture of the four institutions is different in certain respects. These individuals have come to understand, through the program, that "there is more than one type of university, one type of medical school, and one type of culture," and it has allowed them "opportunities for mentorship across different institutions."

Other ideas are structured mentoring programs that include the use of multiple and paired mentors, more direct public and private funding for mentoring (including collaborations between foundations and federal agencies), evaluations of the value of mentoring, and greater use of peer mentoring. Formal and informal mentoring should be compared, and a

retrospective cohort study of current minority faculty could reveal how they got where they are.

"The ineffective structural mentoring that I've talked about is leading to some unintended consequences for these medical schools," concluded Nivet. "[Students] go in with this huge amount of interest and are looking to do wonderful things in both clinical care and in research. But they're being pushed partly away because of these ineffective mentoring relationships."

Academic institutions devote considerable effort to recruitment and retaining minority students. A cultural shift needs to occur that can prepare students for future faculty positions. "It's not just about retaining," said Nivet. "We want these individuals to thrive. Again, it's a conceptual frame shift. . . . We need to move away from recruiting and retaining to attraction and thriving."

8

Innovative Approaches

LEARNING TO READ SCIENTIFIC PAPERS

One reason why students do not get excited about scientific careers is that they are disengaged from undergraduate biology classes, and textbooks are a reason for that disengagement. They are very "dry in terms of how science works," said Sally Hoskins of the City College of New York. Research does not come across as creative, and researchers rarely appear at all. And journal articles, the real language of research science, are often viewed as too difficult for undergraduates to read and understand.

To demystify the process of reading journal articles, and at the same time humanize science, Hoskins and co-PI Leslie Stevens from the University of Texas-Austin devised an upper-level elective class at City College known as CREATE—for Consider, Read, Elucidate hypotheses, Analyze data, and Think of the next Experiment. Students read four articles generated in sequence by a single laboratory, but do not initially receive the abstracts, titles, or discussion sections, only the introduction, methods, and figures and tables. Pedagogical tools adapted to CREATE help students make sense of the paper and arrive in class ready to actively analyze and interpret the data, rather than waiting for the instructor to tell them what the authors did and what it means. "Our goal is to run the class like a lab meeting," said Hoskins.

Students start by using concept mapping to cross-link the ideas in the papers. For example, given the introduction section of the first paper, students create a concept map to relate ideas presented with what they recall from previous courses. If they come across a term they do not recognize

or have forgotten, they are expected to look it up. The students "realize that they have to actively orient themselves in the topic area." They begin to take charge of their own learning.

The instructors "work backwards" from the figures to the experiments that generated them. Students sketch cartoons—visual representations of what went on in the lab—to clarify how the experiment was carried out. The students then look at all parts of the experiment and try to answer such questions as: What question was being addressed by this part of the study? How does the experiment answer that question? Students next look closely at the data, annotating figures, defining control and experimental cases, and determining how each figure builds the overall argument of the paper. They compare their interpretation with the authors' interpretation of the same data, finding to their surprise that they do not always agree.

After students have worked through the first paper in a series, new issues and questions have arisen. The instructors then challenge the students to devise two experiments that they would do next if the paper's data had been generated in their own lab. The students also consider how to fund the next experiment given a limited amount of research money. "For students, this is the first time they've thought about where funding comes from, who makes decisions, and the fact that not everybody will agree." Working in small groups, they debate funding criteria, which gives them insight into the nature of science. They then compare the experiments they have designed and go back to their grant panels to choose one to fund with their imaginary pot of research dollars. Often, different student grant panels choose different "best" next experiments, which is another surprise.

The process repeats with the second, third, and fourth papers so that students see how the authors' project evolved over a period of years. Late in the semester, students discuss "the people behind the papers" and generate a set of questions to e-mail the authors (postdoctoral fellows and graduate students as well as senior faculty). Questions focus not only on the paper but also on lab management, competition, ethical issues, decision making, hobbies, and balancing career and family. "People have been generous about answering," said Hoskins. Reading the variety of different responses to the same questions has opened students' eyes to the fact that researchers are people much like themselves, not just the genius-geeks of popular culture.

The goals of the course are to demystify scientific papers and to humanize the process of science. The key idea is "that these students have to build their understanding of things rather than sit there in class and have us tell them everything, as in the standard lecture." The pedagogical tools help students deal with the paper's data as if those data had been gener-

ated in their own labs. By designing their own experiments and criticizing each others' proposals, students experience research as a creative field in which individuals can follow up their own ideas. This freedom rarely comes through in textbooks, where the progress of science is presented as quite linear.

The CREATE study was assessed with critical thinking tests, concept mapping assessments, attitude surveys, and post-course interviews. CREATE students at CCNY improved in logical thinking, the ability to integrate concepts, and attitudes about science and scientists. Students also reported that the course increased their learning in other courses ("I read everything differently now—I look at the figures" was one student's comment). Many students reported increased interest in science-related careers as well as the wish that they had taken the course earlier. "CREATE is a powerful and cheap way to get students excited about science and get them more interested in going into these research programs," Hoskins concluded. Results from the research study have been published in *Genetics*, the *Journal of Undergraduate Neuroscience Education*, and *The American Biology Teacher*.[1] The CREATE project is at present being tested on multiple campuses in a diverse range of student cohorts.

EARLY ACADEMIC INTERVENTIONS

Students attending the California State University, Northridge, campus are often the first in their families to have attended college, and most are not aware of potential science-based careers. Though graduation rates for minorities have been improving, many still take more than four years to earn their degrees, and failure to graduate remains common.

To address common needs of beginning students at California State University, Northridge, the MORE program there has developed interventions aimed at helping students experience early academic success in gatekeeper courses. The goal is to increase the pool of students who are eligible to participate in the RISE or MARC programs on campus, since underrepresented minority students need to maintain a high GPA to be accepted into the programs. "Most of the biology majors, to be honest, want to go into medicine," said MariaElena Zavala of California State University, Northridge. "And very few actually make it."

An analysis of biology course sequences and cumulative GPAs of

[1]Hoskins, S., Stevens, L., and Nehm, R. (2007). Selective use of primary literature transforms the classroom into a virtual laboratory. *Genetics*, 176:1381–89. Hoskins, S. (2008). Using a paradigm shift to teach neurobiology and the nature of science—a CREATE-based approach. *Journal of Undergraduate Neuroscience Education* 6(2):A40–A52. Hoskins, S. (2008). Developing critical reading and analysis skills by analyzing newspaper science using C.R.E.A.T.E. *The American Biology Teacher*, in press.

approximately 400 students revealed that taking courses out of sequence (for example, attempting an upper division biology course before taking organic chemistry) results in lower GPAs and more course repeats. The problem seems to be that many students do not have the background or support to choose courses appropriately. "How do students choose courses when they don't have a family history of higher education?" Zavala asked. The MORE program therefore developed a system of early academic advisement for first-year biology majors to encourage taking courses in the proper sequence. Students cannot register for courses unless their course selections have been reviewed and approved by an adviser. A retired biology faculty member trained graduate students to advise biology majors and was available for consultation as the advisement was taking place.

The program has not yet been in place long enough to determine whether the enhanced advisement process will help students maintain high GPAs. But students "benefit by accurate and timely advisement," said Zavala.

The other intervention was based on the observation that poor performance in mathematics courses was a major factor shrinking the pool of students eligible for MORE programs. In response, the MORE program created a Summer Math Workshop Series that targets entering first-year students with low scores on the university's mathematics placement exam. Approximately ten students who participated in the program met with a mathematics instructor five days a week from 9 a.m. until 4 p.m. for one month in the summer before their first year. The workshop reviewed basic algebra and geometry skills using a combination of group and individual work. The group focused on mathematics three days a week and on English one day a week and spent one day a week on a field trip as an incentive to work hard. The students were paid $800 to attend the workshop and were given a calculator.

Students who participated in the workshop were compared with a group that was accepted into the program and had similar background characteristics but chose not to participate. The participating students had an 88 percent pass rate in their first-year mathematics classes, compared with a 74 percent pass rate in the comparison group. Furthermore, the participating group took higher level mathematics classes on average than did the comparison group. And participants on average enrolled in more science courses than did the comparison group during their first year.

Evaluations revealed that the participants especially valued the opportunity to get to know other students in the workshop so that they could form study groups during the school year. The workshop also increased interest in research and science-related careers compared with

the nonparticipants. "These students felt empowered to be able to do science through this math intervention," said Zavala. The program is so new that long-term follow-up has not occurred, but "we predict that the early successes resulting from both the advisement and the enrichment activities will contribute to an enhanced sense of self-efficacy as they develop as scientists."

MOTIVATION AND SUCCESS IN SCIENCE MAJORS

Since 1992 the Biology Scholars Program at the University of California, Berkeley, has been working to enlarge and diversify the pool of students who succeed in biology majors and related careers. More than 1,800 students have participated in the program; 80 percent of the students are low-income, first-generation college-goers, 70 percent are women, and 60 percent are from historically underrepresented ethnic groups. "It's a very atypical program if you look at who typically does science at Berkeley," said the program's director, John Matsui. At the orientation for the program, "it looks more like an ethnic studies class than a science class."

When Matsui started the program, a colleague told him that it was a waste of time to run a feel-good program for students who do not belong at Berkeley in the first place. That comment focused Matsui's attention on two aspects of the program: the characteristics of the students being served by the program, and how to evaluate the interventions to ensure that they were effective. In 2003, Matsui and colleagues published a paper that compared students in the program with majority students outside the program.[2] Even though the students in the program were less well prepared than the majority students, as measured by SAT scores and GPAs, students in the program had caught up with the majority students by the time they graduated from college, as measured by their undergraduate GPAs. "We are like the Oakland A's," said Matsui. "These students were under-valued academic players at first. But when we're finished with them, everybody wants them."

Another comment that Matsui has heard often over the years is that even though students in the Biology Scholars Program are less well prepared, they enter college with greater motivation than other students, and their greater motivation is the reason for their success rather than the interventions used by the program. Matsui disagreed, pointing out that "all the students who enter Berkeley—all the students, by and large, who are

[2]Matsui, J., Liu, R., and Kane, C. (2003). Evaluating a science diversity program at UC Berkeley: More questions than answers. *Cell Biology Education* 2:117–121.

interested in science—come in highly motivated." However, the comment sparked his interest in the issue of motivation and de-motivation.

Many of his students told him that features of their introductory science courses such as large class sizes and grading on a curve discouraged them from continuing to pursue science. A study involving incoming first-year students at Berkeley and Stanford who self-identified as pre-medical students gave Matsui and his colleagues an opportunity to analyze issues of motivation. The students filled out a web-based survey at the beginning of their first year and again at the end of their second year, with several hundred respondents at each university. At Stanford, Native American and African-American students had the steepest decline in interest over that period, followed by Latinos and whites, followed in turn by Asian-Americans. But at the University of California, Berkeley, the students who maintained the highest motivation at the end of their second years were on average African-Americans.

To help determine whether the Biology Scholars Program was responsible for the continuation of interest, Matsui did a study of African-American male students both inside and outside of the program. Students outside the program who graduated with a degree in biology had GPAs lower than 3, whereas students in the program had a final GPA above 3. The numbers in this comparison were relatively small (about 60), and further study needs to be done to correct for background factors such as gender and family income. "This is not a finished product but a work in process," said Matsui. Nevertheless, he pointed out, the evidence currently available suggests that the retention of interest in biology among African-American students at Berkeley may be due at least in part to the Biology Scholars Program.

9

Funding and Publishing Interventions Research

Two panels on the final day of the meeting explored the related issues of funding and publishing interventions research. While the discussion centered on particular agencies, programs, and journals, several widely applicable conclusions emerged that can guide anyone working in the field.

FUNDING INTERVENTIONS RESEARCH

The first Request for Applications under the Research on Interventions that Promote Research Careers program was issued in 2004. Since then, the RFA has been revised three times and has resulted in four cycles of applications. For example, the most recent RFA is focused on the causal factors and interventions that promote and support the careers of women in biomedical and behavioral research.

Three broad categories of projects have been funded under the program, said Shiva Singh of NIH's National Institute of General Medical Sciences. One category consists of projects that study associations in an effort to understand whether certain interventions are effective. A second group attempts to understand the institutional factors that influence a student's major and career choice. And a third set of studies investigate the social and psychological elements that lead to success along a biomedical career pathway.

Singh presented a list of items in proposals that in past rounds "have been important in an application getting a good, fundable priority score." First, an application should feature empirical rather than evaluative re-

search. "Your project should have a sound and explicit theoretical basis or hypothesis to be tested. There should be appropriate comparison or control groups. The application should have a sound methodology, including statistics. In many applications that did not do well, power was an issue."

Successful applications often feature team science, Singh said. They encourage evaluations to be conducted through collaborative efforts among scientists, sociologists, psychologists, and other experts, including both Ph.D. and M.D. researchers. "We encourage you to make contact and collaborate with people who would provide you with the appropriate expertise."

Finally, projects funded through the program should help identify principles that involve policy and practice. In that way, conclusions drawn from the research can directly inform and guide future projects.

These principles also are important in projects funded by the Josiah Macy, Jr., Foundation, said chief operating officer and treasurer Marc Nivet. The foundation strives to foster collaborations and interdisciplinary research and to break down silos between disciplines, and supporting research to understand educational interventions is one way to achieve those goals. A previous initiative to diversify the health professions resulted in an organization called Ventures in Education, which exposes talented high school students to research and works with them to gain admission to colleges and universities. The foundation also has been working on faculty development and on supporting teacher leaders. "There are many people who are ready for leadership positions that have not gotten the opportunities," said Nivet. Work with students at the postgraduate, graduate, and earlier levels helps prepare the individuals who will move into leadership positions in the future.

The Macy Foundation is relatively small, with an endowment of about $150 million. It distributes about $5 million per year, which means that it has to be "extremely strategic" to have an effect on an institution as large as the health professional system. One way the foundation leverages its assets is by encouraging organizations and groups with similar goals or emphases to form consortia organized around important issues. Such consortia yield "more bang for the buck," said Nivet, whether the collaborators are located in a single region or are distributed across the country.

The foundation is not prescriptive in its guidelines for grants. Rather, it provides general parameters and encourages potential grantees to be creative. "We want you to be innovators, like venture capitalists. . . . We want you to tell us what the newest, most innovative thing is and help to educate us." The foundation is not interested in the development of buildings or increasing institutional endowments; rather the focus is on

supporting innovation, which typically comes from those immersed in the field. The foundation believes strongly that it is the principal investigators, not the development officers, who are best positioned to submit applications, "because you are the person who is passionate about this issue, you are the person who will pull this off when you run into roadblocks."

The foundation typically gives grants over a three-year cycle, with large grants ranging from $100,000 to $300,000 per year. However, the foundation also provides staff grants of up to $35,000. The staff grant mechanism is often used to think through the issues involved in an idea, after which a larger grant can be sought from the Macy Foundation or another source. Nivet encouraged investigators to get to know the program officers at foundations to be in a better position to apply for a grant. "Don't shy away from talking to these people. They have a wealth of knowledge, usually developed from extensive experience in the field. Most, if not all, are interested in helping to enhance your proposal from the outset, because it usually saves time and effort on the back end of the granting process."

The Macy Foundation has a new president, George Thibault, who is maintaining the foundation's emphasis on diversity in the health sciences. He also is interested in the interface between education and the professions, including the sciences and health care. Education in the professions remains siloed, but interdisciplinary groups of educators and professionals could break through barriers. "We are trying to change the paradigm and the nature of the educational process," said Nivet.

Daryl Chubin of the AAAS provided some insight into funding opportunities at NSF. The foundation is actually composed of "about 300 different agencies," Chubin said, each of which operates with some degree of autonomy. Applicants therefore have to figure out which program within NSF to approach. For example, the education and human resources directorate is focused directly on the kinds of interventions discussed at the meeting, but the research directorates also provide opportunities under the broad goal of broadening participation in research.

Chubin recommended getting in touch with a program officer after becoming familiar with a program's objectives and current funding. "Program officers grow networks of attentive communities—people who they believe are dedicated to achieving the objectives of their program." A particularly valuable experience for a prospective applicant is to become a reviewer for a program, "because you learn a lot around the table, and you get a sense of the mentality that is brought to bear on evaluating proposals."

NSF asks its reviewers to judge both the intellectual merit of a proposal and the "broader impacts" of that research on socially important

goals. This second criterion is unequally applied across different parts of NSF, but over time it is playing a stronger role. For example, NSF has organized a training program for new program officers that emphasizes the criterion. Internal committees at NSF have examined the issue of broadening participation in research, and review panels are increasingly reminded that the objectives of the foundation include broadening participation and other broader impacts. Advisory committees at the directorate level also examine the workings of NSF, including the process for reviewing and accepting proposals.

Community colleges were discussed during the question-and-answer session. Though most of NIH's research funding goes to four-year institutions, two-year colleges are eligible for several programs designed to increase representation in the biomedical sciences. The Macy Foundation also is very interested in the role of community colleges in broadening participation in research, and it is interested in bringing together a group of experts to discuss how to enhance this role. "There are tremendous amounts of talented minority students at our community colleges," said Nivet.

The use of evaluators for grants made under the MORE program also was discussed by the group. The evaluation budget for the Research Initiative for Scientific Advancement program within MORE has been cut in recent years, Singh admitted, partly because many of the evaluations being done were not well thought through. Some evaluations tended to be more about feel-good questions than about empirical research, which did not justify the amounts being spent on them. A new emphasis on evaluation within the MORE program allows grantees to ask for additional money in a grant for evaluation, up to 5 percent of the total budget. This evaluation should be designed to provide information to an institution to make its programs more productive, Singh said.

PUBLISHING INTERVENTIONS RESEARCH

Publication is the ultimate objective of research. It validates conclusions by submitting them to the scrutiny of peers, both during prepublication peer review and after publication. Publication enables others to learn from previously conducted research, adding to the cumulative knowledge of a field and furthering its progress.

Publication also is crucial to the professional lives of scholars. Publications build a researcher's reputation as a scholar and advance that person's career. Many issues therefore surround the visibility and impact of publications. In addition, members of underrepresented groups may need special attention from mentors in proceeding with publication. For example, NSF supports several programs designed to provide mentor-

ship experiences to junior faculty who are seeking to make the transition to senior status.

Students can be exposed to the publication process at very early stages of their education, said William Darity of Duke University. For example, Duke has a summer program in which middle school and high school students are encouraged to do research on significant black intellectuals. This and other research done by younger students can be at least informally published. "We have anthologies of young creative writers," Darity said. "We can begin that process with young scientists."

Even first- and second-year undergraduates can be engaged immediately in research. For instance, in a class Darity teaches on the economics of reparations, one student wrote a paper on how to finance a reparations program that is "very imaginative," he said. "I have encouraged her to do development on that and transform it into publishable work." In some cases, faculty members can provide students with the opportunity to make submissions to journals. One of Darity's students, Parfait Gasana, now a senior at the University of North Carolina, Chapel Hill, already has had a refereed paper accepted for publication in the *Journal of Socio-economics*—a paper that Gasana originally had written during a summer research program under Darity's supervision.

Undergraduates can be enlisted as research assistants and as coauthors on research papers. They also can be involved in research through more formal programs such as summer research opportunities, which are especially valuable if the opportunities are structured as a transition to publication. Sometimes this raises questions about whether a student should be credited as a research assistant or a coauthor, which can be a "judgment call for the senior faculty member." But the choice has important consequences for junior scholars, and "I think that choice should generally be made in favor of the inclusion of the junior scholar as a coauthor." Two years ago, Duke undergraduate Danielle Salters prepared an excellent literature review on the development of the concept of the black middle class that was incorporated into a paper that has been published in the journal *Social Forces*. She was included as a coauthor on the published article.

Publication is also a critical factor for graduate students. Faculty mentors need to help them think through strategies of placement of their research projects in the context of career planning. Many issues surround the visibility and impact of their publications, which is linked to citations and the development of their reputations as scholars.

Some junior researchers are very concerned about targeting the most prestigious journals in their field. But acceptance rates are very low at these journals—just 5 percent at the *American Economic Review*, said Darity. The diversity of the editorial board and the history of a journal may

also be factors for minority researchers who are trying to publish in the social sciences on issues involving race and ethnicity; some journals are more likely to accept such articles than others. Researchers who focus obsessively on prestigious journals may improve their chances of being hired or gaining tenure at some institutions if they are successful in getting such "hits," but they may limit their options to move elsewhere if they publish very few papers by seeking to place the papers only in the highest ranked journals.

"Finally," said Darity, "it is important not to overstrategize. Pursue your passion. Don't simply try to publish in areas that don't necessarily fire your passion because you think you can publish your work in a top journal. And do not subscribe to arguments that violate your ideological core beliefs simply because the majority of people in your field believe those arguments to be true."

Rick Hoyle of Duke University agreed that "ultimately the purpose of a grant is to publish," and that peer-reviewed journals are the "high road" to publication. But he pointed out that many kinds of publications exist with a wide range of objectives. For example, the Society for the Psychological Study of Social Issues publishes a variety of journals and other documents. The society consists of about 3,000 psychologists and others who are interested in the application of their work to solving social problems. "Everything we publish has a goal of finding its way into the hands of people who make decisions and influence policies." For example, the journals are delivered to many staff members on Capitol Hill.

Hoyle edits the flagship journal of the organization, the *Journal of Social Issues*. It is a high-impact journal that has been published since 1945 and reaches a large audience. Each issue of ten or more articles focuses on a specific topic. For example, the first issue of 2008 looked at "off-diagonal students"—individuals who would be expected to excel in their education but do not, and people who might be expected not to excel but do. Themes for future issues are suggested by scholars who think that they can pull together the necessary contributions, with review and comment by the editors. The articles need to be empirically based, either from data or from the research literature. Articles also need to describe the relevance of their findings to the solution of social problems. And the articles in an issue should collectively have a beginning, middle, and end, so that the issue as a whole "tells a story." In effect, said, Hoyle, each issue is an edited book.

The society also publishes other journals that are more suited to some kinds of research. For example, an evaluation of a single program would not be appropriate for the *Journal of Social Issues* but might be published in *Analysis of Social Issues and Public Policy*, which is an online journal with rapid turnaround. The society also publishes two book series, including

one on social issues and interventions such as the ones being discussed at the conference, as well as short authored books on contemporary social issues.

Another valuable outlet for work such as that discussed at the meeting is the *Journal of Diversity in Higher Education* (JDHE), said Michael Stevenson of Northern Arizona University and the founding editor of JDHE. A joint publication of the National Association of Diversity Officers in Higher Education and the American Psychological Association, the journal is aimed at people throughout campuses who are doing work involving diversity issues, which reveals partly how submissions to the journal should be framed. "You are not just trying to reach the people who are very deeply involved in exactly the kind of work that you are doing; we also are trying to reach those practitioners in affirmative action offices, in the president's office, in student life, and in other places who may be able to glean useful information for their work from the work you are doing."

JDHE is based on a multifaceted concept of diversity, said Stevenson. It defines diversity very widely and is especially interested in submissions that deal with more than one aspect of diversity at the same time. Many times, said Stevenson, he has received submissions where data were obviously collected on various aspects of diversity, but the data were not included in the analyses. He often has sent those papers back to the authors with a suggestion to look at interactions among different aspects of diversity or to see if people with multifaceted identities are reacting in different ways to interventions.

JDHE seeks to have evidence-based practice drive decision making. Sophisticated assessments can provide data that address critical issues: What did the people at an intervention do? What did they learn? How is learning assessed?

In addition, the journal provides an opportunity to promote conversations across all institutions of higher education. "When I first began to look seriously at how diversity-related issues were being treated, I often found that some of the most exciting diversity-related work, at least with respect to the curriculum, was being done at small liberal arts colleges." Stevenson has encouraged submissions from throughout higher education to bring these lesser-known efforts to light.

All submissions, reviews, and interactions with authors are done electronically through the journal's website. The only piece of paper that needs to be signed is the copyright form. The journal also publishes occasional special issues. For example, a recent special issue focused on institutional diversity audits, which give institutions an opportunity to share information so that other institutions can learn from it. The journal also plans to publish commentaries by leaders of higher education on how their institutions have made progress on diversity issues.

During the question-and-answer session, discussion revolved around how to convey information in a form that people will read and absorb. Stevenson encouraged authors to write papers that "say what they want to say and no more." He also has found the translation of research results into two-page briefs very helpful. Faculty members are much more likely to read something short than they are a full research paper.

Shine Chang of the University of Texas M.D. Anderson Cancer Center pointed to the Cancer Control P.L.A.N.E.T. (which stands for Plan, Link, Act, Network with Evidence-Based Tools) website developed by the National Cancer Institute, which has a wide variety of resources that are available to practitioners and researchers. She suggested that NIGMS or NSF could develop a similar site for the research discussed at the meeting. Such a site could include social science results from different disciplines and papers originating in different academic fields.

10

Conclusions

In a final plenary session led by Anthony DePass and Daryl Chubin, meeting participants ranged widely over the themes of not just this conference but the previous one and possible future conferences. The meetings have been focused on breaking down two types of barriers, DePass said: barriers between researchers in different disciplines, and barriers between researchers and the practitioners who design, implement, and run educational interventions. Between disciplines, the main challenge is to accommodate different ways of doing and thinking about research. Between researchers and practitioners, the main challenge is increasing the two-way flow of information so that each group's activities inform the other's. "What we want is for trainers to develop a fairly deep—maybe not as deep as the scholars—but a fairly deep understanding of the literature, where they are knowledgeable enough about what is going on to that they can, first, find what they need and, second, learn to assess what is there."

EVALUATION VERSUS RESEARCH

The group discussed the distinction between evaluation and research, which was a central concern of both the previous conference and this one. One important difference between the two, observed Rick Hoyle, is that research conducted on one activity typically can be generalized to other activities. In contrast, evaluations can reveal the immediate outcomes of one program but do not necessarily produce generalizable data. For the

same reason, compiling lists of exemplary programs or best practices does not guarantee that those programs or practices can be replicated elsewhere, though they may produce useful guidance. The design and functioning of an educational program may be so dependent upon particular circumstances that efforts to replicate it elsewhere cannot be guaranteed to work. The generalizability of programs may itself be a useful topic of research.

At the same time, Chubin observed that the line between evaluation and research is not always clearcut. Both types of activities can use very similar instruments, and both activities generate important information. Funders tend to be preoccupied with evaluations, because they want to know whether their expenditures are having the desired effect. The information generated by evaluations can inform and contribute to research, Chubin said, and should not be ignored. For that reason, the interplay between the two types of activities will continue to be an important theme for researchers and practitioners alike.

DEVELOPING A COMMUNITY

The development of a community focused on educational interventions for minority students in the sciences should be inclusive, conference participants said. For example, the directors of intervention programs are a very important audience for the information discussed at the conference, Tama Hasson observed. A mechanism needs to be established to disseminate research results and tools to these individuals, which will serve to integrate them into the research process. Program directors "need to be interacting with the individuals on their campus, the sociologists, psychologists, and so on, to make sure their programs are working." In response, DePass noted that he regularly attends and gives presentations at the Annual Biomedical Research Conference for Minority Students, which brings together program directors and staff as well as students from across the country.

Valerie Wilson of Brown University stated that it is important to involve all of NIH, and not just the MORE program, in the effort to increase the number of minorities involved in the sciences. In particular, all of the training programs at NIH as well as the internal NIH units focused on the social and behavioral sciences should emphasize broadening participation in research.

Many communities that may seem tangential to the core group of researchers and practitioners attending the conference have valuable information and expertise that they can contribute to the cause of broadening participation in biomedical and behavioral research. Rena Pasick, who conducts research on health disparities at the University of California, San

Francisco, Helen Diller Family Comprehensive Cancer Center, said that her research looks at behavioral change and outcomes in diverse cultural settings and therefore has much in common with educational interventions research. Furthermore, minority students involved in her research have gone on to graduate school and have studied the effectiveness of interventions on behaviors. Yet interactions between the two communities have been minimal.

Martin Chemers made a similar point: many other people do research on topics directly relevant to broadening the participation of minorities in the sciences, yet they might not be identified in preparing for a meeting like this one. In recent work for an issue of the *Journal of Social Issues*, he helped gather about a dozen articles, and only two or three would fit the definition of interventions discussed at the conference. Yet other papers on topics such as identity and academic achievement among recent immigrants or educational transitions are obviously relevant. Indeed, diversity research need not be focused only on biomedical research or even on STEM fields but on society in general. In fact, at the most recent review of intervention grants under the MORE program, Chemers said, the most successful applications were those that looked "outside the box" using populations such as women or immigrants.

Travel awards are important for younger researchers and students to be able to attend meetings, said Clytrice Watson from Delaware State University, who was the recipient of a travel award to attend the conference. Travel awards targeted at students and junior faculty doing research in this area can cultivate the next generation of researchers and practitioners and help build a strong foundation for future efforts.

Broad participation in a community of researchers and practitioners is important, Nicole Crane said, but at the same time the effort emerging from the conference needs to be focused. The broader a message becomes, the weaker it can be. "It is important to think about what is the mission of a community like this." The funders of programs also need conciseness in mission statements to satisfy their funding objectives, DePass added.

DISSEMINATING INFORMATION

An important goal of the conference was not only to identify information useful to the broader community of researchers and practitioners but also to identify ways in which that information can be disseminated to those who need and can use it. Several speakers called for the development of a website that would serve as a repository for this information, perhaps built on the website for the conference itself (http://www.understandinginterventions.org). Such a website could cover the entire range of education, from preschool to postgraduate training. It could

offer not just documents but tools such as survey instruments, literature summaries, and statistical packages that could be used by researchers and practitioners alike. The website could serve as a common resource where researchers from different disciplines and practitioners from different fields could come together to share information and develop and maintain tools.

Such a website should devote special attention to the transitions between levels of education, said Robert Megginson from the University of Michigan. Many students are lost at these transitions, partly because many educational programs focus primarily on getting students to the end of their section of the educational pipeline. Programs directed specifically at these transitions could help repair the leaks that result in diminishing numbers of minorities at higher levels of STEM education.

The website also could highlight programs geared not just for students but for those who work with students. In particular, a website could feature interventions for mentors who are expected to work productively with diverse groups of students. The website also could contain information for program practitioners about the uses and value of research. For example, K-12 educators need to know why it is important for them to gather data about their students and how to do so.

OUTCOMES

The conference focused on careers in biomedical and behavioral research, but preparation for a career in research can have many other positive outcomes, DePass reminded the participants. People with bachelor's, master's, and doctoral degrees in science and engineering work in many different fields in academia, government, the private sector, and the nonprofit sector, and any of these outcomes can be counted a success of an intervention program.

Similarly, Donald Barr from Stanford University emphasized what he called the "common undergraduate pathway to science." Many undergraduates go through a very similar set of chemistry, physics, and biology courses. "Whether the student comes out of the common pathway as a physician or a biomedical researcher or an epidemiologist is really irrelevant," said Barr. "The common pathway is crucial for anybody to succeed in the sciences, especially minorities."

The community of researchers needs to be defined broadly. For example, said Michael Leibowitz of the University of Medicine and Dentistry of New Jersey, the number of physicians engaged in biomedical research is small and has been declining. Yet these physician-researchers bring unique perspectives to research, and minorities in these roles can be especially important in representing the views of underserved communities.

FUTURE MEETINGS

Throughout the final plenary session, the conference participants discussed the topics that would be most useful to explore in future meetings. Beverly Hartline of Delaware State University said that future conferences should be organized around specific questions and objectives. For example, a future meeting could look at best practices in programs and the research-based principles behind those practices.

Another possibility would be for a future meeting to be organized around generating a list of questions that can be answered through systematic research. Such a meeting could result in a research agenda that could bring greater coherence and direction to the efforts of the interventions community.

Finally, the participants noted that future conferences should include considerable time for unstructured discussions and one-on-one conversations. The first and second conferences on Understanding Interventions that Encourage Minorities to Pursue Research Careers sought to build an interdisciplinary community of researchers and practitioners who share common interests and objectives. The best way to advance that goal is simply to let people talk directly with each other about their activities, setbacks, convictions, and dreams.

APPENDIX
A

Conference Agenda

Second Annual Conference on Understanding Interventions that Encourage Minorities to Pursue Research Careers

May 2–4, 2008

Atlanta Hilton, Atlanta, Georgia

Friday, May 2

Noon–5:30 pm	Poster set-up
6:00 pm–8:30 pm	**Reception—Atlanta Hilton**

Saturday, May 3

8:30 am–9:00 am	**Welcome and Overview** *Planning Committee Chair* Anthony L. DePass, *Long Island University-Brooklyn*, and *Co-Chair* Daryl E. Chubin, *American Association for the Advancement of Science*
9:00 am–10:30 am	**Opening Panel:** ***Disciplinary/Other Perspectives on Scholarship and Its Utilization in Program Design and Outcomes*** *Moderator:* Wanda E. Ward, *National Science Foundation* *Panelists:* Samuel L. Myers, Jr., *University of Minnesota*, Economics

Willie Pearson, Jr., *Georgia Institute of Technology*, Sociology
Martin M. Chemers, *UC-Santa Cruz*, Psychology

11:00 am–12:30 pm **Concurrent Symposia:**

Identifying the Active Ingredients: *Investigations on the Characteristics of Effective Interventions to Support Minority Student Researchers*

Moderator: Martin M. Chemers, *UC-Santa Cruz*

Presenters:
Kenneth I. Maton, *University of Maryland, Baltimore County*, "Analyzing the Impact of the Meyerhoff Scholars Program"
P. Wesley Schultz, *UC-San Marcos*, "The Benefits of Being in a Minority Training Program: Preliminary Evidence from a National Longitudinal Study"
Merna Villarejo, *UC-Davis*, "Efficacy of Educational Enrichment Activities: A Mixed Methods Approach"

Models for Research Training

Moderator: Angela L. Sharpe, *Consortium of Social Science Associations*

Presenters:
Simeon Slovacek, *California State University-LA*, "An Empirical Validation of a Comprehensive Multiple Interventions Model"
Matea Pender, *University of Maryland, Baltimore County*, "Summer Research Experience and PhD Entry among Talented Students in the Sciences and Engineering"
Nicole Crane, *Cabrillo College*, "Understanding Interventions That Promote Recruitment into the Sciences: The Role of Experiential Science Programs for Youth"
Alan Peterfreund, *Peterfreund Associates*, "With Support Structures in Place, Buying Student Time for Research Yields Significant Outcomes"

12:30 pm–2:00 pm **Luncheon**

Moderator: Orlando Taylor, *Howard University*

Speakers:
Brian Bridges, *American Council on Education*, "Bottlenecks and Bulges: The Minority Academic Pipeline"
Rhonda V. Sharpe, *University of Vermont*, "Obstacles to Achieving Faculty Diversity: Implications for Affirmative Action"

2:00 pm–3:30 pm **Concurrent Symposia:**

Race and Sex

Moderator: Marian C. Johnson-Thompson, *NIEHS/ National Institutes of Health*

Presenters:
Jerlando Jackson, *University of Wisconsin-Madison*, "Beyond Brown: New Approaches to Addressing Inequities in Education for African American Males"
Cheryl Leggon, *Georgia Institute of Technology*, "The Cross Disciplinary Initiative for Minority Women Faculty"
Lori Bakken, *University of Wisconsin-Madison*, "Learning Experiences that Enhance Research Self-Efficacy in Women"

Sociological Approaches to Underrepresentation in STEM: Evidence from Programs and Research

Moderator: Ansley Abraham, *Southern Regional Education Board State Doctoral Scholars Program*

Presenters:
Sandra Hanson, *Catholic University*, "The Use of Sociological Frameworks and Methods in Examination of Young African Women's Experience in Science"
Connie L. McNeely, *George Mason University*, "Planting Seeds and Bearing Fruit: Models Inclusion and Excellence in STEM Preparation"

William Trent, *University of Illinois-Urbana-Champaign*, "Evidence on What Matters for Underrepresented Students in STEM: The Summer Research Opportunities Program (SROP) and the Gates Millennium Scholarship Program"

Methodology in Interventions Research

Moderator: Wendi S. Williams, *Long Island University-Brooklyn*

Presenters:
Anne MacLachlan, *UC-Berkeley*, "Exploration of Methodologies Underpinning Research-Based Hypotheses"
Tama Hasson, *UCLA*, "The Craft of Creating a Control Group: Complexities and Complications"
Roger Levine, *American Institute for Research*, "Use of the Critical Incident Technique to Develop Interventions Broadening Participation in Research Careers and to Measure the Impacts of Interventions"
Nicole Lewis, *Duke University*, "Assessing the Utility of a Social Cognitive Career-Based Theory to Research Programs for Underrepresented Students"

4:00 pm–5:30 pm **Concurrent Symposia:**

Research on Expanding Representation in STEM Fields

Moderator: Samuel Myers, Jr., *University of Minnesota*

Presenters:
Terrell Strayhorn, *University of Tennessee*, "Learning Activities that Affect Minority Undergraduates' Choice of STEM Major"
Angela Byars-Winston, *University of Wisconsin-Madison*, "A Social Cognitive Approach to Retaining URMs in Science"
Wesley Harris, *MIT*, "The Post-Doctoral Experience Plus the First Two Years on Tenure Track"

Mentoring

Moderator: Earnestine Psalmonds, *National Academy of Sciences*

Presenters:

Mica Estrada-Hollenbeck, *UC-San Marcos*, "Mentors Make a Difference: Evidence from a Longitudinal Study of Minority Training Programs"

Richard McGee, *Northwestern University*, "What If Young Scientists Had Coaches and Athletes Had Mentors?"

Elise Lev, *Rutgers University*, "Protégé's Research Self-Efficacy: Perceptions of Mentors and Protégés"

Marc A. Nivet, *Josiah Macy, Jr., Foundation*, "Envisioning Futures Selves: African American Medical Students on the Path to Careers in Academic Medicine"

Approaches

Moderator: Crispin Taylor, *American Society of Plant Biologists*

Presenters:

Sally Hoskins, CUNY-*City College of New York*, "Using Intensive Analysis of Primary Literature to Stimulate Students' Interest in Research Careers—The CREATE Approach"

MariaElena Zavala, *California State University-Northridge*, "Early Academic Interventions to Increase Student Success"

John Matsui, *UC-Berkeley*, "Preliminary Data on the De-Motivation of Biology Majors and the Possible Mitigating Effect of a Science Diversity Program"

Sunday, May 4

8:30 am–9:30 am **Funding Interventions Research**

Moderator: Anthony L. DePass, *Long Island University-Brooklyn*

Panelists:
Shiva Singh, *NIH*
Roosevelt Johnson, *NSF*
Marc A. Nivet, *Josiah Macy, Jr., Foundation*

9:35 am–10:35 am **Publishing Interventions Research**

Moderator: Robert E. Megginson, *University of Michigan*

Panelists:
William Darity, *Duke University*
Michael Stevenson, *Journal of Diversity in Higher Education*
Rick Hoyle, *Journal of Social Issues*

11:00 am–Noon **Closing Plenary Discussion**
Future Directions: *Fostering the Community and Integrating Scholarship into Programs and Interventions*

Facilitators:
Anthony L. DePass, *Long Island University-Brooklyn*
Daryl E. Chubin, *American Association for the Advancement of Science*

APPENDIX
B

Program Committee Biographic Sketches

Anthony L. DePass, *Chair*
Anthony L. DePass is the Associate Dean for Research and Associate Professor of Biology at the Brooklyn campus of Long Island University. He is the PI and Director of the MBRS SCORE program at Long Island University and was Co-PI and a member of the administrative core of a NIH-NCI funded partnership between Long Island University and Columbia University that addresses cancer-related health disparities. Dr. DePass' background in the areas of student and faculty development is quite extensive. He was the principal investigator and co-director of the Multimedia and Interactive Learning (MIL) project. The NSF-funded MIL Project trained math and science faculty from five institutions in the New York metropolitan area in the development and utilization of multimedia applications designed to enhance the active role of students in the learning process. As Chair of the Minority Affairs Committee for the American Society for Cell Biology and former chair of a similar committee for the American Society of Plant Biologists, Dr. DePass has provided leadership in coordinating activities at the national level that are aimed at increasing underrepresented minority representation within the scientific workforce. This work is supported by the respective societies in addition to a MARC grant from NIH-NIGMS awarded to ASCB for which he serves as the PI. Dr. DePass has served on several review panels and advisory committees that focus on the issue of broadening participation in the sciences. Originally trained as a plant biologist, Dr. DePass currently directs a funded research program that explores cell differentiation as a

therapeutic target for cancer therapy. His laboratory provides training for students at the high school, bachelor's and master's levels; several of his underrepresented minority students have gone on to competitive doctoral programs.

Daryl E. Chubin, *Vice Chair*
Daryl E. Chubin became founding director of the AAAS Center for Advancing Science & Engineering Capacity at the American Association for the Advancement of Science in August 2004. Prior to that, he served more than three years as senior vice president, research, policy & programs at the National Action Council for Minorities in Engineering (NACME) in White Plains, New York, after nearly 15 years in federal service. Government posts included senior policy officer for the National Science Board at the National Science Foundation (NSF) (1998–2001); division director for research, evaluation, and communication in NSF's Directorate for Education and Human Resources (1993–1998); and (on detail) assistant director for social and behavioral sciences (and education) at the White House Office of Science and Technology Policy (1997). He began his federal career in 1986 at the congressional Office of Technology Assessment. Dr. Chubin has also served on the faculty of four universities, including Georgia Tech, where he was promoted to full professor. He has published eight books and numerous policy reports, articles, and commentaries on issues in science policy, career development, program evaluation, and engineering education. His honors include AAAS Fellow, Fellow of the Association for Women in Science, Integrator for BEST (Building Engineering and Science Talent), Quality Education for Minorities/Math Science Engineering 2006 Giant of Science, and Sigma Xi Distinguished Lecturer 2007–2009.

Renato Aguilera
Renato Aguilera obtained his B.S. and M.S. degrees in Microbiology from the University of Texas at El Paso (UTEP) and his Ph.D. in Immunology from UC Berkeley in 1987. He subsequently became a tenured professor in the Department of Molecular, Cell and Developmental Biology at UCLA. In 2002, he joined the Biological Sciences Department at UTEP where he serves as the Director of the Biology Graduate Program. Dr. Aguilera's research is in the area of molecular biology/immunology, and his research has been funded by grants from the National Science Foundation, the National Institutes of Health, and research foundations. Dr. Aguilera has an active research laboratory at UTEP and is the director of the RISE Scholars and SCORE programs. At the national level, Dr. Aguilera served on the Board of SACNAS, the Board of Scientific Advisors of the NIEHS, and is currently serving as a member of the Minority Affairs Committee of the American Society for Cell Biology.

Martin M. Chemers
Martin M. Chemers is Professor and Chair of Psychology at the University of California, Santa Cruz. Dr. Chemers came to UC Santa Cruz in 1995 from Claremont McKenna College to accept an appointment as the Dean of Social Sciences and Professor of Psychology. At UC Santa Cruz, he also served as Interim Executive Vice-Chancellor and Provost (December 2003–April 2004) and as Acting Chancellor (April 2004-February 2005). Prior to his tenure at UC Santa Cruz, he was the Henry R. Kravis Professor of Leadership and Organizational Psychology and Director of the Kravis Leadership Institute at Claremont McKenna College. He was previously on the faculties of the Universities of Illinois, Delaware, Washington, and Utah, where he was chair of the Department of Psychology. Since receiving his Ph.D. in Social Psychology from the University of Illinois in 1968, he has been an active researcher in the areas of leadership, culture, and organizational diversity. His current research is focused on psychological factors that affect the commitment and success of underrepresented minority students in science.

Marian C. Johnson-Thompson
Marian C. Johnson-Thompson is Director of Education and Biomedical Research Development at the NIEHS/NIH, where she develops and works with initiatives to increase the participation of underrepresented minorities (UM) in the biomedical sciences and programs to enhance K-12 science education. She has spent the majority of her career in teaching, training, and mentoring underrepresented minority students who have gone on to pursue advanced degrees in STEM and health professional fields. Dr. Johnson-Thompson is Professor Emeritus of Biology and Environmental Sciences at the University of D.C. (UDC) and Adjunct Professor in the Department of Maternal and Child Health, SOPH, UNC-Chapel Hill. Previously, she held adjunct appointments at Howard University and Georgetown University Medical School. Dr. Johnson-Thompson also chairs the NIEHS IRB and serves on the NIH Human Subjects Research Advisory Committee. She is an active member of the following professional societies: AAAS, AACR, ASM, and ASCB. As a member and leader of several organizations and advisory committees that focus on increasing underrepresented minorities in STEM and biomedical fields, Dr. Johnson-Thompson has extensive experience in analyzing associated barriers, challenges, and opportunities. Currently, she chairs the Committee on Microbiological Issues Impacting Minorities for the ASM and is a member of ASM's Public and Scientific Affairs Board. She has served on NSF's CEOSE, chaired the Burroughs Wellcome Fund's Science Student Enrichment Program Advisory Committee, and chaired the National Advisory Committee for Science and Everyday Experiences, a national

informal science education program funded by the NSF. Included among her awards and honors are Sigma Xi, Fellow-American Academy of Microbiology, Fellow-AAAS, 2001-2002 Meyerhoff Mentor of the Year, ASM's Alice Evans Award, the Geraldine P. Woods Award, the Thurgood Marshall Award, several awards from HBCUs, and several NIH Director's Awards.

Jay B. Labov

Jay B. Labov serves as a Senior Advisor for Education and Communications for the National Academy of Sciences (NAS) and the National Research Council (NRC). He also served for three years as Deputy Director for the NRC's Center for Education and was the study director and responsible staff officer for the NRC reports *Enhancing Professional Development for Teachers: Potential Uses of Information Technology* (2007); *Linking Mandatory Professional Development with High Quality Teaching and Learning: Report from a Workshop* (2005); *Evaluating and Improving Undergraduate Teaching in Science, Mathematics, Engineering, and Technology* (2003); *Learning and Understanding: Improving Advanced Study of Mathematics and Science in U.S. High Schools* (2002); *Educating Teachers of Science, Mathematics, and Technology: New Practices for the New Millennium* (2000); *Transforming Undergraduate Education in Science, Mathematics, Engineering, and Technology* (1999); *Needs of Pre-College Science and Mathematics Education: Impact of a Digital National Library on Teacher Education and Practice* (1999); and *Developing a Digital National Library for Undergraduate Science, Mathematics, Engineering, and Technology Education* (1998). He has served as Director of the Center for Education's Standing Committees on Undergraduate Science Education and Science Education K-12, and the National Academies' Teacher Advisory Council. Dr. Labov was the co-PI for a multiyear grant from the National Science Foundation to the Center for Education to offer workshops to grantees of the NSF's Math/Science Partnership Initiative to enable them to better understand and implement the recommendations in NRC reports on education. He also currently oversees efforts at the NAS to confront challenges to teaching of evolution in the nation's public schools, directed a committee of the National Academy of Sciences and the Institute of Medicine that authored *Science, Evolution, and Creationism* (2008), and oversees a recently expanded effort of the National Academies to work more closely with disciplinary and professional societies on education issues. Prior to assuming his position at the NRC in August 1997, Dr. Labov was a member of the faculty in the Department of Biology at Colby College (ME). He was elected as a Fellow in Education of the American Association for the Advancement of Science in 2005.

Carol B. Muller
Carol B. Muller is the founder, president, and chief executive officer of MentorNet, The E-Mentoring Network for Diversity in Engineering and Science. MentorNet (www.MentorNet.net) is a nonprofit organization headquartered in San José, California. Founded in 1997, its mission is to further the progress of women and others underrepresented in scientific and technical fields through the use of a dynamic, technology-supported mentoring network; and to advance individuals and society, and enhance engineering and related sciences, by promoting a diversified, expanded, and talented global workforce. She is responsible for establishing and implementing the vision for the organization and its programs, developing needed resources, and managing those resources with the help of staff, volunteers, and partners to produce services of high quality and to deliver results. In addition to serving as MentorNet's president and CEO, she is a consulting associate professor of mechanical engineering at Stanford University. Both Dartmouth's campus-wide Women in Science Project, which Dr. Muller co-founded and developed when she served as associate dean for Thayer School of Engineering, and MentorNet have been recognized with the Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring. She earned a bachelor's degree in philosophy and English from Dartmouth College and master's and doctoral degrees in education administration and policy analysis from Stanford University.

Samuel L. Myers, Jr.
Samuel L. Myers, Jr., is Roy Wilkins Professor of Human Relations and Social Justice and directs the Roy Wilkins Center for Human Relations and Social Justice. He specializes in the impacts of social policies on the poor. He pioneered the use of applied econometric techniques to examine racial disparities in crime, to detect illegal discrimination in credit markets to assess the impacts of welfare on family stability, and to evaluate the effectiveness of government transfers in reducing poverty. Myers became president-elect of the Association of Public Policy and Management in November 1999 and served as vice president prior to that. He has served on the association's policy council and on the American Economic Association's Committee on the Status of Minority Groups in the Economic Profession. Myers has consulted with the National Employment Policy Commission, National Academy of Sciences, U.S. Civil Rights Commission, U.S. General Accounting Office, and U.S. Congressional Committee on the Judiciary, Subcommittee on Crime. He was on the academic advisory board of the National Forum for Black Public Administrators, National Council of Black Studies board of directors, and editorial boards of the *Journal of Policy Analysis and Management*,

Social Science Quarterly, and the *Review of Black Political Economy.* In 1990, the *Review of Black Political Economy* recognized Myers as one of the top twenty U.S. black economists. He earned a doctorate in economics from the Massachusetts Institute of Technology.

Willie Pearson, Jr.

Willie Pearson, Jr., is Professor in the School of History, Technology, and Society at Georgia Institute of Technology. Prior to joining the faculty, as Chair, at Georgia Tech in July 2001, he held a distinguished appointment as Wake Forest Professor of Sociology at Wake Forest University and Adjunct in Medical Education at Wake Forest University School of Medicine. Dr. Pearson received his Ph.D. in sociology from Southern Illinois University at Carbondale in 1981. In 1993, he received Southern Illinois University's College of Liberal Arts' Alumni Achievement Award. In 1999, Dr. Pearson was selected as one of Quality Education for Minorities in Mathematics, Science, and Engineering (QEM/MSE) Network's Giants in Science. In 2001, he was elected a National Associate (life-time appointment) of the National Academy of Sciences. In 2005, Dr. Pearson was elected as an American Association for the Advancement of Sciences (AAAS) Fellow. He has held postdoctoral fellowships at the Educational Testing Services (ETS) and the Office of Technology Assessment (OTA), Congress of the United States. Most of Dr. Pearson's research has centered on the career patterns of Ph.D. scientists—particularly African Americans and human resource issues in science and engineering. His publications include numerous articles in refereed journals and chapters. He is the author and co-author of seven books and monographs, including *Black Scientists, White Society and Colorless Science: A Study of Universalism in American Science* (1985), *Blacks, Education and American Science* (1989), *Who Will Do Science?: Educating the Next Generation* (1994), *Diversity in Science and Technology Centers* (1996), *The Role and Activities of American Graduate Schools in Recreating, Enrolling and Retaining United States Black and Hispanic Students* (2000), *Scientists and Engineering the New Millennium: Renewing the Human Resource* (2001), and *Beyond Small Numbers: Voices of African American PhD Chemists* (2004). He served as Associate Editor of *Contemporary Sociology, American Sociological Association* (1987-91). Dr. Pearson serves or has served on the editorial boards of *Sociological Spectrum; Science, Technology and Human Values; Journal of Science* and *Engineering Ethics and Educational Evaluation* and *Policy Analysis*. Dr. Pearson is a nationally recognized expert on program evaluation, especially to increase the participation of underrepresented groups in science and engineering and related fields. He serves or has served as the lead evaluator on a variety of science and technology projects and programs (e.g., museums, university alliances, university/school partnerships, work-

shops, non-profit organizations, professional societies and universities) or evaluation consultant (National Science Foundation/Division of Research, Evaluation and Communications, American Society for Cell Biology, American Physiological Society, The Setzer Group). Dr. Pearson also co-chaired the National Research Council Panel on the Evaluation of NIH Minority Traineeships. He was elected president of the Mid-South Sociological Association (1987); a member of the Executive Council, American Sociological Association's Section on Science, Knowledge and Technology (1989-91); and a Governor of the National Conferences on Undergraduate Research (1994-2000). Dr. Pearson has served on advisory boards, board of directors and/or committees for the Winston-Salem Urban League, Family Services, Inc. (Winston-Salem, North Carolina), Forsyth Futures (appointed by the Forsyth County, North Carolina County Commissioners), and Maya Angelou Institute, Winston-Salem State University. Additionally, he served as co-chair of the Review and Comment Committee of the Forsyth County Juvenile Justice Council.

Angela L. Sharpe
Angela Sharpe is responsible for lobbying members of Congress and their staff on health and behavior research, and representing COSSA to executive branch agencies, particularly the Department of Health and Human Services. She runs two coalitions out of the COSSA office: the Coalition to Protect Research (CPR), which has functioned to protect peer-reviewed research projects from congressional attempts to defund them; and the Coalition for the Advancement of Health Through Behavioral and Social Science Research (CAHT-BSSR), which works with the National Institutes of Health's (NIH) Office of Behavioral and Social Science Research to infuse health and behavior issues throughout NIH. She is also a member of the Ad Hoc Group for Medical Research's Steering Committee. She joined the COSSA staff in June 1995. She previously served as a legislative assistant to former Rep. Carrie P. Meek (D-FL) and to the late Rep. R. Lawrence Coughlin (R-PA). Prior to working on Capitol Hill, Sharpe worked for the Library of Congress' National Library Service for the Blind and Physically Handicapped. She earned her Master in Government from The Johns Hopkins University. She received a B.S. in Industrial Relations and a B.S. in Psychology from the University of North Carolina, Chapel Hill.

Crispin Taylor
Crispin Taylor is Executive Director of the American Society of Plant Biologists (ASPB). He was born in the U.K., and immigrated to the U.S. in 1985 after receiving a bachelor's degree in microbiology from the University of Surrey. He obtained a Ph.D. in genetics at the Michigan State University Department of Energy Plant Research Laboratory ("the

PRL"), graduating in 1993. After a short postdoc at the University of North Carolina, Chapel Hill, Taylor jumped from gels to journals, taking over as news and reviews editor at *The Plant Cell*, which is published by ASPB. After four years at ASPB, during which he was promoted to run the peer review and production processes for *The Plant Cell*, Taylor moved to Science's Next Wave, AAAS's potent online resource for early career scientists. At Next Wave (now a part of the Science Careers website; www.sciencecareers.org), Taylor participated in the site's geographic and topical growth, overseeing new components of the site dedicated to European and Asian scientists, and to U.S. postdocs. Taylor also collaborated with AAAS's Education and Human Resources unit to develop the Minority Scientists' Network (www.miscinet.org), and he has stayed active in efforts to increase minority representation in the sciences ever since. He also has remained engaged in efforts to better prepare graduate students and postdocs for their future careers and has been a member of the Advisory Board for the National Postdoctoral Association (http://www.nationalpostdoc.org) for several years. In 2004, Taylor moved back to ASPB and his current position as the CEO of this 5,000-member professional society. In that capacity Taylor is becoming increasingly active in the scholarly publishing arena, serving on the Council of the Association of Learned and Professional Society Publishers (ALPSP; http://alpsp.org/ngen_public/) and the steering committee of ALPSP's North American chapter.