A Report to the National Science Foundation

Education and Training in the Social, Behavioral, and Economic Sciences: A Plan of Action

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A National Workshop on Improving Education
in the Social, Behavioral, and Economic Sciences

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Preface

We are honored to have been asked by the National Science Foundation (NSF) to co-chair the June 2003 National Workshop on "Improving Education in the Social, Behavioral, and Economic Sciences" and to prepare this report. In convening this National Workshop and seeking guidance in the form of an action plan, the Social, Behavioral, and Economic Sciences (SBE) Directorate at NSF took a major step forward—looking beyond its investments in research to assessing how best to invest in building human capacity. The leadership and staff of the SBE Directorate deserve considerable thanks and appreciation for their determination to pursue this effort and take seriously the results.

Norman Bradburn, Assistant Director of the Social, Behavioral, and Economic Sciences Directorate through March 2004, gave both priority attention to this activity and engaged the full support and partnership of Judith Ramaley, Assistant Director of the Education and Human Resources Directorate. Richard Lempert, Director of the Division of Social and Economic Sciences, and Philip Rubin, until September 2003, Director of the Division of Behavioral and Cognitive Sciences, also provided important guidance for this enterprise.

No one individual, however, is more responsible for persisting in the ambition that NSF commit itself to public literacy in the SBE sciences and to building a strong, competent, and diverse talent pool of SBE scientists than Bonney Sheahan, Director of the Cross-Directorate Activities Program in the SBE Directorate. For many years, Bonney Sheahan has urged and pursued NSF activities to promote education in the SBE sciences. We hope this report advances that goal.

The report benefited from the information and wisdom provided by NSF, including data and reports. While we undertook considerable study of NSF's structure and programs as well as needs and challenges in the SBE sciences, the work of the participants at the National Workshop provided the basis for the report. We also benefited directly from reviews of drafts provided by breakout group chairs and reporters and many other Workshop participants. Our role in planning the National Workshop and in preparing this report was made possible by a grant from the National Science Foundation (SES-0335575) to the first author through the American Educational Research Association (AERA). While there is much for NSF to assimilate in this report about expanding opportunities for training and education in the SBE sciences, it is our hope that the report offers a useful roadmap in pursuit of that end.

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Executive Summary

Over the last quarter of a century, the world has undergone rapid change. Almost every aspect of human life is more complex and interdependent, requiring knowledge of human and social systems as well as physical and biological systems. The social, behavioral, and economic (SBE) sciences[1] contribute penetrating insights on such issues as the causes and consequences of conflict, how individuals and groups perceive and misperceive hazards, how they understand or misunderstand the risks they run in their daily lives, and how they organize and structure their interactions and transactions. Understanding and utilizing this knowledge require basic competence in the SBE sciences in all citizens, and a talent pool of SBE scientists to undertake research and teach about it.

Determining how best to improve education and training in the social and behavioral sciences is a challenge. Under the aegis of the Social, Behavioral, and Economic Sciences (SBE) Directorate, and with the active participation of the Education and Human Resources (EHR) Directorate, the National Science Foundation (NSF) has committed itself to this task. This report, undertaken at the request of NSF, is an outgrowth of that ambition. The purpose of the report is to provide guidance to NSF on the development of a strategic plan for education and training in the SBE sciences.

The report focuses on four levels of education—K-12, undergraduate, graduate, and postdoctoral and early career stages—and on diversity issues. In each area, the report addresses key needs, impediments and challenges, and best practices as well as the components of an action plan. The action plan itself is presented in three parts: enhancements to existing NSF programs, new opportunities and initiatives, and immediate steps. An outline of the plan is presented in the Action Plan Summary Table (see pages 19-20).

NSF's commitment to SBE science education and training complements two priorities in the Foundation's five-year strategic plan (FY 2003-2008), NSF's *Workforce for the 21st Century* initiative and the *Human and Social Dynamics* priority area. In 2003, NSF took explicit steps to engage the wider scientific community in providing guidance on education and training in the SBE sciences. First, in January 2003, representatives of approximately 20 social and behavioral science societies attended a Planning Meeting and discussed the state of education and training in their respective fields. Second, in June 2003, 120 leading social and behavioral scientists and educators participated in a National Workshop. (Appendices A-C provide information on the Workshop.) At the June Workshop, participants engaged in intensive discussions about ongoing

[1] Anthropology, cognitive science, economics, geography and regional sciences, history of science, law and social science, linguistics, decision and management science, political science, psychology, social psychology, sociology, and statistics, among others.

programs, innovations, and opportunities at the four stages of education and examined key needs, impediments, and best practices in education and training in the SBE sciences. In the plenary sessions and breakout groups, all participants addressed the topic of diversity.

Considerable research and analysis were undertaken in the preparation of this report and action plan. Also, information presented at the January Planning Meeting and the background papers and materials prepared for both meetings contributed valuably to the report. While all of this work was very useful, the deliberations at the National Workshop provided the basis for the report. In that sense, this plan of action is a collective product reflecting the ideas and input of many experts.

Improving Kindergarten through Grade 12 Education in the SBE Sciences

Current Context

Key Needs

The social, behavioral, and economic (SBE) sciences are largely absent from the K-12 curriculum, and their presence in the high school curriculum is limited, especially compared to the natural sciences. Major investments in curriculum, materials, and teacher training are required to meet current and future needs.

Impediments and Challenges

Impediments and challenges include determining where the SBE sciences should be situated in the K-12 curriculum (especially with respect to general science and social studies); developing appropriate curriculum, content, and materials; and focusing on pre-service and in-service teacher preparation. Interest in SBE science education comes at a time when the current emphasis in the No Child Left Behind Act of 2001 on reading and mathematics coupled with state-based assessment is preoccupying. Also, the absence of the SBE sciences in the National Science Education Standards and in education improvement programs affects the integration and legitimacy of these fields.

Best Practices

Some of the SBE disciplines and scholarly associations offer models of what can be done to improve SBE science education at the K-12 level. National committees of economists developed the Voluntary National Content Standards in Economics (1997), and the American Psychological Association developed and approved National Standards for the Teaching of High School Psychology (1999). Anthropology, economics, geography, psychology, and sociology, among others, have produced instructional materials and mounted teacher-training programs. Largely through the efforts of relevant scholarly societies, advanced placement courses are offered in economics, geography, political science, and psychology. An advanced placement sociology course is in development.

Components of an Action Plan

A commitment by the National Science Foundation to improve social, behavioral, and economic science education in the K-12 curriculum would send a strong signal to the scientific and education communities about the importance of capacity building and the inclusion of the SBE sciences in the "family" of science. Much can be done to advance SBE science education within the contours of existing EHR Directorate programs. Also, NSF should invest in innovations at the K-12 level to enhance the presence and quality of SBE education.

Enhanced SBE Funding through Existing EHR Programs

Greater attention to the SBE sciences and access of SBE investigators to a number of existing programs in the Directorate for Education and Human Resources (EHR) could materially advance SBE science education at the K-12 level. For example, a competition to support a Center for Learning and Teaching with a specific concentration in the SBE sciences could yield a cadre of professionals prepared to incorporate the SBE sciences in K-12 education. Also, the Instructional Materials Development Program, the Teacher Professional Continuum Program, and the Informal Science Education Program are ripe for proposals from and funding in the SBE sciences.

New Opportunities and Initiatives

The SBE and EHR Directorates should consider establishing a new, integrated initiative to advance education in the social, behavioral, and economic sciences at the high-school level. The SBE and EHR Directorates should also collaborate on a Teacher Training Initiative, and on the establishment of a "Bridges to SBE Science Education" Program similar to the joint program between the EHR and the NSF Engineering Directorates. The SBE Directorate should consider establishing a Research Experiences for High Schoolers (REHS) Program similar to the existing Research Experiences for Undergraduates (REU) Program.

Immediate Steps

Three immediate steps to help reshape understandings of the SBE sciences in the K-12 and science communities are: an article co-authored by the Assistant Directors for the EHR and SBE Directorates suitable for *Education Week*, *Science*, or a similarly prominent publication stressing the importance of integrating SBE science education into the K-12 curriculum; a request from NSF to the National Research Council's (NRC) Committee on Science Education K-12 (COSE K-12) to include the SBE sciences in the National Science Education Standards; and a request to the American Association for the Advancement of Science (AAAS) to integrate the SBE sciences into its Project 2061.

Improving Undergraduate Education in the SBE Sciences

Current Context

Key Needs

The progress made by groups convened by national professional associations or higher education commissions notwithstanding, there remains substantial need to move beyond "trickle down" knowledge, notable initiatives, and institutional symbols of support to structural and institutional change. Colleges and universities all grapple with the dual purposes of exposing undergraduates to the thoughts, materials, and methods of fields of inquiry while simultaneously attracting, nurturing, and preparing some of these students to pursue advanced degree training. In almost every SBE science, recognition of the importance of a sequenced and integrated curriculum, sound methodological training, and research-based experience far outstrips implementation of these objectives.

Impediments and Challenges

Key impediments to enhancing literacy in the SBE sciences and enlarging the pool of individuals attracted to scientific careers include the absence of well-defined objectives for SBE general education; the complexity of designing courses that meet the needs of majors and non-majors; structural differences that impede the transition from associate to baccalaureate-degree programs; the inertia, inadequate resources, and absence of rewards that limit faculty collaboration on curriculum change; and the overall absence of an explicit plan for research-based training and mentoring of SBE majors. While the impediments to improving SBE science education at the community college and baccalaureate levels are a varying mix of individual, financial, and institutional factors that depend on specific contexts and circumstances, NSF's strong and historic leadership role in supporting the SBE sciences places the Foundation in a unique position to overcome these challenges.

Best Practices

Best practices in SBE undergraduate education emphasize research opportunities and research-related activities. Institutional change at the department level has been slow to occur. Exemplary practices include attention to an integrated and sequenced curriculum, methodological training and research experiences, active learning techniques, and quality mentoring. The American Sociological Association's Minority Opportunities through School Transformation Program emphasized department-wide, sustainable change in these areas. The Council on Undergraduate Research (CUR) promotes the full integration of the SBE sciences in programs to stimulate undergraduate research and mentoring in all fields of science. Efforts like the UCLA Student Research Program provide a context and infrastructure to support student research and mentoring. Summer programs like the American Psychological Association's Summer Science Institute expose undergraduates to the elements of scientific inquiry and to research areas, researchers, and a cohort of students with research interests and potential.

Components of an Action Plan

Increased investments by NSF would make a major difference in improving and transforming SBE undergraduate education. Strategies that make NSF's existing programs much more accessible to the SBE sciences offer the quickest results at the least cost.

Enhanced Funding for Critical SBE and EHR Programs

Greater access and enhanced funding for SBE sciences in EHR programs designed to attract and retain underrepresented minorities should be a priority. The long-term absence of funding the SBE sciences in programs like the Lewis Stokes Alliance for Minority Participation (LSAMP) Program or Historically Black Colleges and Universities Undergraduate (HBCU-UP) Program is problematic. Other initiatives appropriate for enhanced support for the SBE sciences include the Course, Curriculum, and Laboratory Improvement (CCLI) Program and the Science, Technology, Engineering, and Mathematics Enhancement (STEP) Program. Immediate returns would also be realized through major increases in funding for the Research Experiences for Undergraduate (REU) Program in the SBE Directorate and in particular for the site awards.

New Opportunities and Initiatives

Collaboration of the SBE and EHR Directorates on the workshop that led to this report augurs well for continued cooperation on such efforts as a Systemic Reform of SBE Undergraduate Education Initiative to encourage long-term sustainable change, an SBE Educational Innovation Program that would seek to infuse SBE research results and advances into courses and curriculum, and an Undergraduate Faculty Enhancement Initiative that would provide support to institutions to prepare new faculty and retool experienced faculty in pedagogy or methods related to research courses or supervision of students in research.

Immediate Steps

Three immediate actions that would advance and call attention to the importance of undergraduate education and training in the SBE sciences are: encouragement of nominations for the NSF Director's Award for Distinguished Teaching Scholars (DTS), convening a workshop of recent REU site grantees and SBE-CCLI grantees to examine their innovations, and a request from the highest levels of NSF leadership to the National Research Council that its Committee on Undergraduate Science Education explicitly include SBE sciences in future workshops and reports as well as in the composition of the committee.

Improving Graduate Education in the SBE Sciences

Current Context

Key Needs

The SBE sciences of the 21st century need advanced skills and methodological tools in order to address the vexing problems facing society. The contexts wherein SBE scientists work are also changing. Graduate training in the SBE sciences should be rethought to produce excellent researchers with skills appropriate to diverse work settings. The core curriculum, research training, and mentoring merit fresh consideration in light of changing opportunities and changing career goals and motivations of graduate students. Notwithstanding the fact that the SBE sciences are generally more diverse than other fields of science, there remains a need for a workforce that includes the fuller participation of underrepresented minorities in these sciences. Efforts to meet these needs should be guided by a cohesive human resource policy for the SBE sciences, as is warranted in all fields of science.

Impediments and Challenges

Longstanding practices and perceptions are the greatest impediments to transforming graduate education in the social, behavioral, and economic sciences, including the dominant academic culture and the homogeneity of college and university faculty, limited funds for graduate student training and research, less explicit attention to mentoring and supervised research training than is desirable, and the absence of SBE scientists on most national commissions and committees (e.g., those convened by the NRC or AAAS) charged with improving science education.

Best Practices

Current strategies to improve graduate education in the SBE sciences include programs devised by scholarly societies, academic institutions, various foundations, and combinations of two or three of these stakeholder types. For example, in political science, NSF's support for Empirical Implications of Theoretical Models (EITM) is permitting summer training institutes at universities over a five-year span to enhance the capacity of future researchers to link theory and inquiry. In education research, the American Educational Research Association leads two major initiatives with components directed to early graduate career and dissertation training. One of these efforts, funded since 1990 by NSF with contributions from the National Center for Education Statistics, focuses on the use of large-scale education databases in research.

The Preparing Future Faculty Initiative (PFF), spearheaded by the Council of Graduate Schools and the Association of American Colleges and Universities, includes the SBE fields of communications, political science, psychology, and sociology and partners with universities and two- and four-year colleges in their ambition to train and mentor students in the full range

of faculty roles and responsibilities. The Carnegie Initiative on the Doctorate, which includes education among six scholarly fields, supports multiyear projects and experiments designed to enhance doctoral training and produce training models.

Components of an Action Plan

No effort is more crucial to capacity building in the SBE sciences than NSF's increased involvement in SBE graduate education and training. NSF can play a significant role by supporting initiatives to transform graduate education, create innovative training programs, and attract a wider and more diverse pool of talented students using strategies of the type set forth below.

Enhanced Funding for Critical SBE and EHR Programs

NSF programs that rank high on potentially offering major returns in improved graduate education in the SBE sciences are the Integrative Graduate Education and Research Traineeship Program (IGERT) in the EHR Directorate, the NSF Graduate Teaching Fellows in K-12 Education (GK-12) Program in the EHR Directorate, and the Research Experiences for Graduates (REG) Supplements in the SBE Directorate. Expanded funding and increased access and visibility for these forms of support could have an important impact on SBE graduate students and on how institutions train SBE graduate students.

New Opportunities and Initiatives

The SBE and EHR Directorates need to collaborate on and invest in new opportunities to educate and train SBE graduate students. Priority consideration should be given to support for a Transformed Grants for SBE Doctoral Dissertation Improvement Program with an increased amount of funding ($25,000 to $30,000) to allow resources to be used for student stipends in addition to direct research costs. Also strongly recommended and worthy of priority consideration are a Transition and Early Career Initiative for Graduate Students, a Graduate Education Reinvention Program that would fund the development and implementation of model training programs, and a Preparing Future SBE Scientists Program that would emphasize research training in non-academic research institutions.

Immediate Steps

Short-term actions to improve graduate education in the SBE sciences include modifying the NSF proposal review criteria to include a proposal's effectiveness in advancing graduate student career development; holding a small SBE leadership conference on the 1995 National Academy of Sciences Report, *Reshaping the Graduate Education of Scientists and Engineers*; providing a venue for a meeting of principal directors and advisory committees working on Carnegie Initiatives, PFF Programs, and other graduate-level programs directed to rethinking graduate education; and commissioning or partnering on a study of SBE graduate education, focusing on the rates and causes of attrition and retention of graduate students in the SBE sciences.

Improving Postdoctoral and Early Career Education in the SBE Sciences

Current Context

Key Needs

Most SBE disciplines invest primarily in the development and design of doctoral education and devote less attention to professional growth and education after doctoral training. The absolute number of postdoctoral appointments in science and engineering has increased rapidly, but relatively few of these opportunities to enrich the doctoral research experience and establish a research program exist for SBE scientists. The SBE sciences would benefit greatly from a significant increase in the number of postdoctoral positions and programs. Beyond postdoctoral appointments, new PhDs in all employment sectors would benefit from explicit professional support during the first several years of their careers. The skills and competencies requisite to scholarly productivity and to the advancement of scientific careers require continued development during early career stages, especially for women and underrepresented minorities.

Impediments and Challenges

Postdoctoral training and early career development remain underdeveloped in the SBE sciences, absolutely and in comparison with the attention given in the natural sciences, biomedical sciences, and engineering. The fact that research tends to be funded on a small scale where resources are more limited for postdoctoral and junior-level appointments, that there is little of a tradition of providing systematic advice and mentoring beyond the doctorate degree, and that junior scholars get preoccupied with the day-to-day responsibilities of first positions without a structure of support for developmental opportunities creates impediments for SBE scientists' building strong research programs and careers. Also, graduate department faculties tend to know best environments like their own, and thus there is limited exposure of advanced graduate students, postdoctoral trainees, and junior colleagues either to other academic options or to career opportunities in other sectors of employment. NSF resources and support can create the conditions and incentives for investing more heavily in this professional stage.

Best Practices

Government agencies, academic institutions, and scholarly societies have supported postdoctoral and early career initiatives directed to the professional development challenges encountered by SBE scientists. Although extant programs are insufficient in number and levels of support, they offer examples of mechanisms that could be extended or transported across disciplines or institutions. The National Institutes of Health (NIH) have among the most successful programs of support for institutional training and individual fellowships to ensure well trained scientists, including SBE scientists, in areas of health. An NIH award, for example, to the Carolina Population Center at the University of North Carolina, Chapel Hill supports one-year postdoctoral and predoctoral fellows with an emphasis on research, strong mentoring, and

working in a center environment on all aspects of research competencies. Focusing on education research, the American Educational Research Association (AERA) operates an intensive three-year postdoctoral training program supported by the Institute of Education Sciences in the U.S. Department of Education.

Outside of formal postdoctoral programs, there has been only limited attention to early career development of SBE scientists. For example, again from the area of health, the National Institute of Mental Health offers research support for early career transitions. Research societies also aim to do their part largely through professional development courses and workshops. Each summer, the American Psychological Association offers four-day Advanced Training Institutes to provide exposure to advanced technologies and methodologies. While these illustrations point to strategies that are feasible and desirable for the SBE sciences, there is need for sustained investment and evaluation to determine what works well in engendering successful research careers.

Components of an Action Plan

Enhanced Funding for Critical SBE and EHR Programs

Opportunities exist within NSF for program enhancements directed to the SBE sciences. In some instances, there is a need to broaden awareness of EHR or NSF-wide programs and reduce the perception or reality that SBE scientists are not eligible. The NSF-wide Faculty Early Career Development (CAREER) Program is an example of an initiative that needs to be more accessible and visible to SBE scientists. With a focus on the integration of research and teaching for junior faculty, these five-year awards could usefully enhance the research and teaching of more SBE scholars than are currently funded under this initiative.

Other types of support in the SBE Directorate exist only as small parts of one or a few programs and require much more infusion of funds. For example, the mid-career initiatives in the Methodology, Measurement, and Statistics Program; the Cultural Anthropology Program; and the Law and Social Science Program could be structured into Directorate-wide activities and, with more resources, could make significant gains. The Postdoctoral Fellowships and Small Grants initiative within the Science and Technology Studies Program is another example of a mechanism rarely used and potentially worthy of being instituted Directorate-wide. The Minority Postdoctoral Research Fellowships and Supporting Activities Program is SBE Directorate-wide and is sufficiently important as a developmental training initiative to merit more funds.

New Opportunities and Initiatives

The absence of a tradition of postdoctoral and early career support in the SBE sciences commends it as an NSF priority. New initiatives that could make a difference include the EHR and SBE Directorates' collaborating on a Integrative Postdoctoral Research Traineeship (IPRT) Program in the SBE sciences to foster advanced scientific skills and address issues that transcend any one discipline, an SBE Postdoctoral Research Fellowships Program directed to capacity building for strong research careers, and SBE use of the NSF's Vertical Integration of Research and Education (VIGRE) Awards to encourage innovative training and integration

of postdoctoral appointments. Also, worthy of consideration is establishing an SBE Stimulus Package Partnerships Program for Professional Development with scientific societies to support small-scale innovations aimed at advancing the professional development of junior scholars**.**

Immediate Steps

Immediate steps to improve postdoctoral and early career education in the SBE sciences include enhancing the prominence of existing postdoctoral training opportunities; convening a meeting of key private foundations and federal agencies to identify partners to help make postdoctoral training a more integral part of SBE science education; holding a meeting of key program officers and principal investigators involved in SBE postdoctoral programs to help design an SBE postdoctoral initiative and program solicitation; urging extension of the data gathering conducted by the SBE Directorate's Division of Science Resources Statistics to include detailed information on employment choices, research activities and productivity, and career trajectories across sectors of employment of new SBE doctorates; and working with the AAAS to include the SBE sciences in the AAAS Postdoc Network and the electronic career development database.

Fostering Diversity in Education in the SBE Sciences

Current Context

Key Needs

Numerous studies demonstrate that diversity in education contributes to broadening perspectives, encouraging tolerance, and promoting the development of critical thinking and related skills. Building a scientific workforce that mirrors the U.S. population challenges all fields of science, including the social, behavioral, and economic sciences. Absent intentional efforts to alter recruitment and retention in higher education, the achievement gap between minority populations and non-Hispanic whites will persist or widen. Better recruitment and retention of women at the advanced degree level in the SBE sciences, in particular in certain disciplines and subfields, are also needed. The absolute numbers and the proportions of persons of color in the SBE sciences remain quite small, notwithstanding increases over time.

Impediments and Challenges

Currently there is a gap between aspiration and implementation in achieving more inclusive education in the SBE sciences. Despite examples of innovation, higher education in the SBE sciences requires reinvention to realize the goal of achieving excellence and inclusiveness for all. Changes that would facilitate the development and training of students and early career professionals of color are similar to those that more generally seem to engender professional growth and development (e.g., increased financial support, better mentoring and guidance, better research training and access to information and networks). Areas that warrant special emphasis include the disparities among school systems in SBE science courses, the need for improved SBE

capacity building and faculty development in Historically Black Colleges or Universities, targeted outreach at all levels of education in the SBE sciences to attract students of diverse backgrounds and aspirations, and the persistence of glass ceilings for persons of color and women in all science and engineering specialties.

Best Practices

A variety of successful programs have been established that recruit minority students; provide financial support; and enhance skills and opportunities through mentoring, direct training, and networking. Some have long and enviable records of bringing minority scholars into the SBE sciences through a variety of effective mechanisms. In addition, a few innovative programs aim at producing systemic change in academic departments and other organizational units to alter practices overall. These programs are offered through scholarly societies in many instances, by individual academic institutions in other instances, and sometimes by both, often with support from public and private foundations.

Notable examples for undergraduates include the American Economic Association's summer institute, operating for some 30 years and now at Duke University partnering with North Carolina A&T State University, and the American Political Science Association's Ralph Bunche Summer Institute also at Duke University and almost two decades old. Similarly longstanding at the graduate level are the Minority Fellowship Programs of the American Psychological Association and the American Sociological Association (ASA) providing predoctoral fellowship training in cooperation with graduate programs. Initiatives directed to systemic change are ASA's Minority Opportunities through School Transformation Program that worked with departments to enhance excellence and inclusiveness in undergraduate and graduate education, and the relatively new initiative of the History of Science Society directed to attracting faculty and students at HBCUs to the history of science as a field of inquiry.

Components of an Action Plan

Expanded SBE Access to and Support for Existing Diversity Programs

SBE participation in programs in the Human Resources Division (HRD) in EHR is critical to widening and diversifying outreach in the SBE sciences. The rarity of the SBE sciences supported by such funding initiatives as the Louis Stokes Alliance for Minority Participation (LSAMP), Centers of Research Excellence in Science and Technology (CREST), the Historically Black Colleges and Universities Undergraduate (HBCU-UP) Program and the Tribal Colleges and Universities (TCUP) Program, and the Alliance for Graduate Education and the Professorate (AGEP) Program suggests the need for explicit language in solicitations that alert applicants to the fact that STEM sciences include the SBE sciences and that the SBE sciences are encouraged to apply. NSF should consider explicit encouragement through such mechanisms as supplements for projects that include SBE science components. Additional ways to focus NSF strategies and intensify efforts include making certain that SBE scientists are eligible to participate in all HRD programs and in all programs directed to women and girls. Also, augmented financial support should be directed to programs with a track record of reaching minorities, in particular the

Research Experiences for Undergraduates (REU) Program, the Integrative Graduate Education and Research Traineeship (IGERT) Program, and the SBE Minority Postdoctoral Research Fellowships and Support Program.

New Opportunities and Initiatives

New initiatives to foster diversity in the SBE sciences could further promote a more inclusive talent pool of SBE scientists. Examples include the collaboration of the SBE and EHR Directorates on an SBE Diversity Innovations Program to foster long-term sustainable change in how academic, degree-conferring departments educate students at all levels, and an SBE Launch Awards Program (LAP) for Minority Scholars that would provide underrepresented minorities with a head start in undertaking research and building viable research programs.

Immediate Steps

High priority steps on the part of NSF to augment diversity in the SBE sciences include requesting that the NSF Committee on Equal Opportunities in Science and Engineering (CEOSE) consider this report and recommendations related to diversity; clarifying how NSF staff can address the NSF goal of *Integrating Diversity into NSF Programs, Projects, and Activities* in making funding decisions; developing an NSF incentive program that rewards academic departments, centers, and other units in the SBE sciences for achieving substantial increases in the number of underrepresented minorities; funding the compilation of a *Manual of Best Practices for Recruiting and Retaining Minority Students in the Social, Behavioral, and Economic Sciences*; issuing a solicitation for research on minority access to and participation in SBE science education and training; and urging the American Association for the Advancement of Science (AAAS) to enhance the relevance and utility of its Minority Scientists Network.

Conclusion—Pathways to Advancing SBE Science Education

In 2003, NSF embarked on a historic mission to focus attention on improving education in the social, behavioral, and economic sciences and sought guidance from leading social and behavioral scientists and educators on a plan of action that would permit the Foundation to take concrete steps at all education levels. The aim of this report is to provide a plan that is practical, feasible, and desirable within the context of NSF's structure, programs, and how the agency works. The report recognizes that strategic actions and implementation take time, but offers guidance on changes that can be introduced in the short- and longer-term.

A number of issues critical to effective implementation are presented, including attention to the language used in extant programs and outreach, the commitment of new resources and the reallocation of funds to stimulate and support SBE science education enhancements, and assessment of which new initiatives should have the highest priority for adoption. Also, the report recommends attention to the structural arrangements at NSF to manage and monitor this strategic commitment and calls for immediate and demonstrable progress.

Salient cross cutting themes that emerged from the Planning Meeting and the National Workshop and are evident in the report include:

- the need for improved SBE science education at all levels of education. Despite increasing awareness of the importance of social and behavioral science knowledge, the gaps in SBE education remain large—especially at the earlier stages of science learning;

- greater public understanding of the SBE sciences as integral parts of the STEM (science, technology, engineering, and mathematics) sciences. Public comprehension of the SBE sciences would be greatly advanced by inclusion of the SBE sciences at early stages of science learning;

- the critical leadership role of the National Science Foundation in advancing SBE science education. The National Science Foundation is the sole federal agency charged with advancing the health and well-being of science, including the SBE sciences. Beyond its internal resources, NSF is particularly well situated to support and encourage *systemic* improvement in SBE science education at all levels of education;

- the need for culture change at NSF regarding SBE science education. Joint support from the SBE and EHR Directorates for a strategic plan for education and training in the SBE sciences can help to ensure that the SBE sciences gain the same level of access, intentional programming, and support as do the other fields of science and engineering;

- the value of continuing to strengthen collaboration between the SBE and EHR Directorates. Institutional mechanisms should be devised independent of the rapport that exists between particular incumbent Assistant Directors; for example, cross-appointments to Advisory Committees or the inclusion of SBE scientists on the EHR Advisory Committee and science education experts on the SBE Advisory Committee;

- the need to strengthen communications between NSF and the SBE science community on funding mechanisms to support SBE science education and on relevant NSF's funded projects, and the need also for NSF to facilitate the dissemination of information on best practices;

- the advantages of collaboration between NSF and scientific societies and organizations on SBE science education issues. The SBE science societies and general science organizations (e.g., AAAS) offer opportunities for synergy in improving SBE science education;

- the need to improve knowledge regarding education, training, and career trajectories. Research could provide the foundation for crafting strong programs to improve SBE science education; systematic study and evaluation of SBE science education and training programs are also essential;

- increased investments in the social science of science, including research on SBE science education and professional development. Scientific research on the practices of science and on science education is essential. Consideration should be given to funding an NSF Center for Research on Innovation and Organizational Change in Academic and Scientific Settings.

The National Science Foundation's commitment to devise a strategic plan to improve education and training at all education levels in the social, behavioral, and economic sciences is a major step in articulating and emphasizing the need for a cohesive human resource policy. Appropriately implemented, a priority emphasis on SBE science education can contribute substantially to public understanding of these sciences and their capacity to make important new discoveries.

Action Plan Summary Table: Training and Education in the SBE Sciences By Education Level, Strategic Stage, and Priority

Ed Level	Expand/Alter Existing Programs	New Initiatives	Immediate Steps
K-12	• SBE Center for Learning and Teaching (EHR) • Instructional Materials Development Program (EHR) • Teacher Professional Continuum Program (EHR) • Informal Science Education Program (EHR)	• SBE Science in High School Initiative (SBE/EHR) • Teacher Training Initiative (SBE/EHR) • "Bridges to SBE Science Education" Program (SBE/EHR) • Research Experiences for High Schoolers (REHS) Program (SBE)	• Place high profile NSF articles (e.g., in *Education Week, Science*) on the importance of SBE education in K-12 • Urge NRC to include SBE sciences in Committee on Science Education K-12 (COSE K-12) • Urge AAAS to integrate SBE sciences into project 2061

Under-Graduate	• Underrepresented Minorities Programs (EHR):
	  • Lewis Stokes Alliance for Minority Participation (LSAMP)
	  • Alliance for Graduate Education and the Professorate (AGEP)
	  • Centers of Research Excellence in Science and Technology (CREST)
	  • Historically Black Colleges and Universities Undergraduate Program (HBCU-UP)
	  • Tribal College Undergraduate Program (TCUP)
	• Research Experiences for Undergraduates (REU) Program (SBE)
	• Course, Curriculum, & Laboratory Improvement (CCLI) Program (EHR)
	• Science, Technology, Engineering, & Mathematics Expansion (STEP) Program (EHR)
		• Systemic Reform of SBE Undergraduate Education Initiative (SBE/EHR)
		• SBE Educational Innovation Program (SBE/EHR)
		• Undergraduate Faculty Enhancement Initiative (SBE/EHR)
			• Publicize NSF Director's Award for Distinguished Teaching Scholars (DTS) in SBE community
			• Convene workshop of REU site grantees and SBE-CCLI grantees to identify and disseminate promising practices
			• Urge NRC to include SBE sciences in Committee on Undergraduate Science Education

Graduate	• Integrative Graduate Education & Research Traineeship (IGERT) Program (NSF-wide) • Graduate Teaching Fellows in K-12 Education (GK-12) Program (EHR) • Research Experiences for Graduates (REG) Supplements (SBE)	• Transformed SBE Doctoral Dissertation Improvement Program (SBE/EHR) • Transition & Early Career Initiative for Graduate Students (SBE/EHR) • Graduate Education Reinvention Program (SBE/EHR) • Preparing Future SBE Scientists Program (SBE/EHR)	• Modify NSF review criteria to include proposal's effectiveness in graduate student training • Convene SBE leadership conference on 1995 NAS Graduate Education Report • Convene leadership of programs directed to rethinking graduate education • Commission or partner on study of SBE graduate education
Postdoc & Early Career	• Postdoctoral Fellowships & Small Grants for Training/ Research Fellowships (SGTRF) in STS Program (SBE) • Minority Postdoctoral Research Fellowships & Supporting Activities Program (SBE) • Mid-Career support mechanisms for professional development in various programs (SBE) • Faculty Early Career Development (CAREER) Program (NSF-wide) • Research Opportunity Awards (ROAs) for faculty at predominately undergraduate institutions (NSF-wide)	• Integrative Postdoctoral Research Traineeship (IPRT) Program (SBE/EHR) • Postdoctoral Research Fellowships Program (SBE) • Vertical Integration of Research and Education (VIGRE) Awards (SBE/EHR) • Stimulus Package Partnerships for Professional Development (SBE)	• Promote SBE postdoctoral and early career opportunities • Allocate EHR evaluation funds for evaluations as part of postdoctoral training in evaluation research • Convene federal and private funders of SBE postdoctoral training programs • Convene leadership of postdoctoral programs to help design SBE postdoctoral initiative and solicitations • Extend statistical data collection in SBE/SRS to SBE postdoctoral and early career stages • Urge AAAS to include SBE sciences in postdoctoral networks

Diversity	• Explicit access/inclusion of SBE sciences in underrepresented minorities programs in Division of Human Resource Development (EHR)
	  • LSAMP
	  • AGEP
	  • CREST
	  • HBCU-UP
	  • TCUP
	• Programs Directed to Women and Girls
	  • HRD Program in Gender Diversity in Science, Technology, Engineering, & Mathematics Education (EHR)
	  • Advance Program (NSF-wide)
	• Research Experiences for Undergraduates (REU) Program (SBE)
	• Integrative Graduate Education & Research Traineeship (IGERT) Program (NSF-wide)
	• SBE Minority Postdoctoral Research Fellowships & Support Program (SBE)
		• SBE Diversity Innovations Program (SBE/EHR)
		• Launch Awards Program (LAP) for SBE Minority Scholars (SBE)
			• Request CEOSE to review report and diversity recommendations therein
			• Clarify to staff NSF goal of *Integrating Diversity into NSF Program Projects and Activities*
			• Develop NSF incentive program to reward departments enhancing diversity
			• Support preparation of best practices manual for recruiting and retaining SBE minority students
			• Support research on diversity in SBE sciences
			• Urge AAAS to enhance relevance of Minority Scientists Networks to SBE sciences

Chapter 1

Introduction

There can be no question that the social sciences are an integral part of NSF's vision of research at the frontiers of discovery. Dr. Rita R. Colwell, Director, National Science Foundation (1998-2004)[2]

Need and Challenge for SBE Science Education

Over the last quarter of a century, the world has undergone rapid change. Almost every aspect of human life is more complex and interdependent. Advances in communications technology alone have changed the content, speed, scope, and ease of how individuals, organizations, institutions, and governments function and relate to each other. Around the globe, people rely on advanced knowledge and knowledge acquisition—whether for improving their health, increasing their prosperity, expanding their capacities, or promoting their security. This knowledge itself is complex. It requires an understanding of the synergy among physical, biological, behavioral, and social phenomena.

The implications of this reality are two-fold: First, scientific reasoning and inquiry skills need to be more widespread, irrespective of employment sector or social role. Second, major investments in the research enterprise and in pursuing promising ideas are essential to keep pace with society's need for science. No area is more important for public literacy and for knowledge production than the social, behavioral, and economic sciences (SBE). Throughout the history of science, investments in SBE fields have lagged behind other sciences. Recent recognition of this gap requires not just more funds for research, but also efforts to build public support for SBE inquiry and the scientific talent pool to sustain it.[3]

The social, behavioral, and economic sciences contribute substantially to the public good. These fields consist of such disciplines and interdisciplinary specialties as anthropology, economics, geography and regional sciences, history of science, law and social science, linguistics, decision and management science, political science, psychology, social psychology, sociology, and statistics, among others. Understanding and employing the knowledge provided by the SBE sciences are fundamental and requisite to sound decisions at the individual, group, societal, and

[2] Speech to the Consortium of Social Science Associations, December 4, 2000.

[3] Public understanding and valuing of the SBE sciences begin with the scientific and engineering community's support for the SBE sciences in their own terms, not just from the vantage of how they contribute to explaining biological or physical phenomena. Fuller inclusion of the SBE sciences as scientific partners should be evident from the composition of task forces and commissions addressing issues of science, research and fellowship awards, and the appointments and presence of SBE scientists in representational roles.

global levels. Citizens and experts, for example, who lack basic grounding in economics will be ill-equipped to make intelligent choices among competing policies regarding budget deficits and inflation at the domestic level or about the national balance of trade and globalization at the international level.

The SBE sciences contribute penetrating insights into such issues as the causes and consequences of conflict, how individuals and groups perceive and misperceive hazards, how they understand or misunderstand the risks they run in their daily lives, and how they organize and structure their interactions and transactions. The methods of social science also provide essential tools for rigorously examining human phenomena and unraveling the effects of human and social factors. Individuals and households as well as agencies, firms, and governments would make sounder decisions and formulate more effective policies if the rigor in reasoning and in modes of inquiry produced by the SBE sciences were more widely shared. Utilizing this knowledge, however, requires basic competence in the SBE sciences on the part of all citizens. It also requires the advanced education and training of SBE scientists to undertake high-quality research and provide this teaching.

Goals and Framework of the Report

Determining how best to improve education in the social and behavioral sciences is a challenge. Congruent with its mission to advance the state of science and science education, the National Science Foundation (NSF) has committed itself to this task. Under the aegis of the Social, Behavioral, and Economic Sciences (SBE) Directorate, and with the active participation of the Directorate for Education and Human Resources (EHR), NSF seeks (1) to accelerate educational innovation and improve the quality and diversity of social and behavioral science graduates who enter the workforce, and (2) to advance knowledge and understanding of the social and behavioral sciences throughout our citizenry. This report is an outgrowth of that ambition.

The purpose of this report is to provide guidance to NSF on the development of a strategic plan for education and training in the social, behavioral, and economic sciences based on extant information and extensive consultation with the scientific community.[4] The report offers concrete recommendations to improve education and training in the social, behavioral, and economic sciences at each of four levels of the education process—K-12, undergraduate, graduate, and postdoctoral and early career stages. It aims to identify steps that can make a difference in SBE education in the short- and long-term.

[4] The report is undertaken in response to a request from the National Science Foundation for advice and guidance in the development of a strategic plan. Also, the report is relevant to and challenges educational institutions and administrators at each education level and at different types of institutions (e.g., public and private, 4-year colleges and universities; minority serving); scientific societies and professional organizations; and SBE academic departments, schools, and research institutes. Nevertheless, the focus of the report is on NSF and how, through its leadership role, extant funding programs, and potential new initiatives (including in partnership with other institutions), it can work to advance education and training in the SBE sciences.

The report is written in the form of an action plan. For each level of education, the report presents a brief assessment of the current situation in terms of key needs, impediments and challenges, and illustrative best practices in SBE education. The components of an action plan are then set forth, focusing on (1) NSF educational initiatives especially ripe for a fuller integration of the social and behavioral sciences,[5] (2) initiatives or programs for NSF to consider, and (3) some immediate steps to signal and facilitate change. The report also addresses diversity as a key component in the training of a scientifically literate workforce across all levels of the education process.

Fit with NSF Priorities

NSF's interest in greater attention to SBE education and training complements two priorities in the Foundation's five-year strategic plan (FY 2003-2008). First, NSF's *Workforce for the 21st Century* initiative aims to deepen understanding of the pathways to scientific and engineering (S&E) careers and to ensure both a broad talent pool and excellence in S&E education. A key element of this NSF effort is to prepare a workforce to meet the demands of a technologically and scientifically advanced society. Second, NSF has designated *Human and Social Dynamics* as a key topic for scientific attention to address the profound and rapid changes affecting every aspect of daily life. This initiative addresses significant arenas of change—from the demands placed on the human mind to the functioning of complex multi-national organizations that constitute the bedrock of the world economy. While the SBE sciences have the expertise, knowledge, and tools to contribute to both initiatives, a major commitment to education and training in these sciences would yield considerable payoff.

Steps Toward a Strategic Plan for SBE Science Education

In 2002, as part of adopting *Human and Social Dynamics* (HSD) as an NSF priority area, the SBE Directorate initiated explicit consideration of the need for education and capacity building in the social and behavioral sciences. The Directorate decided to pursue planning on this issue concurrent with the launch of the HSD initiative. The Education and Human Resources Directorate, concerned also with improving and broadening human capacity in all fields of science, indicated a commitment to work with the SBE Directorate on this challenge. In joining this activity, the EHR Directorate hoped to identify significant opportunities for EHR and SBE collaboration, given the growing recognition of the centrality of the SBE sciences to addressing some of the most pressing issues facing society.

As is often the practice within the National Science Foundation, the SBE Directorate took several steps to engage the wider scientific community in developing a strategic plan for improving education in the social, behavioral, and economic sciences. On January 16, 2003, representatives from approximately 20 social and behavioral science societies attended a Planning Meeting at NSF to discuss the state of education and human resource development in their fields and to lay

[5] While the report focuses on opportunities within a large number of extant NSF programs, the intent is to illustrate a more general need for intentional consideration of the SBE sciences in current or future initiatives.

the groundwork for a National Workshop on building scientific capacity and increasing public literacy in the SBE sciences. The National Workshop, held on June 12-13, 2003 in Washington, DC, generated the ideas and recommendations that form the basis of this report.

To help with the development of a strategic plan, the NSF sought the widest possible guidance. SBE disciplines (e.g., anthropology, economics, psychology, sociology) and interdisciplinary fields (e.g., child development, communications, demography, education research) were included whether or not they had identifiable, separate programs in the SBE Directorate. Also, the education community was included at all levels from kindergarten to continuing career development. In addition, NSF determined that it would not itself lead this activity. Accordingly, NSF turned to the authors of this report, through a grant to the American Educational Research Association (AERA), to assist in planning the National Workshop, to direct the Workshop, and to prepare this report.

Planning Meeting of Scientific Societies

The January 2003 Planning Meeting convened by the SBE Directorate brought together representatives of scientific societies to examine education and training needs in the disciplines and specialties they represent. The purpose of the one-day meeting was to (1) learn about the state of education and human resource development across the SBE sciences; (2) share information on the education and training programs and activities of each association; (3) identify needs and opportunities at all educational levels; (4) provide advice on key issues to be weighed in organizing a National Workshop; and (5) consider how education and human resource development should be infused into the emerging NSF initiative on *Human and Social Dynamics*. All of the participants contributed materials for a briefing book that provided useful background for the meeting.

This one-day meeting yielded substantive ideas and information and revealed widespread enthusiasm for convening a National Workshop to identify and address systematically needs, opportunities, strategies, and recommendations for building human capacity. Participants agreed that intentional consideration of education and training in the SBE sciences was critical to ensuring an adequate talent pool of researchers. They also agreed on the need for increasing public literacy about the social and behavioral sciences.

Meeting participants identified specific needs of the social and behavioral sciences at various levels of the education process and highlighted key topics for further attention. Discussion focused on the need to reform curricula from pre-college through higher education, develop innovative approaches and employ new technologies in teaching, emphasize research-based experience and mentoring, enhance teacher training and instruction from K-12 through graduate education, and focus much more on professional development throughout the education process, including at the postdoctoral level and beyond.

The National Workshop

The June 2003 National Workshop on "Improving Education in the Social, Behavioral, and Economic Sciences: A National Dialogue" was a first-ever event focused on capacity building in the SBE sciences (see Appendix A). Approximately 120 leading social scientists and educators participated in this "working" meeting (see Appendix B). As set forth in the agenda, the first day was designed as a series of plenary sessions with brief presentations and open discussion of the major themes and issues to be addressed in the action plan. The second day consisted of four breakout sessions in which participants engaged in intensive discussions about ongoing programs, innovations, and opportunities at the different stages of education: K-12, two-year and undergraduate, graduate, and postdoctoral and career development (see Appendix C).

From the outset, attendees understood that the meeting was aimed at providing advice and counsel that could form the basis of a plan of action for education and training in the SBE sciences. To prepare for the meeting, participants were provided with readings and data on the topical issues to be considered at the Workshop (including the materials prepared by the scientific societies for the January Planning Meeting). The plenary sessions were intended as catalysts for the more focused work that would take place in the breakout sessions.

The breakout sessions were structured around the core issues to be addressed in this report. From the vantage of an educational level, each group examined key needs in SBE education and training, best practices that could make a difference, impediments to overcome, extant NSF programs especially ripe for the fuller integration of the social and behavioral sciences, and new initiatives or strategies that should be considered over the short- and long-term. In addition, all groups were asked to address diversity in students, faculty, and the scientific workforce. Participants were also encouraged to record their ideas on any issues they thought merited additional consideration.

This approach to the Workshop was quite helpful in the preparation of this report. Attendees came from many different disciplines and fields, from diverse backgrounds and institutional settings, and with different levels and types of experience. Those assembled were anchored on the task and discussed, debated, and distilled what they knew and thought with remarkable candor and agility. While the Planning Meeting and all of the background materials were very useful, the deliberations at the National Workshop provided the basis for this report. Thus, in the truest sense, this plan of action to improve SBE science education and training is a collective work reflecting the ideas and input of many experts.

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Chapter 2

Improving Kindergarten through Grade 12 Education in the SBE Sciences

From the earliest grades, students should experience science in a form that engages them in the active construction of ideas and explanations and enhances their opportunities to develop the abilities of doing science.[6]

Current Context

Key Needs

The social, behavioral, and economic (SBE) sciences are largely absent from the K-12 curriculum, despite the fact that science competencies are best learned early and in developmentally appropriate ways. Each year, some 53 million students attend elementary and secondary schools in the United States. Yet, they receive almost no exposure to the theories, concepts, or methods of the SBE sciences, nor are they made aware of the interconnectedness of social, biological, and physical phenomena. Although more SBE science courses are available in high schools, they are few in number in comparison to natural science offerings. Furthermore, when SBE content is part of the K-12 curriculum in social studies or elective courses, the materials too often emphasize facts rather than the study of social and behavioral processes as science.[7]

Data on Advanced Placement (AP) courses indicate the limited presence of the social, behavioral, and economic sciences in the high school curriculum and their secondary status. In the 37,000 public and private secondary schools in the United States, SBE Advanced Placement courses may be the only offering in one or another of the SBE fields, and they are rarely capstone courses preceded by prerequisites. In 2002, AP psychology, economics, and geography courses were taken, respectively, by 52,000 students in 2,400 schools, 32,000 students in 2,000 schools, and 3,250 students in 400 schools. In comparison, AP biology, chemistry, and physics courses were taken, respectively, by approximately 98,000 students in 6,900 schools, 61,500 students in 5,500 schools, and 37,500 students in 3,350 schools. Even in a field like psychology where more students take AP courses than in physics, AP physics is taught in 50 percent more high schools than is psychology (3,350 schools in comparison to 2,400).

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[6] National Research Council, *National Science Education Standards* (Washington, DC: National Academy Press, 1996), p. 121.

[7] The need to improve the quality of pre-college education has received considerable attention by scientific societies in the social and behavioral sciences. In 2001, for example, the American Sociological Association launched a task force to develop an Advanced Placement course—with considerable attention being paid to the development of scientific literacy skills and an understanding of social processes and dynamics.

The relative paucity of the SBE sciences in grades K-12 presents a complex challenge. In formal education, major investments in curriculum, materials, and faculty development are required to meet current and future needs. Strategies need also to be developed that better incorporate the social, behavioral, and economic sciences into K-12 education, emphasizing their connections to each other, to other fields, and ultimately to school or work transitions. Outside of school, in the informal settings where science education occurs (e.g., science museums, media programming, after-school community programs), important opportunities could be nurtured to integrate the social, behavioral, and economic sciences into science learning.

Introduction of the social and behavioral sciences early in and as a part of the elementary school science curriculum provides an excellent context for science learning more generally. Exposing young students to science on phenomena familiar and of interest to them offers an effective framework for learning how to ask testable questions, collect systematic data, inspect and test hypotheses, and produce insights and information. Also, early and frequent exposure to the social and behavioral sciences can avert the misconception that social and behavioral phenomena are not amenable to systematic study and explanation.

Impediments and Challenges

There are serious impediments to the meaningful inclusion of the SBE sciences in the K-12 curriculum. These are typical of the challenges faced in making organizational change in any institution with longstanding practices of behavior, distributed decision making (in this instance, at the federal, state, school district, and school levels), and well-established structures of power and authority over content and resources.[8] A number of challenges are particularly worthy of note:

First, there is the challenge of where and how the SBE sciences should be situated in the K-12 curriculum. As areas of science, the SBE sciences fit logically in the broad science curriculum, and approaches need to be developed to infuse SBE concepts and content. Yet, a well-established history exists of including social and behavioral science content in the social studies curriculum. In general, however, social studies education is not directed to the development of scientific reasoning or literacy.

Second, because K-12 education is a sequenced process of learning, age- and grade-appropriate materials will need to be developed for the SBE sciences in order to integrate these fields effectively into general science courses in elementary or middle schools. The materials and work products developed for SBE courses in high school cannot merely be simplified if they are to be aligned with the cognitive development of younger children.

[8] The neglect of social science in the K-12 curriculum has been a long-term pattern reflecting a complex set of historical forces that have limited the development and presence of these fields. The singular emphasis on reading and writing, mathematics, and the natural sciences have eclipsed nurturing the links and connections to the SBE sciences. Also, ignorance or inhibition about seeing human behavior, interactions, and institutions as amenable to scientific study contributes to its absence in pre-college education.

Third, the comparative absence of materials, especially at the elementary school level, adds to the challenge of making change. There is a tremendous need for curriculum products that can enhance SBE science learning. For example, teachers need accessible materials that can help build understanding of the empirical basis of science; the differences between empirical and normative statements; the types of evidence needed for inferring causality; the difference between a concept, a variable, and an indicator; how to work with and think about data; the distinctions between individualistic and social explanations; and the like. The presence of such materials not only would facilitate the integration of the SBE sciences into the general science curriculum but also would enrich learning scientific reasoning in the general science curriculum more generally.

Fourth, greater attention needs to be paid to how the absence of SBE science content, especially in middle school, abates interest in taking SBE courses in grades 9 to 12, and even affects the availability of such courses. High schools are unlikely to field courses for which students are either not interested or unaware. Thus, the absence of SBE sciences in the general science curriculum has spillover effects on longer-term interest in the SBE sciences.

Fifth, there has been insufficient focus in the SBE sciences on the content of curricula for the earliest stages of learning and education. Overall, social and behavioral scientists have paid limited attention to science education at the K-12 level and to the ideas, techniques, and understandings that children need to develop and master. Within and across SBE disciplines, scientists and educators face the challenge of addressing the "what," the "how," and the "when" of learning in these fields.

Sixth, there is little teacher preparation in the SBE sciences, perhaps because SBE subjects are not considered to be core educational content. Training, skill development, and the enhanced professional identification of SBE science teachers within the K-12 community should be given high priority. Also, SBE scientists in higher education need to improve their attitudes and outreach to those teaching SBE science at the K-12 level.

Seventh, the absence of models for pre-service and in-service training of teachers in the SBE sciences, along with the paucity of support structures to attract and retain quality teachers in these fields, makes it difficult to introduce and sustain educational change.[9] At the broadest level, the next generations of teachers need to have sufficient exposure to the SBE sciences so that they can undertake their work with a solid grounding in the social, cultural, political, and economic foundations of education. At a more specialized level, there is the challenge of preparing teachers well trained and conversant in the SBE sciences.

Eighth, the current emphasis in the No Child Left Behind Act of 2001 on reading and mathematics, coupled with state-based assessment and testing of skill proficiency in these areas, has narrowed the focus on these competencies, seemingly at the expense of other subjects and

[9] Schools and colleges of education require faculty sufficiently well grounded in the SBE sciences to prepare teachers generally and SBE science teachers in particular to teach. The need for teacher training by faculty in schools and colleges of education is a challenge separate and apart from the need for doctoral training in education research.

skill sets. While mathematics and reading could be taught through the lens of other academic subjects or domains, the interest in improving education in the SBE sciences comes at a time when state performance standards and testing tend to constrict the curriculum and encourage teaching to or for the test.

Ninth, the National Science Education Standards released by the National Academy of Sciences in 1996 do not explicitly include the SBE sciences and make reference to human factors only from the perspective of a desire to understand individual and social dynamics that affect the conduct of science.[10] The symbolic and real impact of the SBE sciences being invisible in that document makes the effort to integrate and legitimize them far more formidable.

Best Practices

Relative to the need for improved education in the SBE sciences in K-12 education, best practices are few and far between. Nevertheless, SBE disciplines and national professional associations offer models of what can be done:

- The Council on Anthropology and Education (CAE), which is comprised of more than 800 anthropologists, has produced a series of teaching resources that help to integrate anthropology into the K-12 curriculum.

- In economics, *Framework for Teaching Basic Economic Concepts* was produced in 1995. It focuses on 21 basic economic concepts, including measurement concepts and methods. Guidelines recommend the grade level at which different concepts should be taught and how instruction should progress. The *Framework* has shaped materials for teacher preparation, curriculum guides, textbooks, and state tests. After the inclusion of economics in the Goals 2000 Educate America Act of 1994, national committees of some 26 economists and educators also developed the *Voluntary National Content Standards in Economics* (1997). The document specifies 20 standards and 211 benchmarks describing what students should be able to do at grades 4, 8, and 12.

- In 1992, the American Psychological Association (APA) established an affiliated organization—Teachers of Psychology in Secondary Schools (TOPSS). TOPPS produces unit teaching plans and workshops for teachers, operates national essay contests for high school students in psychology, and undertakes other education-related activities. In 1999, the APA Council of Representatives adopted the APA-approved National Standards for the Teaching of High School Psychology developed under the auspices of APA's Board of Educational Affairs and TOPPS.

[10] The substantive areas of science in the Standards are physical science, life science, earth and space science, and science and technology. While there are Standards related to the history and nature of science and to science in personal and social perspectives, these topics are not depicted as scientific fields but as issues that are important for understanding science.

- With National Science Foundation funding, the Association of American Geographers developed curriculum materials that met the National Geography Standards for middle- and high-school use. Student activities and interactive CD-ROMs constitute the core of the materials.

From these illustrations, it is evident that organizational leadership yields results and that course development must be accompanied by materials development and teacher training. All three components were part of the process by which Advanced Placement courses were established. AP courses themselves are best practices of sorts that enhance high school curricula, directly and indirectly. In the SBE sciences, AP courses are currently offered in psychology, economics, political science, and geography. Sociology is developing a prototype course with the active engagement of high school teachers of sociology. The national professional associations in the SBE sciences have usually led or been major players in bringing about these advances.

Components of an Action Plan

The National Science Foundation is well situated to lead efforts to improve social, behavioral, and economic science education in the K-12 curriculum. NSF's presence would itself send a signal to the scientific and education communities about the importance of including the SBE sciences in the "family" of science. Moreover, the sustained funding that only NSF can provide is essential to the development of curricula, materials and products, as well as pre- and in-service training programs.

Much can be done to advance SBE science education within the contours of existing NSF programs. The Directorate for Education and Human Resources (EHR) has important programs already in place that could play a key role in improving K-12 SBE science education. Not unexpectedly, the most relevant programs for K-12 SBE science education are in the Division of Elementary, Secondary, and Informal Education (ESIE). In addition, the SBE Directorate can collaborate with EHR and invest in strategic innovations at the K-12 level to enhance the presence and quality of SBE education. Existing programs, new opportunities, and immediate action steps are addressed below.

Enhanced SBE Presence in and Funding through Existing EHR Programs

1. A competition to support a Center for Learning and Teaching with a specific concentration in the social and behavioral sciences could produce K-12 educators better prepared in the content and methods of SBE sciences and in innovative instructional practices to incorporate these sciences into the K-12 science curriculum. Fusing a doctoral degree-awarding university (including its SBE departments and school of education), one or more school districts, and a partnering organization with expertise in the SBE sciences, child development, or education research could provide a conducive working environment to train a cadre of high-quality professionals to work in the schools and assess programs.

2. The Instructional Materials Development program could offer critical support for producing SBE materials that advance teaching disciplinary content, scientific methods, reasoning skills, and instructional technologies appropriate for the K-12 curriculum. Especially at the elementary

school level, there is little available. NSF projects like the materials development award to teach mapping and spatial skills and to develop the tools to assess competencies in children need support across many areas of SBE science.

3. The Teacher Professional Continuum program could play an important role in supporting projects related to the recruitment, preparation, enhancement, and retention of K-12 teachers in the SBE sciences. There is enormous need in the SBE sciences to improve the quality and coherence of the learning experiences that prepare teachers (including the development of resources to support teachers, their schools, and their school districts). Projects that enhance skill and provide essential materials (e.g., an NSF project directed to middle- and high-school teachers to provide learning units, workshops, and coaching in using geographic information systems) are far too absent. Teacher recruitment, pre-service and in-service training, and the development of a school support structure for faculty are high priorities for SBE capacity building at the K-12 level.

4. The Informal Science Education program offers an appropriate venue to advance understanding of the knowledge, methods, and science underlying the study of social, behavioral, and economic phenomena. The Directorate of Education and Human Resources wisely recognizes that much education takes place informally—outside of the school. Given the commonplace misperceptions about the social and behavioral sciences, informal science education should be a key component of any SBE science education plan. Exhibits, media programming, and films provide important opportunities to present SBE knowledge and methods to children, youth, and the public more generally. They also offer an opportunity to show the interconnectedness of social, biological, and physical phenomena. Such awards often include traveling lectures, teacher guides, interactive websites or web-based curricula, and other strategies that enhance their value, visibility, and impact.

New Opportunities and Initiatives

Collaboration of SBE and EHR Directorates on an SBE Science in High School Initiative. Paralleling the innovative partnership between research directorates and EHR on Nanoscale Science and Engineering (NSEE), the SBE and EHR Directorates should consider establishing a new, integrated initiative to advance education in the social, behavioral, and economic sciences at the high-school level. Many of the barriers to infusing SBE sciences in the high school curriculum could be addressed by fostering collaborations between the talent pool in colleges and universities in the SBE sciences and their counterparts in education and science education. Such an initiative should aim to develop effective strategies and interventions that can be implemented and assessed. Such strategies include the development of instructional materials and courses; the alignment of SBE science courses with other high school science and social studies courses; the enhancement of teachers' skills, knowledge, and pedagogical methods; and the deepened appreciation by parents and other relevant publics of the SBE sciences, the knowledge and methods they provide, and their synergism with other fields of science.

Collaboration of SBE and EHR Directorates on a Teacher Training Initiative. This initiative would fund workshops, a sabbatical semester or year in an academic or research setting, summer training in existing programs, or the design or development of tailored programs.

Such an initiative would extend and complement the ESIE program in Teacher Professional Continuum. It would provide an opportunity to recruit teachers to SBE science teaching as well as to enhance the SBE knowledge and skills of teachers already teaching in this area. It also could support the development of courses and programs oriented to K-12 teachers at sites such as the Inter-university Consortium for Political and Social Research (ICPSR).

Collaboration of SBE and EHR Directorates on a "Bridges to SBE Science Education" Program. Similar to the joint "Bridges" program between the EHR and Engineering Directorates, this initiative would offer planning grants to institutions, including scientific associations, for proposals to improve SBE content in K-12 education, enhance teacher training (from social studies and social science), and articulate standards (concepts, frameworks, skills, and benchmarks) in the SBE sciences within and across disciplines and fields. Funds could be used for the support of working groups or workshops designed to yield full project proposals.

An SBE Initiative on Research Experiences for High Schoolers (REHS). This initiative would parallel the Research Experiences for Undergraduates (REU) program. REHS supplements could be provided to existing grants to provide hands-on research experiences for high school students. Also, REHS site proposals could be submitted by investigators in or across SBE departments, centers, or research institutes seeking to provide summer research experiences on an ongoing research program or project to six to twelve students from high schools in a local geographic area. Applicants would be encouraged to include such developmental activities as participation of students in science fairs and competitions, science competitions, relevant scientific association meetings, and in-school presentations of research results (after the summer experience). Also, transition back coordination with the high schools to facilitate students' continued engagement during the subsequent academic year would be desirable.

Immediate Steps

Most of the above recommendations can be readily accommodated within existing or expanded programs. The most serious barrier to the inclusion of SBE science at the K-12 level is the long-term entrenched absence as well as the pervasive confusion and misperception about the place and presence of the SBE sciences in science as a whole. Some immediate steps could help start the process of reshaping understandings in the K-12 and science communities. Examples include:

- Publish an article co-authored by the Assistant Directors for the EHR and SBE Directorates in *Education Week* or a similar prominent publication on the importance of and opportunities for integrating SBE science education into the K-12 curriculum. A parallel article in a publication like *Science* or the *Chronicle of Higher Education* could also be important in changing the mindset of the scientific community.

- Request that the National Research Council's Committee on Science Education K-12 (COSE K-12), a standing committee of the Center for Education Standards, revise the National Science Education Standards so that the "processes of science" are set forth for SBE sciences (appropriate to grade level) in the same way that they are already specified for physical science, life science, and earth and space science. If this task cannot be integrated into ongoing

Phase III work of COSE K-12, it could be done as a supplement to the Standards. Continued NSF funding would help accomplish this task. COSE K-12 might draw on expertise in the NRC's Division of Behavioral and Social Sciences and Education (DBASSE).

- Work with the American Association for the Advancement of Science (AAAS) to integrate the SBE sciences into Project 2061.[11] This project is dedicated to reforming K-12 education nationwide so that all high school graduates are science literate when Halley's Comet returns in 2061. It will take resources to alter the work of this major program (ongoing since 1985—the year that Halley's Comet was last visible from earth). NSF could request that AAAS review priorities, products, and ongoing initiatives of Project 2061 and consider short- and long-term strategies and support needs to integrate the social and behavioral sciences into Project 2061.

[11] Project 2061 calls for inclusion of the history of science as a field of inquiry, but it does not appear to be given consideration in curriculum materials or learning outcomes. If the history of science were incorporated as a social science, it could provide one vehicle for learning about the SBE sciences. See American Association for the Advancement of Science, *Science for All Americans* (Washington, DC: American Association for the Advancement of Science, 1989), chapter 13.

Chapter 3

Improving Undergraduate Education in the SBE Sciences

It is not enough that individual faculty members in isolated ways advance student learning. Many . . . have suggested that what we need is not more innovation but more implementation, so that local improvements are both spread throughout the institution and made sustainable over time. Otherwise, gains will be transitory and depend on the comings and goings of individual faculty and administrators.[12]

Current Context

Key Needs

For more than a decade, the social and behavioral sciences, like many fields and disciplines within the arts and sciences, have been engaged in reexamining and reforming undergraduate education. The progress made by groups convened by national professional associations or higher education commissions notwithstanding, there remains substantial need to move beyond "trickle down" knowledge, specific notable initiatives, and institutional symbols of support to structural and institutional change. In 1998, for example, the Boyer Commission on Educating Undergraduates in the Research University called for significant transformations in undergraduate education to make research-based learning the standard. Yet, a survey undertaken three years after the Boyer Report found that only 25 percent of responding universities reported participation in research by at least half of their social science students.

Small colleges and large-scale universities all grapple with the dual purposes of exposing undergraduates to the thoughts, materials, and methods of a discipline or area of inquiry while simultaneously attracting, nurturing, and preparing some of these students to pursue advanced degree training.[13] Particularly in SBE sciences that have very large service courses and train large numbers of undergraduate majors, these goals may seem distinct and difficult to reconcile. Yet, in reality, the very same analytic reasoning and inquiry skills are essential for both advanced

[12] National Science Foundation, *Shaping the Future: New Expectations for Undergraduate Education in Science, Mathematics, Engineering, and Technology* (NSF 96-139) (Arlington, VA: National Science Foundation, 1996), p. 56.

[13] Data indicate that SBE majors do not pursue advanced scientific degrees at the same rate as in the natural and physical sciences or engineering: In 2000, only 4 doctoral degrees were awarded per 100 bachelor's degrees, compared with 9 doctoral degrees for every 100 bachelor's degrees in the other sciences. See National Science Foundation, *Science and Engineering Degrees: 1966-2000* (NSF 02-327) (Arlington, VA: National Science Foundation, 2002).

degree training and strong undergraduate liberal learning.[14] This point was central to reports on arts and sciences majors prepared by 12 disciplines, including economics, political science, psychology, and sociology, as part of a project led by the Association of American Colleges in 1989-1990.[15]

Although the SBE disciplines and fields have pursued a range of strategies to alter education at the baccalaureate level, much remains to be done. In almost every SBE science, explicit recognition of the importance of a sequenced and integrated curriculum, sound methodological training, and research-based experience far outstrips implementation of these objectives. There is also a general awareness that strengthening SBE undergraduate education will require comprehensive faculty development in substantive knowledge, teaching techniques (e.g., active learning), and advising and mentoring. Finally, there is growing recognition of the desirability of rethinking how undergraduate programs in the various SBE sciences relate to each other and align with prior or subsequent education (i.e., K-12 education, two-year college education, and graduate education).

U.S. colleges and universities are quite diverse in terms of their size, structure, mission, and the composition of their student populations. Consonant with this variation, the SBE sciences have an opportunity to advance public literacy in these sciences, to prepare undergraduates for numerous career options, and to enrich the skills and knowledge of those pursuing advanced scientific training in these fields. There are barriers and challenges in doing so, as set forth below, but sustained NSF presence, commitment, and funding can produce meaningful and realistic methods and models of change.

Impediments and Challenges

The gains to be realized from enhancing public awareness and literacy in the SBE sciences and from enlarging the pool of individuals attracted to scientific careers in these fields are enormous.

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[14] In every SBE discipline, there are departments that are successful in educating and training undergraduate students for advanced degrees. Many of these departments, however, still face the challenge of providing majors with skills to enter the labor market. Departments that integrate or offer additional training in research methods and experiences are enhancing students' comprehension of SBE fields as sciences as well as students' job-related skills. Departments with large numbers of majors face particular challenges in meeting these goals.

[15] Each of the social and behavioral science disciplines prepared reports on the undergraduate major under the auspices of task forces convened by their scholarly associations. These reports provide important guidance to departments that seek to mesh the dual objectives of providing strong liberal arts education and the skills and reasoning consonant with developing scientific capacity. See, for example, John C. Wahlke, "Liberal Learning and the Political Science Major: A Report to the Profession," *PS: Political Science and Politics*, March (1991): 48-60, and Paul Eberts, Carla B. Howery, Catherine W. Berheide, Kathleen Crittenden, Robert Davis, Zelda Gamson, Theodore C. Wagenaar, *Liberal Learning and the Sociology Major* (Washington, DC: American Sociological Association, 1990). In 2002, a follow-up Task Force of the American Psychological Association (APA) on Undergraduate Psychology Major Competencies issued a report on the *Undergraduate Psychology Major Learning Goals and Outcomes* that sets forth ten goals and learning outcomes addressed to knowledge, skills, and values consistent with the science and application of psychology and consistent with liberal arts education. See http://www.apa.org/ed/pcue/reports.html.

Among the key impediments to realizing those benefits are:

First is the challenge of designing courses that meet the needs of undergraduate majors, potential majors, and non-majors. The SBE sciences have substantial responsibilities for general education introductory courses and most entering students have little or no background in these fields. This situation requires that courses often serve double or triple purposes. Also, limited cooperation among SBE science departments on matters of substance has been an impediment to collaborating on quality SBE general education for non-majors, whether taught within one SBE department or across several departments.

Second, the absence of well-defined objectives for SBE general education makes it difficult to design and sequence lower-level courses for majors. Better articulation of what constitutes quality SBE general education would enrich SBE education in two-year and four-year colleges and the alignment between the two.

Third, structural differences between two- and four-year colleges and the difficulties students encounter in transferring from the former hamper baccalaureate SBE education in colleges and universities. In the absence of well designed articulation agreements between associate- and baccalaureate-degree conferring institutions, conflicts arise over matters large and small, from the way course credits are counted and calculated, to the definitions of disciplines, and over such broader questions as definitions of the arts, humanities, and sciences.

Fourth, an impediment to curriculum transformation for baccalaureate programs in the SBE sciences is that department faculties too seldom work as groups to craft curricula based on learning objectives and a sequencing of courses that reflect the instructional goals (in concepts and tools) they seek to meet. The inertia of longstanding practices and patterns in academic departments, traditional reward systems that favor individual accomplishment and autonomy, and a lack of information about the processes integral to effective teaching and learning (or indifference to their benefits) will continue to limit change in the absence of intentional commitments to do otherwise.

Fifth, insufficient resources, the absence of institutional signals of support, and pressures on faculty time are real and symbolic impediments to department-wide examination of courses and materials and to the pedagogical changes essential to transforming SBE undergraduate education. At the individual level, there are issues of faculty workload, training, and development. At the department or other institutional level, there are issues of how to make intentional and sustainable change when resources and facilities are often quite limited and faculty—at various career stages, with varying backgrounds, and at different levels of motivation—may need to be convinced that changes are feasible and desirable.

Sixth, the overall absence of an explicit plan for research-based training and mentoring limits the quality of the developmental experience for many SBE majors. Though disciplines vary (with psychology incorporating the most research training), research experiences and mentoring typically derive from one-on-one, ad hoc matches between faculty and students—with little department-level consideration of what research experience should be provided to all majors and with the elements of quality mentoring assumed, rather than examined.

Seventh, the demands on faculty for quality research experiences can vary within and across disciplines, depending on the nature of the research and the research programs of interest to students or being undertaken by faculty. Projects that require intensive fieldwork or the design and development of new research instruments can be far more demanding of faculty training and mentoring time than projects where students join laboratory teams when experiments are underway or where students are using extant databases.

Eighth, SBE departments have put limited emphasis on examining pedagogical strategies in light of education research and cognitive psychology. Knowledge of how students learn, assessment instruments, and performance are seldom used as tools to evaluate students' progress and determine what works. It is difficult to work effectively with students or design sequenced curricula without better knowledge about how to enhance retention of knowledge, improve the integration of knowledge, and promote understanding and combining of concepts.

Ninth, foundations, agencies, and other entities allocate insufficient funds to enhancing undergraduate education in the SBE sciences. College and university faculty members who are motivated to improve SBE education within or beyond their own disciplines have few or no incentives for devoting time and energy to such efforts within current reward structures, and may in fact encounter real disincentives. They are particularly discouraged by reports that NSF enrichment programs for undergraduate science education exclude (or are told to exclude) the SBE sciences.

In sum, the impediments to improving SBE education at the community college and the baccalaureate level are a varying mix of individual, financial, and institutional factors that depend on specific contexts and circumstances. For example, challenges to change may vary by available resources and by the scale of a department—in particular, student-faculty ratio and whether master's or doctoral programs are offered. Nevertheless, because of NSF's strong and historic leadership role in supporting the advancement of the SBE sciences, it is in a unique position to help overcome such challenges and impediments.

Best Practices

Most of the best practices in SBE undergraduate education to date have emphasized research opportunities and research-related activities. The value of such experiences has been tested over many years with support and leadership from SBE science societies and funding agencies (e.g., through NSF's funding of REU supplements and sites). Institutional change at the department level, however, has been slow to occur despite recognition by a number of disciplines of the need to develop integrated and sequenced curricula, to devote greater attention to methods training and research experiences, to utilize active learning techniques, to incorporate quality mentoring, and to provide a broader spectrum of materials. Illustrative best practices making a difference in SBE undergraduate education include:

- Since 1993, the American Sociological Association has led two major initiatives aimed at transforming undergraduate education through department change. The first initiative, Minority Opportunities through School Transformation (MOST), funded by the Ford

Foundation, worked with competitively selected departments on department-wide, sustainable change in terms of curriculum (emphasizing analytic and methodological skills), research training, mentoring, climate, and outreach to enhance the educational experience for *all* students. The second initiative (Integrating Census Data Analysis into the Curriculum), undertaken with National Science Foundation support, works with cohorts of departments and their faculties on the development of scientific reasoning skills by incorporating data analysis throughout the curriculum.

- The Council on Undergraduate Research (CUR) is a national membership organization dedicated to promoting undergraduate research and mentoring. Comprised of 380 institutional members (from primarily undergraduate institutions) and over 3,200 individual members (from more than 900 colleges and universities), CUR has promoted the full integration of the social sciences in all of its activities and programs. Explicitly emphasizing the importance of cross-disciplinary exchange, in 2001 CUR expanded its division structure (which also defines its governing Council) by adding a Social Sciences Division. Previously, a Psychology Division was the only SBE science division.

- The UCLA Student Research Program (SRP), in tandem with the Undergraduate Research Center for Humanities and Social Science, provides opportunities for students' engagement in research under the guidance of mentors. While the vast majority of SRP students major in the physical and life sciences (82 percent of some 2,500 student annually), a sizable number of SBE students are funded each year, and the existence of the Center sends a strong signal of interest and support to SBE students. Course credit (up to four units for 20 hours per week), an SRP contract between student and mentor, and research-stipends for financially eligible students all help encourage research experiences. The Center provides the infrastructure for supportive activities, including sponsorship of a poster day, assistance to departments in featuring their students' work, an undergraduate research website, an archive of collected data, a student journal, and funds to students to defray the costs of travel to present research papers.

- Since 1996, the American Psychological Association (APA) has offered a nine-day Summer Science Institute. With demand for admission far exceeding available places (32 students are selected from about 500 applications), this APA program focuses on rising sophomores and juniors. While short in duration and not the intensive experience that, for example, REU sites provide, the institute stimulates bonds across a national talent pool of psychology majors, exposes them to interactive discussions about scientific inquiry and hands-on laboratory research, and conveys information about career options and graduate training. The APA model illustrates that some gains are possible with limited resources.

Components of an Action Plan

These examples point to some of the ways SBE undergraduate education is being enhanced. While funding has been limited in absolute dollars, the National Science Foundation has played a key role in supporting innovative projects. Increased investments would make a major difference in improving and transforming SBE undergraduate education. Among possible strategies, those

that build on making existing NSF programs explicitly accessible to the SBE sciences offer the quickest results at the least cost. Extant programs within EHR are particularly ripe for SBE applications, and strategies to encourage submissions should be pursued.

Enhanced Funding for Critical SBE and EHR Programs

1. EHR Programs to Diversify the Presence of Underrepresented Minorities in SBE Sciences within the Division for Human Resource Development are appropriate to developing and training a diverse pool of SBE scientists, improving the skills and capacities of the scientific workforce, and strengthening the role of minority-serving institutions. Immediate and significant improvements in SBE undergraduate education would result from participation by SBE faculty and students in existing NSF programs, including:

- LSAMP (Lewis Stokes Alliance for Minority Participation);
- AGEP (Alliance for Graduate Education and the Professorate);
- CREST (Centers of Research Excellence in Science and Technology);
- Historically Black Colleges and Universities Undergraduate Program (HBCU-UP); and
- TCUP (Tribal College Undergraduate Program), among others.

Since many of these programs cut across educational levels, they are considered more fully in the chapter on Diversity in SBE Science Education. These initiatives have valuable consequences for capacity building in doctoral training, and thus the overall absence of funding of the SBE sciences is problematic. For example, LSAMP and AGEP seek to enrich the pool of underrepresented minorities pursuing doctoral study and ultimately research careers in science. Such initiatives are essential to the SBE sciences. Whether SBE scientists are being excluded from these programs or whether they are not applying because they believe they do not qualify, the net effect is the same: Opportunities to improve SBE science education are being missed, and efforts to enhance the skills of SBE scientists are not being nurtured.

2. The NSF Research Experiences for Undergraduates (REU) Program in the SBE Directorate, and in particular the REU site awards, are a critical component of SBE science education and should be substantially expanded. Now typically summer intensive programs (of five to ten weeks in duration), the REU site awards provide sound models for training and education. On issues ranging from experimental psychology and behavioral and cognitive sciences to cultural anthropology and minority group demography, REU projects provide solid coursework, an intensive research experience and mentoring, exposure to research careers, and contacts with a cohort of students engaged in learning about options and opportunities. These projects also enhance the teaching and mentoring skills of participating faculty.

A major increase in funding for the REU program within the SBE Directorate, coupled with explicit efforts to encourage broader participation by SBE disciplines in two-year and four-year colleges and universities, would yield immediate and significant payoffs in improved SBE education. The flexibility of institutions to adapt REU awards to their distinctive needs, specialties, and mores should be maintained, and even expanded. For example, as part of outreach to students not otherwise drawn to research, awards could include partnerships

with academic service learning programs to train students in research skills in the context of community service activities. Awards could be offered at the institutional level (as is now done, but with an additional focus on the academic year and potentially across departments), at the regional level with several institutions engaged in collaboration, or at the national level through leadership and coordination from SBE scientific societies. REU site awards are excellent vehicles for enhancing the participation of students of color in the SBE sciences and in research groups.

3. The Course, Curriculum, and Laboratory Improvement (CCLI) Program in the EHR Division of Undergraduate Education offers a key opportunity for expanded support of the SBE sciences. This program area has funded creative work in these sciences. Whether the emphasis is on instructional innovation (e.g., use of Just-in-Time teaching methods in economics), curriculum development (e.g., a two-course sequence building upon active learning in GIS-science education), or materials development (e.g., using DVD technology for samples of real behavior for classroom use), much can be gained from greater investment in improving SBE undergraduate education. Currently, funding in SBE undergraduate education is very limited in the CCLI tracks, depending on the area, with no or few awards directed to the assessment of student achievement. Expanded funding through EHR could add projects in SBE areas where almost nothing currently exists and be directed to working with investigators to scale up projects, institutionalize change, and help map better strategies for SBE education reforms.

Especially important would be major and sustained allocations for projects that have considerable potential for transportability and implementation within or across SBE disciplines and fields. For example, the current three-year award on Renewing the Undergraduate Curriculum to the Society for American Archaeology, a five-year award for Workshops and Seminars to Improve the Teaching and Learning of Geography in Higher Education, or the previously mentioned three-year award to work with cohorts of sociology departments to integrate data analysis throughout the curriculum all aim to reach large numbers of departments, faculties, and students and to work at national as well as institutional levels. Initiatives of this scope, ambition, and duration can profoundly enhance undergraduate education within and across the SBE sciences.

4. The Science, Technology, Engineering, and Mathematics Expansion (STEP) Program is well suited to meet the challenges of SBE science education. To date, this initiative has not funded projects in the SBE sciences. STEP, however, has considerable potential for expanding the talent pool of individuals (including of persons of color) exposed to scientific work in SBE fields. The SBE sciences face the problem of late declaring majors. The STEP program offers a solution. High school transition projects (e.g., summer bridge projects), programs that establish undergraduate science community centers with developmental experiences for undergraduates (making the transition from Peer Leader to Pathway Scholar), partnership programs with high schools (especially those with at-risk students), partnership programs between two- and four-year institutions, mentor-intensive projects, and peer instruction initiatives that increase student engagement as teachers and learners are all promising avenues to better education in the SBE sciences. While many SBE sciences have large numbers of majors, the STEP program provides a funding framework to enable SBE majors in increasing numbers to become scientists-in-training early in their careers.

New Opportunities and Initiatives

Collaboration of SBE and EHR Directorates on a Systemic Reform of SBE Undergraduate Education. This initiative would encourage proposals that seek to implement long-term sustainable change within SBE departments, across departments, or in interaction with centers. Curriculum reexamination, research-based training and mentoring, and the development of innovative materials and tools could all be features of such proposals. The emphasis would be on model programs that can be tested and transported to other institutions. This initiative should incorporate ongoing interaction among funded projects to share and disseminate information on systemic reform (perhaps by convening an annual grantees meeting). Any disciplinary or interdisciplinary program, department, institute, or school seeking to develop appreciation and comprehension of SBE-related sciences by undergraduates should be eligible to apply. Preparing Future Faculty-type projects could usefully be considered under this initiative as long as their strategies seek to produce institutionalized change.

Collaboration of SBE and EHR Directorates on SBE Educational Innovation. Similar to the Educational Innovation Program in the Computer and Information Science and Engineering Directorate, this program would seek to improve the undergraduate learning experience by infusing research results and advances into courses and curricula. This initiative would aim to strengthen the content of courses with current research (including attention to the tools and methods used to produce it). Projects that engage active researchers in collaborating on course redesign and teaching and that link enhanced research-based courses with actual research experiences for undergraduates could be given priority. Projects directed to the development of education standards in disciplines, interdisciplinary fields, or across fields, led by teams, working groups, or scientific associations could be supported under this initiative.

Collaboration of SBE and EHR Directorates on Undergraduate Faculty Enhancement. This initiative would provide support to institutions (scientific societies; the Inter-university Consortium for Political and Social Research; consortia of two-year colleges, four-year colleges, and universities) to design and offer workshops, mini-courses, and extended institutes to new faculty and to experienced faculty members wanting to retool their pedagogy or methods as they relate to courses or to guiding students in research-based experiences. Student involvement in the design of such projects could usefully enhance the fit between teaching and learning. Faculty taking such training would receive support as part of this initiative.

Immediate Steps

- Publicize the program announcement for the NSF Director's Award for Distinguished Teaching Scholars (DTS) through outreach to SBE scientific societies and to grantees from SBE fields in the SBE and EHR Directorates. Encourage nominations of individuals notable for their significant scholarship and their commitment to teaching. The impact on many different audiences of seeing that such awards are conferred on SBE scientists cannot be underestimated.

- Convene a workshop of REU site grantees and SBE-CCLI grantees from fiscal years 2001-2003 to present their innovations (e.g., process, progress, pitfalls); identify commonalities in terms of course, curriculum, and educational practices; and consider strengths, gaps, next steps, and strategies for dissemination and diffusion. Include non-grantees from across the SBE disciplines and fields, including in research areas where there are not separately designated SBE programs (e.g., demography, education research, child development). Ensure a dissemination plan to make known promising practices and transportable approaches for improving SBE science education.

- Request that the National Research Council's (NRC) Committee on Undergraduate Science Education explicitly include SBE sciences in future workshops and reports as well as in the composition of the committee. Commission a panel review, convene a workshop, or fund a brief supplement (e.g., to the Social Science Research Council or to this NRC Committee, possibly in collaboration with DBASSE) to examine the NRC reports on undergraduate education in terms of the applicability of their contents and recommendations for SBE undergraduate education. These reports are *Transforming Undergraduate Education in Science, Mathematics, and Technology* (1999); *Evaluating and Improving Undergraduate Teaching in Science, Technology, Engineering, and Mathematics* (2003); and *Improving Undergraduate Instruction in Science, Technology, Engineering, and Mathematics* (2003).

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Chapter 4

Improving Graduate Education in the SBE Sciences

A world of work that has become more interdisciplinary, collaborative, and global requires that we produce young people who are adaptable and flexible, as well as technically proficient.[16]

Current Context

Key Needs

Graduate education in the social, behavioral, and economic (SBE) sciences has changed little over the past several decades. Yet, during this period, almost every discipline has become more specialized and, in some instances, has spawned new disciplines and fields (e.g., cognitive science from psychology). Despite these changes, there has in principle been far more acknowledgement of the need to rethink graduate education and training than has occurred in practice. The need for such rethinking arises not only endogenously as these sciences have become more complex, but also exogenously as the changing nature of human life and its social organization requires new knowledge from all arenas of inquiry.[17]

The SBE sciences of the 21st century have evolved to a stage where the next generations need advanced skills and methodological tools in order to address the vexing problems facing society. While specialized knowledge is important, there is growing awareness that social and behavioral scientists need rigorous training in diverse modes of inquiry and methods of analysis as well as education in how best to use these skills for different purposes. Also, there is greater appreciation that training requires enhanced interdisciplinary integration across the SBE sciences and between these sciences and other fields.[18]

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[16] National Academy of Sciences, *Reshaping the Graduate Education of Scientists and Engineers* (Washington, DC: National Academy of Sciences, 1995).

[17] In addition to a need for integrated training across disciplines, there is also a need to prepare the next generation of SBE scientists for research that is multi-level in scale and international or comparative in scope.

[18] For SBE fields like law and social science or education research that have their foundation in multiple disciplines, education occurs in different disciplinary departments and professional schools (e.g., law schools and schools of education). From one vantage, such fields have already been working on interdisciplinary integration as central to their research and tend to be more reflective and critical. From another vantage, education and training in these fields constitute a "distributed" system where a cohesive strategy may be eclipsed by what is either intellectually central to constituent disciplinary departments or to the primary mission of professional schools. See Felice J. Levine and John R. Goss, III, "Education and Training in Educational Research: Human Resource Development in a Multidisciplinary Field" (Paper delivered at the National Science Foundation Planning Meeting: Education in the Social, Behavioral, and Economic Sciences, Washington, DC, January 16, 2003).

Beyond changes in the SBE sciences and in society, the contexts where SBE scientists work are also changing. While SBE scientists still tend to be located in the academy more than scientists trained in many other fields, SBE scientists are increasingly present in non-academic work settings—aligned with growing demand and awareness of opportunities in research institutes and laboratories and the public and private sectors over the last several decades.[19] Even within higher education, more graduates are taking jobs in two- and four-year colleges and non-research intensive universities.

Graduate training in the SBE sciences faces the challenge and opportunity to rethink how to produce excellent researchers with skills appropriate to such diverse work settings.[20] Intentional department-wide planning is essential to enhancing the breadth and flexibility of graduate training consonant with quality research and the specialty competencies of faculty. The core curriculum, research training, and mentoring merit fresh consideration in light of changing opportunities and changing career goals and motivations of graduate students. This rethinking should be pursued cognizant not only of the range of places where SBE scientists may work, but also of the growing need for them to collaborate with scientists from other fields and communicate to other professionals and the public. The role of a professional master's degree in preparing graduates for different employment sectors (including for high school teaching) should be an important part of any rethinking of graduate education.

Another pressing need is to close the gap between the technical training required at the graduate level and the training currently provided in typical undergraduate programs. Prior chapters of this report have addressed the importance of pre-college and undergraduate education in improving the skills and capacities of those ultimately pursuing advanced degrees. Preparation for graduate work requires much more attention to problem formulation, quantitative methods, and the sophisticated use of qualitative modes of inquiry and analysis. Overall undergraduates have limited exposure to the principles and tools of undertaking SBE science, including an appreciation of ethics and the responsible conduct of research. As graduate education increasingly draws on students from a broader range of undergraduate institutions, graduate programs may need to help bridge that transition.

Finally, there is a need for a more diverse workforce in the social, behavioral, and economic sciences. While the SBE sciences are in general more diverse than other fields of science, racial and ethnic minorities (and women in some disciplines and subfields) are still proportionally lower in numbers and in specific types of employment. Outreach and the identification of non-traditional pathways, targeted investments in training, and strategies to support persons who are often first-generation in their pursuit of graduate careers are all necessary to enhance the presence of underrepresented minorities in the SBE sciences.

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[19] National Science Foundation, Survey of Doctorate Recipients (SDR). Data are published in *Characteristics of Doctoral Scientists and Engineers in the United States 2001*, NSF03-310, NSF/SRS, Table 13.

[20] The fact that graduate students may need different training does not mean that they need more training. Indeed, the structure of training, the form of faculty mentoring and guidance, and time-to-degree could all benefit from further review.

The 1995 National Academy of Sciences (NAS) report on *Reshaping the Graduate Education of Scientists and Engineers* made similar observations regarding *all* fields of science. The report pointed to changing demands for new knowledge, the changing labor markets for scientists, the need for versatile scientists with a wider variety of skills, and the continued importance of a diverse talent pool. This report, now some nine years old, remains timely in its essential recommendations. It rightly acknowledged the special strength of graduate education in the United States in carrying out training in institutions "where a large portion of the nation's best research is done" (p. 1). While emphasizing the value of synergistic activity between research and training, the report also expressed serious concerns that "[t]here is no clear human-resources policy for advanced scientists and engineers, so their education is largely a by-product of policies that support research" (p. 2).

There is need for a cohesive human resource policy to guide and support building human capacity in the SBE sciences. With the exception of some work led by SBE scientific societies, there has been little concerted effort within these disciplines to examine graduate education and training. Also, except for this 1995 NAS report, there has been no general consideration of education and training in science that is germane to all SBE fields. As with other fields of science, the content and structure of graduate education for the majority of SBE sciences remain the purview of individual graduate programs, despite greater or lesser consensus among them resulting from common disciplinary assumptions and needs. How to make this issue a top priority for graduate programs and for the SBE sciences remains a challenge.

Impediments and Challenges

As with other arenas of institutional change, longstanding practices and perceptions create the greatest impediments to transforming graduate education in the social, behavioral, and economic sciences. Since departments are largely responsible for shaping graduate education, most challenges relate to departments' reinventing themselves as organizational units and linking their approaches to wider considerations in their disciplines or other SBE fields. Among the key impediments are the following:

First, the challenge of changing the entrenched academic culture and business-as-usual practices is a key impediment to graduate education. Faculties operate with implicit understandings of their disciplines or fields and tend not to question these assumptions unless concerns are raised from outside of the department or new opportunities present themselves. Complacency, limited time, an inflexible reward structure, the view that graduate training is primarily for reproducing new faculty much like themselves, and the rarity of departments undertaking faculty-wide initiatives contribute to maintaining the status quo—absent insight, incentive, or leadership.

Second, department faculties tend to be much more homogeneous in their backgrounds and views than their student bodies. These differences can affect day-to-day communication between faculty and students and the nature of long-term mentoring relationships. SBE graduate students may have different aspirations and priorities, including training for nonacademic employment. Even students who seek appointments at major research universities may view their relationships with those institutions and their local communities differently from the ways their mentors

conceive them. The failure to respectfully accommodate different and varying interests and goals can erode student motivation, identification, and confidence in the career lines they have chosen and can also limit the quality and breadth of the training provided by faculty.

Third, insufficient training support for graduate students is a major impediment to effective education. The absence of adequate support affects the quality of students' training, the timeliness of completion of their graduate work, and, under certain circumstances (e.g., family responsibilities), their ability to remain in school. For example, in 2002, approximately 35 percent of graduate students had research assistantships in the natural and physical sciences, compared to only about 15 percent in the SBE sciences. More than 50 percent of SBE graduate students relied on "other" forms of support compared to 25 percent of the graduate students in the natural and physical sciences.[21] Also, the National Science Foundation has awarded far fewer graduate fellowships and traineeships in the SBE sciences than in other fields of science and engineering.[22]

Fourth, limited research funds create an impediment to graduate education and training in SBE fields and disciplines. There is a long-term pattern of less federal support for research in absolute dollars and of a net decrease of support for the SBE sciences compared to the natural and physical sciences and engineering.[23] The adequacy of research funding and the quality of training are linked. As wisely pointed out in the 2001 National Research Council report on *Trends in Federal Support of Research and Graduate Education*, decreased research support in a field affects the supply of researchers directly by reducing the number of research positions and indirectly by signaling to prospective graduate students that some fields offer fewer opportunities (p. 5).

Fifth, the amount and nature of research and training support can shape how training gets done and how students are exposed to a range of approaches. While the SBE sciences vary within and between fields, compared to other sciences, SBE graduate students often work more autonomously and with more limited interaction with their mentors than in fields where students are typically part of large-scale laboratories or research teams. Especially because of the relatively limited funds available to the social and behavioral sciences over the last quarter of a century, few SBE faculty and graduate students have experience with research practices that would prepare them for large-scale inquiry or work across disciplines or fields. Training is affected when interaction with a large number of scientists is limited and intermittent and when there are fewer opportunities for multiple mentors, including junior and senior peers.

Sixth, most science-wide initiatives (commissions, committees, panels) aimed at improving education and training in science do not include or address the SBE sciences. The capacity of such initiatives to contribute meaningfully to rethinking graduate education in the SBE sciences or to sending symbolic signals of the importance of these fields erodes quickly in the absence of serious attention.

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[21] See Survey of Graduate Students and Postdoctorates in Science and Engineering: Graduate Student Survey, Fall 1972-2000, as compiled by Westat (figure 2g), May 2003.

[22] See Survey of Graduate Students and Postdoctorates in Science and Engineering: Graduate Student Survey, Fall 1997-2000, as compiled by Westat (figure 2h), May 2003.

[23] See Survey of Scientific and Engineering Expenditures at Universities and Colleges R5/21/2003 Expenditures FY1973-2000 as compiled by Westat (figure 3b), May 2003.

Best Practices

The SBE sciences have pursued a number of strategies to improve graduate education in their respective fields. The mix includes initiatives directed to institutional change as well as national programs of support and training:

- Directed to graduate students and junior faculty in political science, the Center for Basic Research in the Social Sciences at Harvard University is coordinating four summer institutes (at Harvard, the University of Michigan, Duke University, and the University of California-Berkeley) on Empirical Implications of Theoretical Models (EITM). A parallel grant for four summer institutes was also provided to Washington University. With each summer institute being one-month long, this initiative aims to train the next generation of scholars (graduate students and junior scholars) to be better equipped to link theory and empirical work. NSF's support of this project was an outgrowth of a workshop held by the Political Science Program in 2001 on EITM to improve technical-analytic proficiency.

- The American Educational Research Association (AERA) operates two national programs to enhance the research skills and professional development of graduate students. Funded since 1990 by the National Science Foundation, with contributions from the National Center for Education Statistics (NCES), the AERA Grants Program supports advanced graduate students using large-scale education databases in their dissertation work.[24] Each year, grantees selected from diverse SBE fields participate in an intensive conference and receive other professional support. With funding from 1994 to 2004 from the Spencer Foundation, AERA has also operated a Pre-Dissertation Fellowship Program. This program provides a one-year fellowship to doctoral students early in their careers. Drawing from a range of disciplines, awardees have a primary research interest in education. In addition to stipends and travel support, the Fellowship Program includes two training institutes (at the beginning and end of the fellowship year); a mentor from an institution other than the fellow's home site; special activities at the AERA Annual Meeting; and a cohort experience with a national group of scholars in training.

- The Preparing Future Faculty (PFF) initiative is a cooperative effort of 43 doctoral degree-granting institutions and more than 295 partner institutions to enhance the preparation of future faculty in institutions of higher learning. Sponsored by the Council of Graduate Schools (CGS) and the Association of American Colleges and Universities (AAC&U) with support from the National Science Foundation, the Pew Charitable Trusts, and the Atlantic Philanthropies, PFF programs provide doctoral students with opportunities to observe and experience faculty responsibilities at a variety of academic institutions with varying missions, diverse student bodies, and different expectations for faculty. The national PFF program (1) establishes a cluster model partnering a doctoral degree-granting institution with one or more community or liberal arts colleges; (2) addresses faculty roles in these

[24] The Program includes other components including research grants, postdoctoral awards, and an annual advanced statistical institute.

institutions, including teaching, research, and service; and (3) establishes a system whereby doctoral students have multiple mentors and receive feedback for teaching and service as well as research. Of the SBE fields, communications, political science, psychology, and sociology have participated in the PFF Program.

- The Carnegie Initiative on the Doctorate (CID), funded by the Carnegie Foundation for the Advancement of Teaching, supports multiyear projects to encourage reexamination of the preparation of doctoral students. The purpose of this program is to encourage and support departments' efforts to more purposefully structure their doctoral programs. The Foundation is working closely with six fields of study: chemistry, education (educational psychology and curriculum and instruction), English, history, mathematics, and neuroscience. The aim is to foster conceptual work and design experiments in a small number of selected departments that can enhance these doctoral programs and produce findings that can be disseminated and potentially applied elsewhere. With the exception of education research, no other SBE field is included under the CID guidelines. The approach provides a strategy for reexamination that could be adapted to the needs of the SBE sciences by other funding agencies, including NSF.

Components of an Action Plan

To date, the National Science Foundation has played only a limited role in supporting graduate education in the SBE sciences. The number of **Graduate Research Fellowships**, albeit critical, is a small proportion of the applicant pool to this program in any one year (about 10 percent) in the SBE and other sciences. Research assistantships have been the primary vehicle for graduate student support, but the overall small size and duration of research grants in the SBE sciences and the stringent success rate for funding make this at best an ancillary approach to graduate student training. Also, as emphasized above, faculty research grants are intended for research and are not per se aimed at training students. Doctoral dissertation research improvement grants—a longstanding mechanism of support in the SBE Directorate—are valuable, though available dollars cover only research expenses related to the dissertation.

No effort is more crucial to capacity building in the SBE sciences than NSF's increased involvement in SBE graduate education and training. NSF can play a significant role by supporting initiatives to transform graduate education, create innovative training programs, and attract a wider and more diverse pool of talented students. Promising strategies are set forth below.

Enhanced Funding for Critical SBE and EHR Programs

1. The Integrative Graduate Education and Research Traineeship Program (IGERT) in the EHR Directorate has supported initiatives that include, or are anchored in, the SBE sciences. Enhanced visibility for IGERT and expanded opportunities for this research training support could add to the skills and knowledge of future cohorts of SBE scientists—preparing them to work in interdisciplinary teams and settings and to tackle complex and multifaceted problems. The emphases on engaging the participation of multiple disciplines, departments, and even institutions; delivering professional development experiences (e.g., summer institutes, seminars, specialized courses) beyond department-level requirements; and providing mentoring are all

essential to building scientific capacity and training a versatile workforce of the future. Stipends and tuition allowances to graduate students facilitate their pursuing this advanced cross-training. For the SBE sciences, potential partnerships between IGERT and initiatives for underrepresented minorities (e.g., LSAMP, AGEP, CREST, HBCU-UP, TCUP) could contribute to outreach and training on major issues that transcend disciplinary boundaries. Also, community organizations relevant to the IGERT award could be participating institutions.

2. The NSF Graduate Teaching Fellows in K-12 Education (GK-12) Program in the EHR Directorate could further reach out to and emphasize the SBE sciences. This initiative could engage master's and doctoral-level graduate students in improving public literacy in the SBE sciences. The aspiration of many SBE graduate students to bring science to bear on issues of social significance is served by fuller graduate student engagement as mentors and resource persons in K-12 settings. Graduate student involvement benefits students with greater understanding of the dynamics of teaching the SBE sciences at early educational levels and benefits teachers by connecting them to current work. This initiative is especially appropriate for institutions, departments,[25] and investigators seeking to work with secondary schools or for those developing Professional Master's Degree Programs where K-12 teaching could be an attractive option. Given the importance of informal education, community organizations might be encouraged to join as participating institutions.

3. Research Experiences for Graduates (REG) Supplements in the SBE Directorate should be expanded to include a wider number of scientific fields. REGs provide opportunities for intensive research-based experiences and quality mentoring to graduate students early in their doctoral careers. Only two SBE programs (Law and Social Science and Cultural Anthropology) currently offer these supplements. This mechanism provides a direct training and mentoring opportunity with an NSF-funded investigator on an identifiable research project or problem (they are not intended as research assistantships). Absent substantial investments in graduate research training grants (which would be important), these supplements can enhance the research capabilities and professional development of graduate students.

New Opportunities and Initiatives

Collaboration of SBE and EHR Directorates on a Transformed Grants for SBE Doctoral Dissertation Improvement Program. The EHR and SBE Directorates are well situated to mesh their respective experiences with graduate research fellowships and doctoral dissertation improvement grants. Such an initiative would increase the size of these awards and allow the possibility of stipend support as part of a budget request.[26] Currently, depending on the participating SBE program, funding ranges from $5,000 to $12,000, without stipend support.

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[25] Graduate schools and departments of education could play an important role in training doctoral students in education research and preparing them to teach K-12 teachers in SBE sciences through participating in such programs.

[26] Submission and review mechanisms need to be identified for graduate students undertaking doctoral dissertations in SBE fields that do not have identifiable disciplinary or interdisciplinary programs in the SBE directorate (e.g., communications, education research, and parts of child development or demography when students are not in doctoral psychology or sociology programs, respectively). In the case of education research, EHR could initiate a doctoral dissertation improvement program to be jointly administered by the SBE and EHR Directorates.

A maximum amount of $25,000 to $30,000 for dissertation improvement grants (over a one- to two-year period) is a funding range more in line with the time and costs of undertaking and completing doctoral work (and could include the use of funds for a stipend). This amount approximates the $30,000 that NSF now provides for Graduate Research Fellowships for one year and the $25,000 that the National Institute of Mental Health awards for doctoral dissertation grants for underrepresented minorities.

Collaboration of SBE and EHR Directorates on a Transition and Early Career Initiative for Graduate Students. This initiative would provide summer training and support for undergraduates in the transition to SBE graduate programs and for early-career graduate students. Funding could take the form of individual awards (based on proposed developmental plans), institutional awards to clusters of departments or schools (within or across disciplines), programs at academic or research institutes (e.g., the Inter-university Consortium of Political and Social Research), or SBE scientific societies. Emphasis would be on the enhancement of research skills (e.g., quantitative methods, statistics), intensive study in areas more difficult to master in the midst of other coursework (e.g., languages), or professional development topics (e.g., scientific writing, public presentation). Small, individual awards to students should permit them to fill gaps in skills or knowledge. Institutional awards for student transition would emphasize basic substantive and professional skills and also provide quality mentoring. Other institutional awards could support intensive training (like the NSF Summer Institute for Research Design in Cultural Anthropology).

Collaboration of SBE and EHR Directorates on a Graduate Education Reinvention Program. This initiative would support innovative projects seeking to transform graduate education programs in one or more SBE fields of science.[27] The initiative would fund model programs for periods of five years that aim to work at the department level (including across departments or centers) to strengthen methodological skills, provide a plan for research training, consider educational needs from the vantage of diverse workplace opportunities (inside and outside of the academy), and reexamine the role and nature of mentoring throughout the graduate student career. Emphasis would be on systemic and sustainable change and on the development of transportable models that could shape education in other graduate education sites. Preparing Future Faculty and Preparing Future Scientists efforts (see below) could be features of proposals as long as they are part of a sustainable plan of department-wide change. Efforts to introduce or strengthen a Professional Master's degree could also be proposed.

Collaboration of SBE and EHR Directorates on a Preparing Future SBE Scientists Program. This initiative would provide graduate students with research and professional development experiences in non-academic locations. The program would emphasize first-hand training in scientific research, roles, and responsibilities in different environments where SBE science is done. Graduate research assistantships could be placed in state or federal government

[27] Professional schools (e.g., law schools, schools of education, business schools) seeking alone or with SBE disciplinary departments to address research capacity building and transform doctoral training programs in research would be eligible to apply.

agencies (e.g., U.S. Census Bureau, Science Resources Statistics at NSF, Council of Economic Advisors), research institutes (e.g., The RAND Corporation, American Institutes for Research, Educational Testing Service), for-profit applied social research firm (e.g., Sociometrics Corporation, The Roper Center for Public Opinion Research), or non-profit organizations (e.g., Child Trends) that undertake research in the SBE sciences. SBE graduate programs (in one or more fields) would apply for support in cooperation with non-academic training sites (typically several). Graduate research assistantships at host sites would generally be from six- to twelve-month posts. Developmental plans, including an identified host-site mentor, would be established between the graduate student, graduate program, and the site. Trainees would be expected to participate in regular seminars and present their work at department colloquia.

Immediate Steps

- Modify the NSF review criteria for evaluating SBE research proposals to include the proposal's effectiveness in advancing graduate student career development and integration. Explicit attention to this issue would focus applicant and reviewer attention when graduate student support is requested in a grant application. Reviewers could be asked to address such considerations as part of criterion 2 (Broader Impacts of the Proposed Activity) in the standard NSF review questions.

- Hold a small, SBE leadership conference on the 1995 National Academy of Sciences Report, *Reshaping the Graduate Education of Scientists and Engineers.* This report explicitly included the social sciences in the definition of science, but the report was not very visible in the SBE science community (only one of 19 committee members was an SBE scientist). The recommendations warrant further consideration. The SBE Directorate could convene a meeting—in collaboration with scientific societies, the Consortium of Social Science Associations, or the Social Science Research Council—and widely disseminate a summary statement to SBE graduate departments.

- Provide a venue, perhaps in coordination with the Carnegie Foundation for the Advancement of Teaching, for a meeting of principal directors and advisory committees working on Carnegie Initiatives, PFF Programs, and other graduate-level programs directed to rethinking graduate education, the links between research and teaching, and systemic change.

- Commission or initiate a study on SBE graduate education, focusing on the rates and causes of attrition and retention of graduate students in the SBE sciences.[28] Systematic data, for example, on mentoring, monitoring student progress, career guidance, student-faculty interaction, curriculum strengths and weaknesses, professional development

[28] In July 2002, the American Economic Association embarked on a project with Ford Foundation support to undertake a comprehensive analysis of the graduate school and career experiences of graduate students in economics, focusing on recruitment, enrollment, retention, characteristics, and time-to-degree. Core to this study is examining aspects of the PhD production process that affect the number of PhDs produced. This research and the longitudinal study of PhD graduates from 14 scientific fields (including economics, political science, psychology, and sociology) initiated in 1997 by the national scientific societies under the auspices of the Commission on Professionals in Science and Technology may be helpful in developing a research plan.

experiences, financial and social support, and related professional development issues could add knowledge essential to restructuring graduate education and understanding its impact. The SBE Directorate, through the Science Resources Statistics Division, could explore with the Graduate Record Examination (GRE) Board the possibility of the Educational Testing Service undertaking or partnering with NSF on a tracking study of persistence and completion of SBE graduate students as it related to aspects of training and types of funding.

Chapter 5

Improving Postdoctoral and Early Career Education in the SBE Sciences

Excellent postdoctoral experiences for new scientists and engineers are critical to the health and productivity of current and future research.[29]

Current Context

Key Needs

There is a high-priority need to address the continuing development and training of social, behavioral, and economic (SBE) scientists beyond their doctoral degrees. Despite the very real challenges for SBE science education considered in prior chapters of this report, most SBE disciplines invest primarily in the development and design of doctoral education and devote little attention to professional growth and education after doctoral training. The postdoctoral period of professional transition is critical to building and solidifying skills; charting robust research agendas; locating one's scientific interests in the context of larger disciplinary or interdisciplinary concerns; and building strong networks of guidance, collaboration, and enrichment. Whether new doctorates pursue formal postdoctoral programs or are otherwise employed, opportunities and support at this professional stage are critical to both the quality of their research and their career advancement.

Postdoctoral Positions and Programs. Since the mid-1980s, the number of postdoctoral appointments in science and engineering has increased rapidly, but relatively few such opportunities exist for SBE scientists.[30] Over the 30-year period from 1965 to 1995, for example, the number of doctorates receiving postdoctoral appointments in psychology increased from 22 to 32 percent, whereas the number in physics increased from 29 to 73 percent, in chemistry from 31 to 63 percent, and in the biological sciences from 40 to 71 percent.[31] The most recent data

[29] National Research Council, *Enhancing the Postdoctoral Experience for Scientists and Engineers* (Washington, DC: National Academy Press, 2000), p. *x*.

[30] Postdoctoral appointments are defined as "a temporary position awarded in the academe, industry, or government for gaining additional education and training in research." See National Science Foundation/Division of Science Resources Statistics, 2001 Survey of Doctorate recipients. Footnote 1,Table 1

[31] Although some of the dramatic rise in postdoctoral appointments in certain fields is attributable to changing employment opportunities and the limited academic market, in general those in postdoctoral positions report that they seek these experiences in order to obtain advanced training in their fields, training outside of their fields, or training with specific scientists. Mark C. Regets, "Has the Use of Postdocs Changed?," NSF 99-310, *Issue Brief* (NSF 99-310) (1998).

on such appointments vividly illustrate the lagging SBE situation: Of the 28,564 postdoctoral appointees in science and engineering in doctorate-granting institutions in 1999, 703 (2.5 percent) were in psychology and 451 (1.6 percent) were in all other social sciences combined.[32] At the same time that SBE fields were taking up only 4.1 percent of all postdoctoral appointments, they constituted about 30 percent of all doctoral degrees in science and engineering.

Postdoctoral appointments—whether through fellowships, traineeships, or positions on research grants—provide an opportunity to enrich the doctoral research experience and establish a scholars' research program. Though postdoctoral appointments do not always realize their stated educational goals (the National Academy of Sciences report cited above outlines key areas for improvement in postdoctoral training),[33] such advanced apprenticeships are invaluable periods for honing scientific and professional skills and promoting career-long scientific productivity. Absent postdoctoral training immediately after graduate school or in early stages of a career, most newly minted doctorates in the SBE sciences move into tenure track or temporary academic positions where they face heavy teaching, course preparation, and service responsibilities before they have adequately sharpened their skills and established their research trajectories. Despite unevenness in the quality of postdoctoral training, it is far more intentional and institutionalized than the support and mentoring that junior faculty typically receive from senior faculty in most colleges and universities.

The SBE sciences would benefit greatly from a significant increase in the number of postdoctoral positions and programs that offer strong developmental components, closer alignment with the contexts in which SBE researchers work, and explicit attention to building skills across specialties and fields. As with doctoral training, current postdoctoral programs in science (including in the SBE sciences) largely focus on preparing graduates for academic careers in research universities despite employment opportunities in a range of academic markets and in non-academic settings. In all fields of science, most postdoctoral positions are located in academic institutions; this is especially true of postdoctoral programs in SBE sciences. In addition, too little attention is paid to developing interdisciplinary skills and ties. Also, postdoctoral programs need to examine their mentoring and training components, the adequacy of support packages for appointees, the duration of the postdoctoral traineeship, and even the prestige of the appointment. Thus, along with the need to increase the number of postdoctoral positions and programs in the SBE sciences is the need to do so in ways that improve upon what often constitutes the postdoctoral experience.

Career Development Beyond the Doctoral Degree. Capacity building and strengthening the human infrastructure for research are key to advancing productivity in the SBE sciences. The continuing education needs of junior and early career scientists vary by discipline, doctoral

[32] National Science Foundation/Division of Science Resources Studies, Survey of Graduate Students and Postdoctorates in Science and Engineering, 1999, Table A-17.

[33] In 1998, the Association of American Universities issued a report prepared by its Committee on Graduate Education. This report includes some consideration of postdoctoral appointments and the analyses and recommendations therein are relevant for graduate as well as postdoctoral study. For the full report, see http://www.aau.edu/reports/GradEdRpt.html.

training programs, professional location (e.g., research institutes, teaching intensive institutions, government agencies), and individuals' experiences (e.g., extent of prior research support, publications). While strategies should be flexible, new PhDs in all employment sectors would benefit from explicit professional support especially during the first several years after their doctoral degrees. Academic and non-academic employers would be wise to consider professional development opportunities (e.g., seed money to nurture research ideas, reductions in teaching loads, travel support) as appropriate and sound investments. Also, national research societies can advance their disciplines and fields through intentional efforts directed to junior scholars. Professional development courses, workshops, and institutes on substantive, methodological, and professional issues or mentor-match programs can yield large dividends through enhancing the knowledge and networks of new SBE doctorates.

In essence, the skills and competencies requisite to scholarly productivity and to the advancement of scientific careers require continued development during early career stages. For women and underrepresented minorities (especially those who are first generation doctorates), there may be a special need for specific guidance in responding to the particular challenges they face in scientific and academic careers—ranging from stereotypes about their professional skills to being more in demand to advise students or serve on committees. Efforts on the part of senior colleagues, departments, disciplines, and institutions are important in alerting new scholars to obstacles and opportunities and in helping them overcome distinctive impediments. Strong signals about the legitimacy of seeking and receiving support are essential. So too are steps to ensure that such support is maximally available.

Impediments and Challenges

For far too long, SBE scientists have given insufficient attention to the role of postdoctoral training and early career development in enhancing research productivity. Although there is variation among the SBE sciences, overall they have moved toward collaboration at a slower rate than the natural and biological sciences, and thus the normative structures of these fields tend to support greater independence in scholarly research.[34] Since postdoctoral training almost by definition assumes explicit connection to a senior investigator, work group, or team, this mechanism of professional development might be expected to be less prevalent in SBE fields. Just as access to funding over time engenders research collaboration in science, so too the presence of financial support can be instrumental in encouraging postdoctoral training. At present, impediments and challenges include the following:

First, as already implied, postdoctoral training is most prevalent in large-scale centers or research contexts where the scope of work, including the scope of funding, can support both the research and training of postdoctoral appointees and professional research staffs. Perhaps as a function

[34] A number of studies make this point. See generally Felice J. Levine, "Professionalization of Social and Behavioral Scientists: United States," in *The International Encyclopedia of the Social & Behavioral Sciences* (London: The Elsevier Science Ltd, 2001), pp. 12146-12154. For a recent example, see Nicholas Babchuck, Bruce Keith, and George Peter, "Collaboration in Sociology and Other Scientific Disciplines: A Comparative Trend Analysis of Scholarship in the Social, Physical, and Mathematical Sciences," *The American Sociologist* Fall (1999), pp. 5-20.

of far more limited resources than in other fields of science, the culture of science in the SBE sciences is typically smaller in scale and premised on more individuated work. Thus, the paucity of large-scale laboratories and centers has limited the venues for employing postdoctoral trainees and developing effective models for doing so.

Second, for many new scholars, the pleasure taken at completing the doctorate is quickly overwhelmed by the strains resulting from the increasingly daunting task of building or linking to a research program and establishing an autonomous career. Absent appropriate advisement, new PhDs get caught up in meeting day-to-day responsibilities and too often are not well positioned to plan strategically for their research careers. At a broader level, the comparatively small size of many SBE disciplines, academic departments, and scholarly societies makes it difficult to mount programs that can enhance career development for new PhDs.

Third, experienced SBE scientists too frequently assume that new scholars are savvy about how to manage and pace their early career efforts. Overall there is limited systematic advice, an absence of assistance in applying for research funding or preparing articles for submission, only modest opportunities for leave during the early career period, and mixed support for special programs designed to assist women and minorities. Too often, the time at which the first sabbatical leave is earned comes too late or at a time when family obligations make it difficult for junior faculty members to go on leave.

Fourth, graduate department faculties tend to know best environments like their own. The dominant culture of graduate education manifests limited awareness of the nature and conditions of employment in other kinds of academic and non-academic institutions; insufficient appreciation of the range of career options available to students completing doctorates; and an absence of deliberate, self-conscious attention to mentoring beyond that required for the completion of the doctoral degree. Moreover, there are few incentives for reshaping the assumptions and expectations of those involved in preparing doctoral students, training postdoctoral fellows, or guiding new scholars. Under the proper conditions and with adequate support and resources, however, these patterns and practices should be amenable to change.

Best Practices

Government agencies, private foundations, academic institutions, and scholarly societies have invested in initiatives and activities—large and small—that address some of the professional development and early career challenges encountered by SBE scientists. Although extant programs are insufficient in number to meet SBE science needs, they offer examples of mechanisms that could be extended or transported to other institutions or disciplines to improve early career training. The variation in these initiatives speaks to the importance of flexible and adaptable approaches. All aim to provide positive developmental experiences for junior scholars and have their interests as the focal point.

Many of the best known and most successful postdoctoral programs have been funded by the National Institutes of Health (NIH) through the National Research Service Act (NRSA) Program. Established by legislation in 1974, the purpose of the NRSA Program is to help ensure

that a diverse and highly trained workforce is available to lead efforts to advance the country's biomedical and behavioral research agenda. NRSA is an excellent model of a flexible funding mechanism. It provides institutional training (T32) grants and individual (F32) fellowships to ensure a continuing supply of well-trained scientists prepared to conduct cutting-edge research. The NIH has used the NRSA Program as the primary means of supporting graduate and postdoctoral research training, including behavioral and social science training related to health and well-being. The first two examples below are supported by NRSA funding:

- Established in 1976, the Program for Research on Black Americans (PRBA), one of several programs in the Research Center for Group Dynamics at the University of Michigan, has been a long-term site for postdoctoral training under the leadership of James S. Jackson. In 1991, PRBA received support from the National Institute of Mental Health (NIMH) for a multi-year program to support more than 50 minority postdoctoral scholars for training in substantive and methodological issues related to HIV/AIDS in minority communities. Recently, NIMH allocated support for postdoctoral training related to mental health disparities among racial and ethnic groups. This award provides for ten trainees appointed for two years to participate in training seminars, take advanced statistics and methods coursework, have one-on-one mentoring, meet weekly on progress and experiences, participate in academic writing with appropriate guidance, and engage in professional development activities through conferences and workshops. In addition to these trainees, other postdoctoral fellows from a range of disciplines participate. PRBA postdoctoral training also includes year-long and summer fellows taking coursework and doing research.

- The Carolina Population Center (CPC) at the University of North Carolina, Chapel Hill operates a program of training for predoctoral and postdoctoral fellows. The postdoctoral trainees hold doctorates in such diverse fields as anthropology, sociology, demography, geography, and social statistics. With NRSA support, CPC offers one-year postdoctoral appointments that emphasize preceptorships between postdoctoral scholars and faculty sponsors; a weekly population seminar; research, writing, and proposal preparation; and sessions on research ethics. Scholars are early career fellows—ranging from those directly out of graduate school to those several years into their careers. With NRSA support from the National Institutes of Health, this funding permits intensive support and training to a cohort of scholars each year.

- The American Educational Research Association (AERA) operates a postdoctoral training program funded by the Institute of Education Sciences (IES) in the U.S. Department of Education. While this AERA-IES Grants Program includes mechanisms of support for doctoral dissertation research and small research grants, the cornerstone of the program is a series of three-year postdoctoral fellowships, wherein fellows and their designated mentors work jointly on research problems. Priority is given to research that enhances the educational opportunities of underrepresented minorities in education, focuses on literacy and mathematics, and involves cutting-edge research. The program aims to strengthen the research infrastructure through professional development opportunities that provide fellows with training and research outside of their own specialties or in new analytic or methodological techniques. In addition to fellows' undertaking research, the program

fosters strong mentoring relationships and interaction across cohorts of postdoctoral fellows. Fellows and their mentors come from diverse SBE disciplines, yet share a common interest in scientific research in education. As a by product of the program, cohorts of mentors also develop skills in working with postdoctoral fellows.

- Outside of formal postdoctoral support, there has been limited attention to initiatives directed to the development of junior scholars early in their careers. The American Council of Learned Societies (ACLS) has a fellowship program for newly tenured faculty members (about 20 each year) in the humanities and humanities-related social sciences that provides up to a one-year sabbatical in order to consolidate and extend research. For SBE scientists with specialties in mental health, there is the potential for early career support offered by the National Institute of Mental Health through the Behavioral Science Track Awards for Early Transitions (B/START). Similar programs in the SBE sciences might be desirable to provide research support for junior scholars or funding opportunities for mid-career scholars to change directions or master new technologies. While the SBE Directorate has some early- and mid-career offerings, they are currently limited to certain programs and modest in scope and level of support. These funding mechanisms deserve consideration.

- Almost all scholarly societies in the SBE sciences include professional development activities as part of their programs. Often associations hold courses or workshops aligned with their annual meetings; sometimes they operate additional institutes or workshops as freestanding initiatives. While scholars at all career stages take these courses, most attendees are advanced graduate students or scholars at early- to mid-career stages. For example, the American Statistical Association (ASA) and the American Psychological Association (APA) have formalized submission and review procedures to identify a roster of half- and full-day courses and also offer continuing education credits that can be especially useful for SBE scientists in non-academic appointments. In addition, the ASA and APA sponsor other developmental activities. For example, each summer, APA holds four-day Advanced Training Institutes to expose psychological scientists to important technologies and methodologies.

These illustrations point to postdoctoral and early-career training strategies that are feasible and desirable for the SBE sciences. As with best practices at every educational level, there is need for both sustained investment and also assessment and evaluation to determine what works well in engendering productive and successful research careers.

Components of an Action Plan

Enhanced Funding for and Wider Use of Critical SBE and NSF-wide Programs

There are opportunities within the structure of NSF for program enhancements directed to the SBE sciences. Some of the existing programs identified below are Directorate- or Foundation-wide; other initiatives are offered or included in only one or a few NSF programs. Postdoctoral and early career education in the SBE sciences would be materially improved if more funds were available for these initiatives and if they were more visible. In some instances, there is the need both to broaden awareness of programs and reduce the perception or reality that SBE scientists are not eligible for funding.

1. Postdoctoral Fellowships and Small Grants for Training and Research Fellowships (SGTRF) in the Science and Technology Studies (STS) Program are two modes of support directed to postdoctoral education and training. For both Fellowships and Small Grants, applicants must propose a training and a research component, and they must be within five years of receipt of their PhD. The primary difference between these two mechanisms is that SGTRF awards permit support of up to three graduate students. The postdoctoral fellow prepares the proposal in cooperation with the host faculty member at the host institution who also submits a plan to work with the fellow (and, where appropriate, graduate students). These well-specified mechanisms could be important to early career training in the SBE sciences well beyond the STS Program. Current award lists for the STS Program suggest that these Fellowships and Small Grants are few in number. Expanded use of these mechanisms across SBE sciences could contribute significantly to postdoctoral training in these fields.

2. The Minority Postdoctoral Research Fellowships and Supporting Activities Program in the SBE Directorate offers enhanced scientific training and career development for underrepresented minorities.[35] This initiative includes a number of components directed to Fellows' professional growth (e.g., two-years of support, a sponsoring mentor, an annual Sponsoring Scientist and Fellows Workshop, and the possibility of a one-year follow-up starter grant). Since 2001, the SBE Directorate has invested approximately $3.5 million dollars supporting 32 minority postdoctoral fellowship awards and supporting activities. Proposal submissions have been steadily increasing, and more funds are needed to support this important program.

3. Mid-career mechanisms of support for professional development are also available through several programs in the SBE Directorate. The **Professional Development Fellowships** offered by the Science, Technology and Society Program (STS) are specifically directed to scholars seeking to expand their skills outside their areas of expertise (e.g., sociologists of science who wish to improve their knowledge of science or engineering, or conversely to physical scientists who seek training in STS disciplines). As with the STS postdoctoral initiatives, applications must include training and research components and a work plan prepared by a host faculty member. The Methodology, Measurement, and Statistics Program similarly offers **Mid-Career Methodological Opportunities Fellowships** that emphasize deepening skills as well as accomplishing research. These Fellowships are for nine- to twelve-month periods. The Cultural Anthropology Program also offers **Scholar Awards in Methodological Training for Cultural Anthropologists** to upgrade researchers' methodological skills by learning specific methods or techniques during a summer period or for as long as an academic year. And, finally, the Law and Social Science Program offers stipends of up to $15,000 for **Mid-Career Training Fellowships** aimed at encouraging scholars (including tenured faculty) to pursue advanced methodological or theoretical training (e.g., institutes, workshops, seminars, courses). All of these mechanisms are rarely used. Examining the appropriateness of these initiatives directorate-wide, giving some a higher profile, and allocating adequate funds are essential steps to making meaningful investments in early or mid-career professional training for SBE scientists.

[35] Applicants from all disciplinary and interdisciplinary fields within the SBE sciences should be encouraged to apply irrespective of whether there is a dedicated funding program within the SBE Directorate.

4. The Faculty Early Career Development (CAREER) Program is an NSF-wide activity with considerable potential for social, behavioral, and economic scientists seeking support through the SBE or EHR Directorates. With a focus on the integration of research and education, this program seeks to invest in junior faculty with high potential for a lifetime of contributions to both domains. There are far fewer CAREER awards in SBE and EHR than in other NSF Directorates, suggesting that these two Directorates should seek applications and request the additional funds that would need to go with it. (In 2001, there were 397 CAREER awards NSF-wide, with 20 in SBE and 8 in EHR; in 2002, there were 392 CAREER awards with 10 in SBE and 11 in EHR; and in 2003, there were 406 CAREER awards with 18 in SBE and 9 in EHR.) These five-year awards are directed to junior faculty or their equivalents in tenure track positions who have the dual ambition of contributing to research and to education. In addition to enhancing the research and teaching capacities of CAREER recipients, an increased number of CAREER awards in the SBE sciences would improve undergraduate and graduate education in these fields.

5. The Research Opportunity Awards (ROAs) for faculty members at predominately undergraduate institutions is an extant mechanism of NSF support that could enhance the research skills and capacities of SBE scientists. Usually put in place as supplements to NSF research grants at host institutions, ROAs permit eligible applicants to pursue work as visiting scientists for periods ranging from a summer to a year in order to increase their research capabilities and effectiveness and to improve research and teaching at their home institutions. Expanded use of ROAs would ensure that early career SBE scientists at primarily teaching-intensive institutions continue to build their research skills, research networks, and programs of research. To widen the opportunities to do this in the SBE sciences, NSF might consider making *direct* awards to host institutions for applicants with strong rationales for being at a site and with strong developmental plans involving host scientists, without the requirement that these awards need to supplement extant NSF awards.

New Opportunities and Initiatives

Collaboration of SBE and EHR Directorates on an Integrative Postdoctoral Research Traineeship (IPRT) Program. The comparative absence of postdoctoral training in the SBE sciences and the need to foster advanced scientific skills to address issues that transcend any one discipline suggests the need for an Integrative Postdoctoral Research Traineeship Program in the SBE sciences. One of the goals of IGERT is to "catalyze a cultural change" in graduate education. In the SBE sciences, where postdoctoral training is rare and undervalued, there is a parallel need for a cultural change at this career stage. Following the IGERT model, IPRTs should also be five-year awards submitted by investigators who seek to engage in research and postdoctoral training on important scientific themes requiring interdisciplinary innovation. While IPRT funding would focus on postdoctoral fellows, resources from these awards or other funding could appropriately be used to support graduate fellows and undergraduate research interns as part of creating effective research teams and workgroups and providing postdoctoral fellows with direct experience in training other students at different points in their career preparation. IPRTs would have the dual goal of expanding the research skills and capabilities of new PhDs (within two years of degree completion) under the guidance of seasoned mentors and of enhancing fellows'

own experiences in training and supervising others. Proposals from research organizations as well as academic institutions and partnerships should be welcome. Problems within the Human and Social Dynamics (HSD) priority area would be especially ripe for IPRT focus.

An SBE Postdoctoral Research Fellowships Program. The National Science Foundation could have a major impact on the scientific workforce in the SBE sciences by investing in a program of postdoctoral research fellowships. The imbalance between the large number of scientists who receive PhDs in the SBE sciences and the small number of postdoctoral appointments in these sciences compared to the natural sciences, engineering, and medicine suggests that SBE fields would benefit greatly if new PhDs received advanced training, time for intensive research, and career development guidance in strengthening their skills and establishing research programs. Similar Fellowship Programs are present in other directorates and divisions outside of SBE in areas where capacity building is particularly important (e.g., microbial biology in the Directorate for Biological Sciences). Such a program would aim to identify fellows with strong training and career objectives as well as research plans. While applicants should be close to their PhDs (within two or three years), those in academic positions or with job offers should be encouraged to apply—with their home sites agreeing to stop the tenure clock. Academic and non-academic institutions should be eligible to be host sites. Also, any new initiative should be of sufficient duration (e.g., a five- to seven-year program) to permit meaningful assessment of the impact of such support on early cohorts of fellows and on the research environments in which they work. Institutions and individuals should be eligible to submit proposals.

SBE Vertical Integration of Research and Education (VIGRE) Awards. As noted earlier, the SBE sciences still tend to be conducted more by independent individuals than by researchers operating as members of large collaboratories or work groups. Disciplinary departments tend to train with an implicit model of the solo investigator rather than with a research and education framework that fosters teamwork. For a number of years, the NSF Division of Mathematical Sciences has been working to remedy a similar pattern and practice through VIGRE funding (recently integrated into a new initiative on Enhancing the Mathematical Sciences Workforce in the 21st Century). This mechanism holds promise for SBE as well. VIGRE awards aim to change the basis of education and training in departments by building team approaches to research and education where postdoctoral associates receive quality mentoring and training and serve in an educative role. VIGRE awards to departments (or to large groups within a department) seek to (1) strengthen the integration of research with educational activities; (2) enhance interaction among undergraduates, graduate students, postdoctoral associates, and faculty members; (3) broaden the educational experiences of students and postdoctoral associates to prepare them for a wide range of career opportunities; and (4) deepen department-wide appreciation of the value of collaborative work.

SBE Stimulus Package Partnerships for Professional Development. This initiative would partner the National Science Foundation with SBE scientific societies in order to accelerate attention to professional development in these fields. Scientific societies are well situated to partner with the NSF on a low-cost, low-overhead stimulus package of professional development activities. Support could include resources for such activities as conducting courses or institutes, providing small grants for research innovations, supporting research-related travel,

or coordinating mentor-match programs. Scientific societies have contacts with junior scholars (directly and through their work with department chairs), know the needs of their fields, are experienced in conducting peer review, and can capitalize on a tradition of volunteerism of accomplished researchers. These partnerships will allow NSF and professional associations to assess professional development needs using flexible strategies and evaluate the return on "venture" capital investments. Funding would be used primarily for external expenses (e.g., junior faculty support to cover travel to a workshop) although associations would need some support for the planning and execution of these activities.

Immediate Steps

- Enhance the prominence of existing postdoctoral training opportunities by preparing and disseminating an announcement that summarizes opportunities for postdoctoral training and early career development in the SBE sciences. Disseminate this announcement on the SBE and EHR pages of the NSF website, enlist the help of scientific societies and offices of sponsored research in its wide distribution, and encourage program officers to emphasize postdoctoral training and professional development opportunities in workshops and visits to academic institutions.

- Redirect on a pilot basis some resources dedicated to evaluation contracts within EHR to postdoctoral evaluation programs aimed at both evaluation studies and training SBE postdoctoral fellows (including education researchers) in evaluation research.

- Convene a meeting of key private foundations and federal agencies engaged in the support of SBE research and training initiatives to consider these recommendations and to identify funding partners that might participate in an effort to help make postdoctoral training a more integral part of SBE science education.

- Given the limited number of postdoctoral training programs in the SBE sciences (and given that they are largely health-related), convene a meeting of key program officers and principal investigators of postdoctoral programs to build on their operational experience and wisdom to help design an SBE postdoctoral initiative and program solicitation. A new program should pursue those strategies likely to have the broadest possible impact on the SBE sciences as well as on the postdoctoral fellows themselves. Depending on the level of resources that can be mustered, decide whether to solicit institutional proposals from departments, research centers or institutions, or scientific societies; whether to entertain individual fellowship applications; or whether to encourage both as done under the National Research Service Act.

- Extend the current statistical programs conducted by the SBE Directorate's Division of Science Resource Studies to gather, summarize, and interpret detailed information on employment choices, research activities and productivity, and career trajectories across sectors of employment of new PhDs. Encourage research proposals addressed to scientific training and career development in the SBE sciences for submission under the Workforce

for the 21st Century priority area or the HSD priority area. NSF would be better situated to improve postdoctoral and early career education in the SBE sciences if there were more complete and reliable data on the production and career development of SBE scientists.

- Urge the American Association for the Advancement of Science (AAAS) and the Alfred P. Sloan Foundation to include the SBE sciences in Postdoc Network (part of *Science* magazine's Next Wave Website). Encourage the AAAS to include the SBE disciplines and SBE postdoctoral opportunities in its electronic career development database (i.e., the Career Development Center for Postdocs and Junior Faculty). Provide support to develop this website and promote its existence.

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Chapter 6

Fostering Diversity in Education in the SBE Sciences

We as a nation cannot afford to educate only those who can afford college and the associated perks that influence decisions about admissions (notably, standardized tests). We cannot de facto limit access to gatekeepers who transmit information and provide guidance in negotiating the state and local education apparatus. This kind of an education "system" is unevenly functional at best. It wastes talent and forecloses opportunity. That is why higher education—all sectors and kinds of institutions—must adopt and, most of all, invest in a doctrine of excellence for all.
Dr. Eleanor L. Babco, Executive Director, Commission on Professionals in Science and Technology [36]

Current Context

Key Needs

Explicit attention to diversity in education and training is essential to any consideration of the future workforce in the United States.[37] Diversity in the United States is not just a core value; diversity in the workforce also affects the country's capacity to nurture democracy and encourage civic participation, maintain competitiveness in an increasingly global economy, enhance the quality of education, and promote the health and safety of all citizens. Numerous studies demonstrate that diversity in education contributes to broadening perspectives, encouraging tolerance, and promoting the development of critical thinking and related skills. Beyond the substantive enrichment of the social, behavioral, and economic sciences by scholars bringing diverse sets of interests, questions, and skills, learning is strengthened when guided by faculty and mentors of diverse backgrounds and expertise. In particular in higher education, SBE faculties teach large and diverse pools of students and thus are strategically well situated to introduce them to science.

Building a scientific workforce that mirrors the U.S. population challenges all fields of science, including the social, behavioral, and economic sciences. Demographic trends portend an increasingly diverse U.S. population in the 21st century. From 1990 to 2000, the country's minority population increased by 35 percent and the non-Hispanic white population by 3.4 percent. The U.S. Census Bureau forecasts that these trends will continue. Non-Hispanic whites will comprise 53 percent of the population by 2050 (a projected drop from 69 percent

[36] Eleanor L. Babco, *Trends in African and Native American Participation in STEM Higher Education* (Washington, DC: Commission on Professionals in Science and Technology, 2003), p. 11.
[37] This chapter focuses on outreach to and training of persons of color and women in the SBE sciences. Inclusive training in the SBE sciences also commends attention to persons with disabilities. The National Workshop and this report do not specifically address issues of access and opportunities for this population of researchers, though the issue is important.

in 2000), Hispanics will account for the largest share of population growth, and the African American population will nearly double. Consistent with this overall pattern, the traditional college-age population will also increase by an estimated 16 percent from 2000 to 2015. Of these new students, it is estimated that 80 percent will be non-white and nearly half of these will be Hispanic.[38]

Absent intentional efforts to alter recruitment and retention in higher education, the achievement gap between minority populations and non-Hispanic whites will persist or widen. In 2000, African Americans constituted just over 12 percent of the population, but earned 9 percent of all bachelor's degrees and 6 percent of all doctoral degrees; Hispanics totaled 12.6 percent of the population, but earned only 6.3 percent of all bachelor's degrees and 3.8 percent of all doctorates.[39] Completion rates for bachelor's degrees captures the problem: According to a report from the American Council on Education (cited above), in 2000, 28 percent of non-Hispanic whites completed baccalaureate degree programs compared to less than 17 percent of African Americans, and 11 percent of Hispanics.

Although the presence of persons of color in science and engineering, including in the SBE sciences, has increased in recent decades, the absolute numbers and proportions are still quite small.[40] For most minority groups, there is both underrepresentation and attrition in these fields. The one exception is Asian Americans and Asian permanent residents who in 2000 constituted 3.6 percent of the U.S. population and 8.9 percent and 10.0 percent of those receiving bachelor's and doctorate degrees.[41] For other minority groups, the picture looks as follows: In 2000, African Americans earned 8.3 percent, Hispanics 7.2 percent, and Native Americans 0.7 percent of bachelor's degrees in science and engineering and an even lower proportion of doctorate degrees (African Americans earned 4.2 percent; Hispanics, 4.3 percent; and Native Americans, 0.5 percent of all PhDs). Focusing only on the SBE sciences as a subgroup, the drop off is much the same: At the bachelor's level, 9.8 percent and 7.9 percent of the degrees were, respectively, earned by African Americans and Hispanics in comparison to African Americans and Hispanics earning only 6.4 and 5.2 percent, respectively, of all SBE doctorate degrees.[42]

In comparison to other fields of science, the SBE sciences have over time made more progress in attracting, retaining, and granting degrees to historically underrepresented minorities (African Americans, Hispanics, and Native Americans), especially African Americans. At the bachelor's,

[38] American Council on Education, *Investing in People: Developing All of America's Talent on Campus and in the Workplace* (Business-Higher Education Forum) (Washington, DC: American Council on Education, 2002), p. 13.
[39] Felice J. Levine, Havidan Rodriguez, Carla B. Howery, and Alfonso R. Latoni-Rodriguez, *Promoting Diversity and Excellence in Higher Education through Department Change* (Washington, DC: American Sociological Association, 2002), p. 6.
[40] Faculty of color and women are also underrepresented at institutions producing most of the PhDs and receiving most of the R&D funds.
[41] The natural and physical sciences and engineering confer larger proportions of degrees to Asians than to other minority groups. In 2000, Asian citizens and permanent residents earned 5.2 percent of the doctorates in the SBE sciences in comparison to their earning 11.2 percent and 17.1 percent of the doctorates in the natural and physical sciences and engineering, respectively.
[42] National Science Foundation, Division of Science Resources Statistics, WebCASPAR, Survey of Earned Doctorates: Doctorate Records File-Doctorate Institutions, AY 1973-2001 (compiled by WESTAT for NSF in May 2003).

master's, and doctorate degree levels, the overall differences are modest, but stable. For example, in 2000, underrepresented minorities received 12.3 percent of the doctorates awarded in the SBE sciences in comparison to their only receiving 7.2 percent and 6.3 percent of the doctorates in natural and physical science and engineering, respectively.[43] Even for the SBE sciences, however, the overall numbers are small and well below the presence of underrepresented minorities in the general population or the need for this scientific talent pool to sustain SBE research and education.

Better recruitment and retention of women is also needed at the doctorate degree level in the SBE sciences, especially in certain fields and subfields. As in science and engineering generally,[44] women earn more than half of all bachelor's degrees in the SBE sciences, but they earn lower proportions of doctoral degrees. In disciplines such as geography, sociology, psychology, and anthropology, women earn more than half of the doctorates, but in economics and political science, women are underrepresented. In 2000, 27 percent of doctorates in economics and 37 percent of those in political science were conferred on women. These proportions are somewhat greater than in the physical sciences but less than in the biological sciences.[45] Within subfields, considerable variation also exists. In psychology, for example, women are much more likely to receive PhDs in developmental, school, or clinical psychology than in experimental or cognitive psychology.

Impediments and Challenges

Currently there is a gap between aspiration and implementation in achieving more inclusive education in the SBE sciences, with challenges and impediments varying at different levels of education. At the K-12 level, for example, the challenge is to craft and institute SBE programs that reach out to diverse students and prepare teachers for a sector of education where the SBE sciences have had only minimal presence. The initiatives outlined in the K-12 section of this report should be directed explicitly to persons of color, to men and women, and to recent and more experienced scholars to attract them to the challenge of conveying SBE education to children and youth in ways appropriate to their developmental levels. The challenge for postdoctoral and early career preparation is also formidable, more because of the absence of funding than the absence of testable models. While intentional programs for underrepresented minorities do not exist in great numbers, a number of available strategies seem promising for the SBE sciences.

Despite examples of innovation, higher education in the SBE sciences requires reinvention to realize the goal of achieving excellence and inclusiveness for all. Some of the strategies considered previously with respect to undergraduate and graduate education and the

[43] Ibid.

[44] Overall 36.2 percent of women earn doctorate degrees in science and engineering—markedly less than the 50.4 percent of all bachelor's degrees awarded to women. Commission on Professionals in Science and Technology, Professional Women & Minorities (Washington, DC: Commission on Professionals in Science and Technology, 2002), p. 53 [Retrieved from http://www.cpst.org/pwmchap.cfm on January 3, 2004.]

[45] American Sociological Association. Table on Percentage of Doctorate Degrees Earned by Women in Selected Disciplines, 1966-2001. [Retrieved from http://www.asanet.org/research/docsocscigen.html on January 4, 2004.]

recommended components of an action plan could ameliorate some of the most serious obstacles to the education of underrepresented minorities and women. Challenges range from the very structure of the curriculum, ad hoc versus department-wide opportunities and planning, and the amount of faculty time devoted to mentoring and advising, to outreach strategies, admissions criteria, the fit between pedagogy and learning styles, and the amount of student exposure to research training. In addition, there is a need for greater attention to diverse work sector opportunities and to student aspirations and goals. Absent incentives to change and a culture that supports it, faculties and departments can be passive or resistant—seeing change more as taking on new tasks than as transforming old ones.

The programs and transformations that would facilitate the development and training of students and early career professionals of color are similar to those that more generally seem to engender professional growth and development. Any differences are more of degree than of kind. Foremost among the needs are more financial support, better mentoring and guidance throughout the education process, improved training in the conduct of SBE sciences, and greater access to professional information and networks. Capacity building in quality and quantity is needed across the SBE sciences, but the need for increased numbers of underrepresented minorities to contribute to the social, behavioral, and economic sciences is especially acute. For underrepresented minorities in particular, challenges appear at the earliest steps on the path to career development and persist beyond doctoral training. Some that warrant special emphasis include:

First, at the K-12 level, substantial disparities exist among school systems in access to materials and human resources. SBE science courses are rare even in secondary schools. For example, when Advanced Placement courses are present, they are more likely to be in schools where there are many other AP courses in science. There are also serious challenges to attracting teachers well trained in SBE sciences to K-12 teaching, given that science in these fields is less frequently taught by SBE-trained scientists than in other science and engineering fields. With fewer teachers trained in SBE sciences in K-12 education and a low proportion of persons of color pursuing advanced degrees in SBE fields, the probability of having teachers well tutored in their fields serve as positive role models and mentors for students of color is further diminished.

Second, insufficient attention has been paid to faculty development and capacity building in the SBE sciences in Historically Black Colleges or Universities (HBCUs) and other minority serving institutions.[46] In science generally, but far less so in the SBE sciences, HBCUs have been important pathways into graduate training. Approximately 40 percent or more of bachelor's degrees in the life, mathematical, and physical sciences earned by African Americans were conferred by HBCUs while only about 20 percent of the social science bachelor's degrees were

[46] An examination of the participation of HBCU faculty in NSF-funded research in the social, behavioral, and economic sciences is reported in Gregory N. Price, "National Science Foundation-sponsored Basic Social Science Research at Historically Black Colleges and Universities: Assessment and Implications" (Paper delivered at the 2004 Annual Convention of the Allied Social Science Associations, San Diego, CA, January 2004).

earned at HBCUs. Given the critical role of HBCUs in doctoral degree production,[47] there is need to work with and strengthen the research and student-support infrastructure of SBE departments at these institutions.[48]

Third, targeted outreach efforts need to be mounted at all levels of education in the SBE sciences to attract students of diverse backgrounds and aspirations. Outreach to high school students could include summer internship programs, assistance with college applications and SAT preparation, or other strategies that could make the college experience in SBE sciences attractive and attainable. Similarly outreach to HBCUs, community colleges with highly diverse student bodies, and other minority serving institutions is needed to engage students with the rewards of graduate education and training as well as career opportunities. Given the large number of students of color in community colleges, these institutions like the HBCUs are ripe for both faculty development and student training in the SBE sciences.

Fourth, is the challenge of broadening the criteria for admissions to college and to graduate school. Barriers to using broader admissions criteria include institutional inertia, confusion about options, and concerns that alternatives will be no better and will take more time. The submission of portfolios by those applying to programs, the weighting of research and other related work experience, an emphasis on written work (including personal statements), and the examination of grades to identify areas of strength and progress over time can be used to complement or even substitute for standardized tests.

Fifth, faculty members bring limited experience in working as a group on department-wide activities. While there are overall benefits to embracing collective goals, it is particularly important on issues of diversity. How this is done will vary. There is no one-size-fits all solution; disciplines and fields differ depending on institutional culture and mission. Departments can leverage their human and financial resources if they work more systemically on strategies and plans. Changing the entrenched culture and a traditional reward system that has emphasized autonomous accomplishment requires long-term, sustainable effort.

Sixth, effective mentoring and guidance are far too often absent for persons of color and women as SBE students, early career faculty, and mid-career scientists. Limited guidance, information, and support (e.g., on how to map careers, what to study, how to negotiate graduate school, how to land first jobs, and how to prepare proposals and publish) can affect career productivity. In many SBE undergraduate and graduate programs, mentoring relationships are generally left to chance, with current reward structures providing few incentives for improved mentoring. Guidance, feedback, and supervision on substantive work; help in navigating learning environments; support in making transitions (e.g., from non-research institutions to graduate school); advice on

[47] Eleanor L. Babco, *Trends in African American and Native Participation in STEM Higher Education* (Washington, DC: Commission of Professionals in Science and Technology, 2003).

[48] Federally financed R&D expenditures at HBCUs in the social and behavioral sciences are extremely small in comparison to the natural and physical sciences and engineering. Over the past ten years, it is about five percent of the total federally financed R&D expenditures. See National Science Foundation/Division of Science Resources Statistics, WebCASPAR, Survey of Scientific and Engineering Expenditures at Universities and Colleges: R5/6/2003 Expenditures, FY 1973-2000.

balancing education, career, and family; and help in building networks of contacts are essential to professional growth and development, but are rarely provided with enough intentionality to students and junior scholars.

Seventh, glass ceilings persist for persons of color and women in all science and engineering specialties whether in the academy, government, research institutions, or industry. This pattern holds true across the SBE disciplines. An NSF Program like ADVANCE seeks to address organizational constraints through its Leadership and Institutional Transformation Awards. The fuller inclusion of the SBE sciences in such funding initiatives could yield better knowledge and models for change.

Best Practices

A variety of successful programs have been established that recruit minority students; provide them with financial support through stipends and other means; expand their opportunities through mentoring, networking, and other direct methods of training; and in general provide guidance and encouragement at the undergraduate level, through graduate education, and into productive careers.[49] In addition, innovative programs have been established that produce systemic changes in departments and other organizational units, thus improving the quality of education for all students. Some examples of these programs, often initiated by the SBE scientific societies, include:

- The American Economic Association (AEA) dedicates talent and resources to enhancing the undergraduate and graduate school experience of underrepresented minorities. With support from NSF, among others, the AEA for more than three decades has operated a summer program for undergraduates with an emphasis on minority scholars and scholarships. Under the auspices of AEA, the Department of Economics at Duke University is currently partnering with North Carolina A&T State University on this program. Also, in 1998, with leadership from the AEA's Committee on the Status of Minorities in the Economics Profession, the AEA commenced the Economics Pipeline Project that provides graduate students of color with an additional mentor to assist and advise at critical junctures throughout students' graduate careers. All participants attend a pipeline workshop each year where they have an opportunity to meet other minority students and their mentors.

- The Ralph Bunche Summer Institute (RBSI) of the American Political Science Association (APSA) is currently supported through the NSF Research Experiences for Undergraduates (REU) Program. The RBSI is a five-week, intensive program designed to simulate the graduate school experience; provide guidance and mentoring; and expand academic

[49] In addition to initiatives specific to the social, behavioral, and economic sciences, there are a number of national programs that provide support to undergraduates, including in the SBE sciences, through cooperating institutional support. For example, the Ronald McNair Postbaccalaureate Achievement Program seeks to provide research opportunities, mentoring, summer internships, tutoring, assistance in the graduate admissions process, and so forth to participants from disadvantaged backgrounds. The program involved 156 institutions. Also, the Summer Research Opportunity Program (SROP) provides 8-10 weeks of summer research experiences for approximately 500 underrepresented students at 93 universities.

opportunities for African American, Latino/Latina, and Native American students. Starting its eighteenth year, the RBSI has helped talented minority students between their junior and senior years of college prepare for graduate school. The program emphasizes statistical analysis of data, research writing, and analytic skills and addresses career development issues (e.g., preparation for the Graduate Record Examination, meetings with leading scholars). The APSA partners with Duke University in the conduct of this Institute. Participants in the program typically pursue advanced degrees, with more than 50 percent continuing in graduate training in political science.

- The Sociology Department at Texas A&M University conducts a summer training program (Research Experiences for Undergraduates Summer Institute) that operates for eight weeks with ten students. The program offers formal coursework with academic credit, participation in a research project under the supervision of a faculty mentor, a professional socialization seminar, preparation for the Graduate Record Examination, a capstone research presentation at the conclusion of the Institute, and presentation of a paper the following spring (after subsequent work at the student's home site) at the Southwestern Sociological Society meeting. The program has institutional as well as individual ambitions in addition to the specific training selected students receive. Faculty members from Texas university affiliated campuses nominate students, with the home mentor committed to providing support during the subsequent academic year. This link to Texas-area regional campuses helps contribute to the training of students more generally at these home institutions. This initiative is also made possible through NSF's REU Program.

- Both the American Sociological Association and the American Psychological Association (APA) have offered national graduate fellowship training programs for underrepresented minorities with support from the National Institutes of Health and, in particular, the National Institute of Mental Health (NIMH). For more than 30 years, these Minority Fellowship Programs (MFPs) have provided a package of support, training, and the opportunity to work with a cohort of Fellows that has produced the leading scientists of color in both disciplines and has greatly benefited the disciplines themselves. For example, launched in 1974, the APA's Minority Fellowship Program has supported more than 1,000 trainees at more than 85 different institutions—of whom more than 600 have earned doctoral degrees. About three quarters of the current applicants to the APA's MFP Program are women. The program success rate is excellent: 75 percent of participants graduate within seven years and more than 90 percent graduate within ten years. Most MFP Fellows pursue research and teaching careers. The ASA's MFP Program reports similar results.

- As noted in the Undergraduate Education chapter, the Minority Opportunities Through School Transformation (MOST) Program of the American Sociological Association was an eight-year effort designed to achieve excellence and inclusiveness in education at the department level. Over this period, the program worked intensively with 11 departments (four of which were PhD-conferring and seven of which were BA-conferring) in order to produce intentional and sustainable change. MOST achieved dramatic results. For example, in 1993-1994, only about one quarter of the courses taught in MOST departments contained diversity content compared to more than 50 percent in 2000-2001. Overall, the percent of

graduating minority majors nearly doubled during the program. By 2000-2001, 33 percent of the graduating majors were minorities, with many advancing to graduate study. Departments reported similar results for minority faculty. Although MOST was located in departments of sociology, the goal of the project was to identify strategies, best practices, and approaches to addressing barriers that could be transportable to all SBE sciences and to other fields as well.

- The History of Science Society (HSS) is also directing attention to systemic change in educating students of color. HSS is the only scholarly society with a program of activities directed to change at Historically Black Colleges and Universities (HBCUs). Working since 2003 with six HBCUs (Howard University, Morgan State University, Bennett College, Morehouse College, Spelman College, Clark Atlanta University), the HSS emphasizes partnering with HBCU faculty and administrators on building curriculum modules for teaching history of science. A key goal is also to involve undergraduates and faculty in projects on the history of science. The HSS aims both to attract faculty and students at HBCUs to the history of science as a field of inquiry and to add to the limited body of knowledge about the history of science at HBCUs.

Components of an Action Plan

Prior chapters of this report offer facets of an action plan appropriate to challenges and opportunities at each educational level. They also emphasize outreach and the importance of attracting and retaining a diverse talent pool in the SBE sciences. This chapter highlights some additional ways to focus NSF strategies and intensify efforts to foster diversity in the SBE sciences.

Expanded SBE Access to and Support for Existing Diversity Programs

1. Special Attention to Inclusion of the SBE Sciences in Programs within the Division of Human Resource Development (HRD) should attract more students of color and promote the professional development of faculty in the SBE sciences:

- **The Louis Stokes Alliance for Minority Participation (LSAMP)** develops long-term, comprehensive strategies to strengthen the preparation of minority students and increase the number who successfully complete baccalaureates in STEM (science, technology, engineering, and mathematics) fields. The Program envisions partnerships that could capitalize on the experience of professional associations in the SBE sciences and draw on research and non-profit organizations as well as majority and minority serving academic institutions. With LSAMP emphasizing the progression of baccalaureate students through graduate careers, SBE proposals that create academic partnerships with other SBE organizations and institutions (including government agencies) could be extremely helpful in attracting students to SBE doctoral training.

- **Centers of Research Excellence in Science and Technology (CREST)** that focus on or explicitly include the SBE sciences should be nurtured and promoted by the Directorate for Education and Human Resources and the Directorate for Social, Behavioral and Economic Sciences. CREST provides substantial resources to upgrade the capabilities of the most

research-productive institutions that serve minorities. Awards that establish or improve SBE research centers at minority serving institutions (through, for example, laboratories, state of the art software and hardware, access to and training at such research or data centers as the Inter-university Consortium for Political and Social Research) should enhance research by scholars, encourage retention of strong scholar-teachers, and advance teaching and training at these institutions.

- **The Historically Black Colleges and Universities Undergraduate Program (HBCU-UP)** seeks to enhance the quality of undergraduate science, technology, engineering, and mathematics education at HBCUs. With an emphasis on instruction and curriculum, HBCU-UP aims to improve access to and retention in science. Similarly, **the Tribal Colleges and Universities Program (TCUP)** is designed to enhance the quality of science, technology, engineering, and mathematics education with emphasis on the leveraged use of information technologies at tribal colleges and universities, and at institutions that serve Alaskan Natives and Hawaiian Natives. Pathways to graduate training in the SBE sciences and the quality of SBE education at HBCUs and TCUs could be advanced if the SBE sciences were more fully integrated into these funding initiatives. As with other fields of science, SBE students and faculty in minority-serving institutions are an untapped talent pool for research and teaching.

- **The Alliances for Graduate Education and the Professorate (AGEP) Program** could also contribute to increasing the participation of underrepresented minorities in the SBE sciences. While there are some exemplary programs that emphasize quality mentoring and training, in the main, the SBE sciences would benefit from AGEP support, with its emphasis on innovative models of recruiting, mentoring, and retaining doctoral students and its innovative strategies for identifying and supporting underrepresented minorities. Such strategies could include coordination with LSAMP alliances and long-term collaboration on research and research training between doctoral programs and institutions that serve predominantly minority undergraduates. Explicit encouragement to institutions to include the SBE sciences in AGEP proposals and encouragement to the SBE science community to prepare AGEP proposals would strengthen the SBE sciences.

Expanded SBE participation in programs of the Human Resources Division in EHR is critical to widening and diversifying outreach in the SBE sciences. The rarity of the SBE sciences supported by these funding initiatives suggests the need for explicit language in solicitations that alerts applicants to the fact that the STEM sciences include the SBE sciences. It also suggests a need for dedicated or supplemental funding for competitive projects that develop SBE components as part of institution-wide initiatives. Program Directors in EHR and SBE are at the fore of communication with applicants and can exert effective leadership in making these possibilities known.

2. Programs Directed to Women and Girls need to include SBE Sciences. The larger proportion of women in the SBE sciences than in the STEM sciences generally does not diminish the need for initiatives to attract, train, and enable the career paths of SBE women scientists. As pointed out previously, there is considerable variation across SBE disciplines and within fields in the number of women scientists and in their roles. The HRD Program in Gender Diversity in

Science, Technology, Engineering, and Mathematics Education is ripe for projects, information dissemination, and research that focus on or include the SBE sciences. Such initiatives as MentorNet could usefully be extended to the social, behavioral, and economic sciences. More initiatives would be desirable like the University of Michigan's demonstration project on Girls Exploring Mathematics through Social Science, which strengthens middle school girls' interest in the social and behavioral sciences while simultaneously enhancing their mathematical skills. Also, NSF-wide programs such as the Advance Program should more intentionally include SBE women scientists in competitions for Fellows Awards, Leadership Awards, and Institutional Transformation Awards. More vigorous outreach, designated funds for a specific number of years to support SBE Fellows, and incentives to institutions that explicitly include the SBE sciences would yield more complete inclusion of these scientific fields.

3. The Research Experiences for Undergraduates (REU) Program has been a highly successful initiative to support projects aimed at attracting students of color to careers in the SBE sciences. Approximately 45 to 50 percent of supported students are underrepresented minorities. Many impressive REU awards have long histories of demonstrable success in realizing such gains. Allocating more resources to such programs and expanding their numbers to reach many SBE disciplines would be an effective way to increase the participation of historically underrepresented racial and ethnic minorities.[50] In economics, for example, as noted above, the undergraduate two-month summer program undertaken by AEA and supported in part with REU funds trains a substantial proportion of the students of color entering graduate programs each year. As with the AEA award, partnerships with minority-serving institutions could enhance the effectiveness and outreach of these initiatives.

4. The Integrative Graduate Education and Research Traineeship (IGERT) Program is now in its seventh year and is a potentially promising mechanism for the graduate training of underrepresented minorities in the SBE sciences. The IGERT emphasis on catalyzing cultural change in graduate education provides just the right framework for testing innovative strategies of training and mentoring for persons historically excluded from the educational system. IGERT's emphasis on interdisciplinary teams, attention to quality mentoring and building a sense of professional community, and focus on cross-cutting issues has generated engaging innovations in the SBE sciences. The explicit IGERT Program goal of training a more diverse and flexible talent pool of scientists makes it an apt means for ensuring that outreach and resources are directed to underrepresented minorities.

5. Expanded Funding for the SBE Minority Postdoctoral Research Fellowships and Support Program would help overcome the absence of a tradition of postdoctoral training in the SBE sciences. More generous funding is needed for this SBE initiative. Ten or fewer minority postdoctoral fellowships awarded each year are too few to affect the SBE disciplines. NSF may not be able to meet the full demand for postdoctoral training at the individual level, but,

[50] In some fields like education research where there is no pattern or tradition of undergraduate research training (i.e., research training occurs essentially at the doctoral level), REU-type support can make a major difference in attracting undergraduates of color and undergraduates more generally into these fields.

at the broader level of impact on the SBE sciences, an increase in the number of SBE Minority Postdoctoral Research Fellowships could provide the critical mass needed to help shape and influence these sciences.

New Opportunities and Initiatives

A great deal could be accomplished by ensuring that all existing NSF programs are open to applicants from the SBE sciences and are sufficiently funded to enhance diversity in SBE fields. In addition, new initiatives to foster diversity in the SBE sciences could further promote a more inclusive talent pool of SBE scientists. Examples include:

Collaboration of the SBE and EHR Directorates on an SBE Diversity Innovations Program. To keep pace with the diverse populations pursuing education and the challenging scientific questions being addressed, an initiative is needed to foster long-term sustainable change in how academic, degree-conferring departments, schools, or programs educate and train undergraduate and graduate students. This initiative should be open to degree granting SBE units at all colleges and universities interested in making systemic changes in educating the U.S. citizenry and workforce about the SBE sciences and in bringing more scientists into SBE fields. Proposals should aim to improve the lives of all students, but specific attention to innovations likely to meet the needs of underserved populations should be their primary focus. Summer institutes, enhanced research training, and other add-on activities could be included in any plan (and REU site or IGERT funding can be pursued), but proposals should emphasize the ways academic units would be transformed in their day-to-day operations. This program could be funded under the NSF Human and Social Dynamics Initiative. Scientific societies that seek to work with a group or cluster of departments should be eligible to apply. This initiative would complement the Systemic Reform of SBE Undergraduate Education initiative and the Graduate Education Reinvention Program proposed earlier in this report.

SBE Launch Awards Program (LAP) for Minority Scholars. The aim of this small grants initiative would be to provide underrepresented minorities with a "running" head start in doing research and building a viable research program. LAP would be directed to persons of color in order to enable their effective transition to a first project after completion of their degrees. The demands in particular on the time of junior faculty of color commend a LAP initiative. While such funding is desirable for all new faculty members, there is a critical need for the full participation of historically underrepresented minorities in SBE sciences. Heavy teaching loads, particularly at Historically Black Colleges and Universities and other minority-serving institutions, commend investments in research support. Scientists in SBE fields did not receive much funding through the former NSF *Research Planning Grants and Career Advancement Awards for Minority Scientists and Engineering.* The underlying rationale for these initiatives, however, remains compelling. For ten years, the National Institute of Mental Health has been supporting new investigators through B/START (Behavioral Science Track Award for Rapid Transition) awards at a maximum of $50,000. LAP is similar in goal.

Immediate Steps

- Ask the Committee on Equal Opportunities in Science and Engineering (CEOSE) to consider the recommendations in this report regarding diversity in the SBE sciences and the fuller inclusion of the SBE sciences in NSF programs addressed to diversity and to recommend further implementation steps, activities, and policies to advance the diversity components of this action plan.

- Clarify how NSF staff can consider the NSF goal of *Integrating Diversity into NSF Programs, Projects, and Activities* in making funding decisions. Division-wide discussion, program officer training, or guidance on how best to weigh such factors could help to further transform this NSF-stated goal from principle to practice.

- Develop an NSF incentive program that rewards academic departments, centers, and other units in the SBE sciences for achieving substantial increases in the number of underrepresented minority students, faculty, and researchers over given periods of time. Include in any such program, attention to academic units that partner across academic settings (e.g., initiatives between graduate programs and community colleges, 4-year colleges, and HBCUs).

- Fund the compilation of a *Manual of Best Practices for Recruiting and Retaining Minority Students in the Social, Behavioral, and Economic Sciences*. Identification of commonalities among effective programs in SBE disciplines and in diverse colleges and universities would be helpful in disseminating innovations to other academic units.

- Support research (following a call for proposals) on ways to achieve diversity in the SBE sciences via basic understanding of such issues as how minority and disadvantaged students decide whether to pursue post-secondary education, what affects their selection of majors and their experiences as undergraduates, and the determinants of entry and attrition in graduate school.

- Urge the American Association for the Advancement of Science (AAAS) to enhance the relevance and utility of its Minority Scientists Network to the SBE sciences. This collaboration between *Science* magazine's Next Wave Web Site and the AAAS Directorate for Education and Human Resources could have considerable value for students, scientists, faculty, and administrators in the SBE sciences.

Chapter 7

Conclusion—Pathways to Advancing SBE Science Education

Pipeline thinking has dominated science and engineering workforce preparation and education for decades. . . . We need to devise fundamentally new arrangements that convert "the pipeline" into pathways that are multiple, flexible and adaptable. . . . Cutting these fresh patterns is our challenge in preparing the 21st century workforce. This is a tall order, but we can do it. It means keeping our eyes open to new developments, and experimenting. We may believe that this is someone else's job. But we are all in this together - educators, researchers, and administrators, whether from the private sector, academe, or government. We all want to be in the vanguard - to ride the crest of the wave, and not be bowled over by its force. Dr. Joseph Bordogna, Deputy Director, National Science Foundation[51]

In 2003, the National Science Foundation embarked on a historic mission to focus attention on improving education in the social, behavioral, and economic sciences. As part of this process, NSF organized a Planning Meeting in January 2003 of representatives of social and behavioral science societies and held a National Workshop in June 2003 of leading educators and social, behavioral, and economic scientists. The Foundation's goal was to obtain advice from the scientific community on a plan of action that would permit it to formulate concrete programs to improve SBE education at all levels.

This report is the product of that process. Based on input from these meetings as well as analysis of extant studies, documents, and data, four chapters assess the current state of SBE science education, examine impediments and challenges, highlight best practices, and specify components of an action plan for improving education and training in the SBE sciences at each critical level of the education process—K-12, undergraduate, graduate, and postdoctoral and early career. A fifth chapter focuses specifically on fostering diversity in the SBE sciences.

Framework of an Action Plan

By design and at the request of the National Science Foundation, the action plan is core to this report. Components of the plan are presented separately for each education level and on the subject of diversity in order to make clear the connections between relevant issues and recommended actions. The full plan is outlined in the Action Plan Summary Table (see pages 86-87). The plan itself sets forth pathways for improving education in the SBE sciences through (1) expanding resources or giving higher priority to the SBE sciences in existing programs, (2) pursuing new opportunities and initiatives, and (3) taking some immediate steps.

[51] "From Pipeline to Pathways." Speech to ATE National Principal Investigators Conference, October 24, 2002.

The aim of the report is to provide a plan that is practical, feasible, and desirable within the context of NSF's structure, extant programs, and how the agency works. NSF has in hand many of the tools it needs to launch a vigorous program to advance SBE science education. The plan of action offered in this report seeks to provide recommendations that can improve extant programs and expand funding for them. The plan also identifies opportunities that flow from careful assessments of NSF funding mechanisms, needs in the SBE sciences, and plausible recommendations for new initiatives. The plan finally suggests immediate steps that might be considered the "low hanging fruit" to maintain and build further momentum. Strategic actions and implementation take time, but demonstrable progress by the Foundation can and should be possible.

The Road From Here

The state of the economy and the resources currently available for science may raise questions about how best to think about investments in education and training in the social, behavioral, and economic sciences in a context where support for SBE science itself is scarce. The National Science Foundation and in particular the leadership of the SBE Directorate determined that the need for a scientifically literate public and a robust talent pool of SBE scientists warrants engaging in this task. At one level, the action plan is ambitious in setting forth substantial ideas meriting resources within existing programs and new initiatives. There is a great deal that NSF can and should do in terms of SBE science education and training. At another level, the report is realistic in so far as it systematically examines needs and analyzes what can be done in the short- and longer-term to enhance support for the SBE sciences within the contours of extant programs and new initiatives.

What does this mean for NSF in terms of priority setting? In education and training programs within EHR or NSF-wide, where initiatives exist but have not been sufficiently inclusive of the SBE sciences, intentional steps to realign priorities are urgent and necessary. The plan also provides the SBE and EHR Directorates with analysis and recommendations that should form the basis for enhanced funding of existing initiatives and support of new programs. In moving from report and action plan to priority setting, there are a number of implementation issues that require attention. These include:

- how the language of extant programs and outreach needs to be changed;
- how funds need to be committed, dedicated, or reallocated to stimulate and support SBE education enhancements;
- which programs at each level are most ripe for immediate transformation and likely to produce the highest immediate return on investment;
- which new initiatives have the highest potential for adoption;
- what indicators of performance (for enhanced attention to SBE science education and training) can be specified and in what timeframe; and
- what structural arrangements need to be put in place to manage and monitor this strategic commitment.

In 2003, the National Science Foundation challenged itself to examine how best to invest in education and training in the SBE sciences. Embedded in this ambition was recognition that "business as usual" practices in NSF's levels and forms of support would need to change. While institutional transformation is not easy (as this report makes clear), the momentum initiated by NSF in 2003 augurs well for how the Foundation can effectively use this report and action plan.

Cross-Cutting Themes

Beyond the specific plan of action set forth in this report, the meetings and deliberations identified a number of salient cross-cutting themes:

The Need for Improved SBE Science Education at All Levels of Education

Improved SBE science education is urgently needed at all education levels in the United States. Globalization; the complex leadership role that the United States plays; and the increasing awareness that behavioral, economic, political, and social relationships are central to sound policy and societal well-being have led to greater appreciation and demand for knowledge from the SBE sciences. Public officials need social and behavioral science insights if they are to chart a wise course, whether with respect to the education of our citizenry or the strategic decisions involved in dealing with the international community. Private entrepreneurs need social and behavioral science insights if they are to succeed or even survive in the fiercely competitive global marketplace. Citizens need social and behavioral science insights if they are to understand domestic and international policy choices, be effective consumers of public information, and make personal and professional decisions based on what is known about human interactions and organizations. Despite increasing awareness of the importance of social and behavioral science knowledge, the gaps in SBE science education remain large—especially at the earlier stages of science learning.

Public Understanding of SBE Sciences as Integral to STEM

A recurrent theme is the need for greater acknowledgement that the SBE sciences are an integral part of science, technology, engineering, and mathematics (STEM). The SBE sciences can point to genuine progress at the National Science Foundation and in other institutions central to understanding the texture and scope of this scientific enterprise. Nevertheless, the NSF has a continuing opportunity to foster a more complete acceptance of the SBE sciences in the "family of science." No place is more ripe for building this awareness than in science education itself and, in particular, in K-12 education, where the SBE sciences are conspicuously absent from introductory materials on the nature of science and the identification of phenomena that are amenable to scientific analysis. Public comprehension of the SBE sciences would be greatly advanced by inclusion of the SBE sciences at early stages of science learning.[52]

[52] Full inclusion of the SBE sciences will take sustained leadership and rethinking from the science and education communities. For example, the biennial Survey of Public Attitudes Toward and Understanding of Science and Technology undertaken by NSF currently asks no specific questions that would probe awareness of the scientific study of human and social dynamics.

The National Science Foundation as Key to Advancing SBE Science Education

The National Science Foundation is the sole federal agency charged with advancing the health and well-being of science. As such, the Foundation plays a pivotal role in influencing the directions of and understandings about science and science education. No other organization or agency commands comparable respect in science, in the social and behavioral sciences, and in the science education communities**.** Therefore, the Foundation's commitment to identifying and taking strategic steps to advance education in the SBE sciences is of major significance.

Beyond its own programs, NSF is particularly well situated to support and encourage *systemic* improvement in SBE science education at all levels of education. An expanded presence in the secondary school curricula, for example, is critical to making students aware of the existence and fascination of SBE science. Students can hardly be expected to select career options when they are unaware that they exist. Similarly, a stronger presence in the kindergarten through grade 8 curricula is an essential building block for what might be offered in grades 9 through 12. "Early and often" are the basic ingredients of scientific literacy and interest in all fields. At each stage in the education process, there are important challenges and opportunities for SBE science where NSF's leadership is key.

NSF and the Challenge of Culture Change

The National Science Foundation has supported cutting edge SBE science and has been at the cutting edge in advancing SBE disciplines and interdisciplinary fields. Great strides have been made internal to NSF in comprehending the role and importance of social, behavioral, and economic science theory, methods, and knowledge. The establishment of a separate Social, Behavioral, and Economic Sciences Directorate more than a decade ago was one indicator. The new NSF-wide competition on *Human and Social Dynamics*—the first ever where the entire scientific enterprise is studying phenomena grounded in social processes—is another. The initiation of this exercise on SBE science education, with the active participation of the EHR Directorate, is a further indicator that the culture of science at NSF is amenable to change.

Joint support from the SBE and EHR Directorates for a strategic plan for education and training in the SBE sciences will further affirm NSF's commitment to improving SBE science education in the short- and long-term. It will send a loud and clear signal that the integration of science and education should be a priority and not an afterthought. It will also signal that education in the SBE sciences requires the same level of intentional programming and support as in other fields of science. In the past, the SBE sciences were not eligible for support from some NSF education and training programs. Because ambiguities regarding eligibility pervade the SBE research community and were explicitly (and frequently) expressed at the National Workshop, clarification is necessary to ensure that SBE proposals are welcome independently or as components of institution-wide projects. Long-term patterns and practices can be hard to transcend without affirmative messages; full participation of the SBE sciences in all relevant NSF programs will require explicit encouragement.

Strengthening Collaborative Ties Between the SBE and EHR Directorates

The gains made over the last several years in communication, coordination, and rapport between the SBE and EHR Directorates are laudable. The full participation in and commitment of the EHR Directorate to this SBE-initiated activity are visible and welcome signs of the potential for further collaboration between these two Directorates. Because Assistant Directors (ADs) currently serve fixed terms, institutional mechanisms should be devised independent of the rapport that exists between particular incumbents. One step would be to institute a joint staff implementation committee that reports directly to the ADs; another is to institute cross appointments between the EHR and SBE Advisory Committees.

Appointing an expert or experts in science education to the SBE Advisory Committee and SBE scientists to the EHR Advisory Committee, with perhaps at least one individual serving on both advisory committees, would help to ensure that educational implications are kept in mind during SBE Directorate policy discussions, and that the SBE sciences are not overlooked during the formulation and review of EHR policies and programs. In contexts where it would be productive to do so, cross appointments between EHR and SBE proposal review panels might also be considered.

Strengthening Communication with the SBE Science Community

The importance of communication was a theme that emerged during the Planning Meeting and the National Workshop. The research community would benefit from knowing more about funding mechanisms available through NSF and about the results of projects that have been funded. Participants also thought that NSF would benefit from continued interaction with SBE scientists. A number of the recommendations speak to recognizing and publicizing best practices in SBE science education at all levels. NSF could use its website or other media to highlight model initiatives that might be adopted or modified for use by others.

Working with Scientific Societies and Organizations

Tremendous advantages would result from collaboration between NSF and scientific societies in promoting education and training at all levels in the SBE sciences. High priority should be given to working with other organizations, especially the relevant scholarly societies, the American Association for the Advancement of Science (AAAS), and the National Academy of Sciences (NAS). The elected officers and the professional staffs of social, behavioral, and economic science societies can offer useful expertise and deep commitment to education and training. They can also provide powerful links between NSF and relevant research communities. Many associations have effective, long-standing programs devoted to producing curriculum materials, enhancing the teaching of their subjects, and training students.

The American Association for the Advancement of Science and the National Academy of Sciences have fielded multiple committees, commissions, and programs focused on science education. Unfortunately, the social and behavioral sciences are far more conspicuous by their absence than by their participation in AAAS and NAS efforts to improve science

education. Given the number of other areas of successful integration of the SBE sciences in the work and programs of the AAAS and the NAS, this pattern of under-inclusion on issues of science education should, with the right points of contact and encouragement, be amenable to transformation and change.

Bringing Research and Evaluation To Bear

As might be expected in a national workshop of participants with research backgrounds, commitment ran high for better data and greater knowledge about education, training, career trajectories, and the processes that sort and select persons into, through, or out of scientific careers. More investment in scientific research on these and other issues was considered to be important to understanding scientific careers and professions and the role of educational processes and systems in that regard.

In addition to a general call for more research, which itself is of merit, there was a parallel call for systematic study and evaluation of education and training programs. There was pervasive agreement that, whatever programs NSF alters or establishes in response to the need to improve SBE science education, they should contain mechanisms for evaluation. The funds earmarked for evaluation within each project should be appropriate to the individual goals, methods, and expected outcomes from that effort. But no project intended to yield specific and measurable improvements in SBE science education should miss the benefits that derives from built-in evaluation for both project improvement and for helping to shape and refine future investments for the field.

Elevating the Social Science of Science Education

The call for research noted above raises more fundamentally the need to encourage greater investment in the social science of science, including on issues of education and professional development. This important arena of scholarship could benefit from more resources and a broader mandate to widen its scope to explicitly include the SBE sciences. While charting a research agenda is beyond the scope of this report, just as education needs to be connected to science, so too does science need to be a central part of sound science education. This theme was emphasized at the National Workshop.

In reflecting on the need for research and data, workshop participants saw the concept of a center dedicated to the study of academic and scientific systems and institutions to be very promising. An NSF Center for Research on Innovation and Organizational Change in Academic and Scientific Settings could be appropriately supported within the scope of the *Human and Social Dynamics* Initiative. Widespread systemic change in SBE science education at all levels would benefit from a deeper understanding of how change has been and can be accomplished in academic and scientific settings. Funding a National Center for Research on Innovation and Organization Change in schools, colleges, and universities and in research contexts would signal the Foundation's long-term and continuing commitment to understanding the functioning and role of academic systems and building knowledge-based recommendations for change. Such a center could command the interest and support of all NSF disciplines and directorates, the

education community, scholarly societies, and such major institutions as AAAS and NAS. Establishing such a center and coordinating its efforts should yield the knowledge, strategies, and tactics needed to improve education and training in all science.

Final Thought

This report concludes with a note of optimism for what the National Science Foundation has achieved by mandating this exercise and by seeking to devise a strategic plan for the improvement of education and training in the social, behavioral, and economic sciences. NSF's next steps can have a major impact on SBE science and training, as we have known it. In five, ten, and twenty years from now, the public's capacity to understand the SBE sciences and the capacity of the SBE scientific community to contribute new and important discoveries will, we believe, be traced to NSF's seizing the opportunity to commit itself to this important educational mission and goal.

Action Plan Summary Table: Training and Education in the SBE Sciences By Education Level, Strategic Stage, and Priority

Ed Level	Expand/Alter Existing Programs	New Initiatives	Immediate Steps
K-12	• SBE Center for Learning and Teaching (EHR) • Instructional Materials Development Program (EHR) • Teacher Professional Continuum Program (EHR) • Informal Science Education Program (EHR)	• SBE Science in High School Initiative (SBE/EHR) • Teacher Training Initiative (SBE/EHR) • "Bridges to SBE Science Education" Program (SBE/EHR) • Research Experiences for High Schoolers (REHS) Program (SBE)	• Place high profile NSF articles (e.g., in *Education Week, Science*) on the importance of SBE education in K-12 • Urge NRC to include SBE sciences in Committee on Science Education K-12 (COSE K-12) • Urge AAAS to integrate SBE sciences into project 2061

Under-Graduate	• Underrepresented Minorities Programs (EHR):
	  • Lewis Stokes Alliance for Minority Participation (LSAMP)
	  • Alliance for Graduate Education and the Professorate (AGEP)
	  • Centers of Research Excellence in Science and Technology (CREST)
	  • Historically Black Colleges and Universities Undergraduate Program (HBCU-UP)
	  • Tribal College Undergraduate Program (TCUP)
	• Research Experiences for Undergraduates (REU) Program (SBE)
	• Course, Curriculum, & Laboratory Improvement (CCLI) Program (EHR)
	• Science, Technology, Engineering, & Mathematics Expansion (STEP) Program (EHR)
		• Systemic Reform of SBE Undergraduate Education Initiative (SBE/EHR)
		• SBE Educational Innovation Program (SBE/EHR)
		• Undergraduate Faculty Enhancement Initiative (SBE/EHR)
			• Publicize NSF Director's Award for Distinguished Teaching Scholars (DTS) in SBE community
			• Convene workshop of REU site grantees and SBE-CCLI grantees to identify and disseminate promising practices
			• Urge NRC to include SBE sciences in Committee on Undergraduate Science Education

Graduate	• Integrative Graduate Education & Research Traineeship (IGERT) Program (NSF-wide) • Graduate Teaching Fellows in K-12 Education (GK-12) Program (EHR) • Research Experiences for Graduates (REG) Supplements (SBE)	• Transformed SBE Doctoral Dissertation Improvement Program (SBE/EHR) • Transition & Early Career Initiative for Graduate Students (SBE/EHR) • Graduate Education Reinvention Program (SBE/EHR) • Preparing Future SBE Scientists Program (SBE/EHR)	• Modify NSF review criteria to include proposal's effectiveness in graduate student training • Convene SBE leadership conference on 1995 NAS Graduate Education Report • Convene leadership of programs directed to rethinking graduate education • Commission or partner on study of SBE graduate education
Postdoc & Early Career	• Postdoctoral Fellowships & Small Grants for Training/ Research Fellowships (SGTRF) in STS Program (SBE) • Minority Postdoctoral Research Fellowships & Supporting Activities Program (SBE) • Mid-Career support mechanisms for professional development in various programs (SBE) • Faculty Early Career Development (CAREER) Program (NSF-wide) • Research Opportunity Awards (ROAs) for faculty at predominately undergraduate institutions (NSF-wide)	• Integrative Postdoctoral Research Traineeship (IPRT) Program (SBE/EHR) • Postdoctoral Research Fellowships Program (SBE) • Vertical Integration of Research and Education (VIGRE) Awards (SBE/EHR) • Stimulus Package Partnerships for Professional Development (SBE)	• Promote SBE postdoctoral and early career opportunities • Allocate EHR evaluation funds for evaluations as part of postdoctoral training in evaluation research • Convene federal and private funders of SBE postdoctoral training programs • Convene leadership of postdoctoral programs to help design SBE postdoctoral initiative and solicitations • Extend statistical data collection in SBE/SRS to SBE postdoctoral and early career stages • Urge AAAS to include SBE sciences in postdoctoral networks

Diversity	• Explicit access/inclusion of SBE sciences in underrepresented minorities programs in Division of Human Resource Development (EHR)
	  • LSAMP
	  • AGEP
	  • CREST
	  • HBCU-UP
	  • TCUP
	• Programs Directed to Women and Girls
	  • HRD Program in Gender Diversity in Science, Technology, Engineering, & Mathematics Education (EHR)
	  • Advance Program (NSF-wide)
	• Research Experiences for Undergraduates (REU) Program (SBE)
	• Integrative Graduate Education & Research Traineeship (IGERT) Program (NSF-wide)
	• SBE Minority Postdoctoral Research Fellowships & Support Program (SBE)
		• SBE Diversity Innovations Program (SBE/EHR)
		• Launch Awards Program (LAP) for SBE Minority Scholars (SBE)
			• Request CEOSE to review report and diversity recommendations therein
			• Clarify to staff NSF goal of *Integrating Diversity into NSF Program Projects and Activities*
			• Develop NSF incentive program to reward departments enhancing diversity
			• Support preparation of best practices manual for recruiting and retaining SBE minority students
			• Support research on diversity in SBE sciences
			• Urge AAAS to enhance relevance of Minority Scientists Networks to SBE sciences

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Appendix A:

National Workshop Agenda

June 12-13, 2003
Improving Education in the Social, Behavioral, and Economic Sciences: A National Dialogue

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June 12-13, 2003

Renaissance Mayflower Hotel
1127 Connecticut Ave., NW
Washington, DC

AGENDA

Thursday, June 12

8:00-8:30am Registration and Continental Breakfast

(Promenade; outside first floor Grand Ballroom)

8:30-9:00am **Welcome** *(Grand Ballroom until 5:00 p.m. breakouts)*

Norman M. Bradburn
Assistant Director, Directorate for Social, Behavioral, and Economic Sciences, NSF

Judith A. Ramaley
Assistant Director, Directorate for Education and Human Resources, NSF

9:00-9:15am **Goals of the Workshop**

Felice J. Levine
Workshop Co-Chair
Executive Director, American Educational Research Association

Ronald F. Abler
Workshop Co-Chair
Secretary General, International Geographical Union

9:15-9:45am **The Social, Behavioral, and Economic (SBE) Sciences and the Educational Process**

Nancy Cantor
Chancellor, University of Illinois at Urbana-Champaign

Willie Pearson, Jr.
Professor and Chair, School of History, Technology, and Society, Georgia Institute of Technology

9:45-10:00am **Overview of Degree Attainment, Employment, Diversity, and Support in the SBE Sciences**

Wanda E. Ward
Deputy Assistant Director, Directorate for Social, Behavioral, and Economic Sciences, NSF

10:00-10:15am **Break**

10:15-11:15am **Programs and Priorities of NSF's Education and Human Resources Directorate**

Moderator: **Judith A. Ramaley**
Assistant Director, Directorate for Education and Human Resources, NSF

Panelists: **William J. Frascella**
Director, Division of Elementary, Secondary, and Informal Education, NSF

James E. Hamos
Program Director, Math-Science Partnership Program, NSF

Myles G. Boylan
Program Director, Division of Undergraduate Education, NSF

Paul (Wyn) Jennings
Program Director, Division of Graduate Education, NSF

11:15am-12:00pm **Challenges in Education at the K-12 Level**

Moderator: **Ronald F. Abler**
Secretary General, International Geographical Union

Panelists: **Jesus Garcia**
Professor of Education, University of Kentucky
Vice President, National Council for the Social Studies

Margaret M. (Peggy) Altoff
Supervisor of Social Studies,
Colorado Springs, School District 11

12:00-1:00pm **Luncheon with Brief Remarks**

Irwin Feller
Senior Visiting Scientist, American Association for the Advancement of Science; and Professor Emeritus of Economics, Pennsylvania State University

1:00-2:00pm **Undergraduate Research and Scholarship in Diverse Academic Settings: Common Issues; Uncommon Needs**

Moderator: **Felice J. Levine**
Executive Director, American Educational Research Association

Panelists: **Wendy Katkin**
Director, The Reinvention Center, SUNY-Stony Brook

Mark W. Vernoy
Dean, Human Arts and Sciences Division, Palomar College

Jose Zapata Calderon
Professor of Sociology and Chicano Studies, Pitzer College

Pamela E. Scott-Johnson
Chair and Associate Professor of Psychology,
Morgan State University

2:00-2:45pm **Graduate Education: What is Working and What is Not?**

Moderator: **Debra W. Stewart**
President, Council of Graduate Schools

Panelists: **Joan F. Lorden**
Dean, University of Alabama-Birmingham; Dean in Residence, NSF

Joseph R. McGhee
Washington DC Representative, Institute for Global Conflict and Cooperation**,** UC-San Diego

2:45-3:00pm **Break**

3:00-4:00pm **Post Doctoral and Career Development**

Moderator: **James A. Griffin**
Assistant Director for Social, Behavioral, and Education Sciences,
Office of Science and Technology Policy,
Office of the President

Panelists: **Edmund W. Gordon**
Director of the Institute of Urban and Minority Education,
Teachers College of Columbia University

Cora B. Marrett
Senior Vice President for Academic Affairs,
The University of Wisconsin System

4:00-5:00pm **Best Practices Regarding Diversity in the SBE Sciences**

Moderator: **Joyce B. Justus**
Special Assistant to the Chancellor, UC-Santa Cruz

Panelists: **Paula D. McClain**
Professor, Political Science and Law, Duke University
Director, Ralph Bunche Institute

James M. Jones
Professor of Psychology, University of Delaware
Director, American Psychological Association Minority Fellowship Program

Rogelio Saenz
Chair, Department of Sociology, Texas A&M University

5:00-5:15pm **Charge to Breakout Groups**

Attendees will be divided into 4 groups:

K-12: *(North Carolina Room, 2nd Floor)*
Two-Year and Undergraduate: *(New York Room, 2nd Floor)*
Graduate: *(New Jersey Room, 2nd Floor)*
Post-Doc and Career Development: *(Massachusetts Room, 2nd Floor)*

(All groups will be asked to incorporate diversity issues into their deliberations and recommendations.)

5:15-6:00pm **Breakout Groups Meet-n-Greet** *(Same meeting rooms as above)*
(Groups will have the opportunity to meet, go through introductions, and plan how they will address the issues at the next day's breakout sessions.)

6:00-7:00pm **Reception** *(Colonial Room, Lower Lobby Level)*

7:00-8:30pm **Dinner with Featured Speaker** *(Colonial Room, Lower Lobby Level)*

Speaker: **Teresa A. Sullivan**
Executive Vice Chancellor for Academic Affairs
The University of Texas System

Friday, June 13

8:00-8:30am **Continental Breakfast** *(Grand Ballroom, 1st Floor)*

8:30-8:45am **Reiteration of Charge to Breakout Groups**

8:45am-2:00pm **Breakout Groups Meet**

To maximize time spent addressing the issues, groups will be encouraged to take one break and have a working lunch. Lunch will be available beginning at noon. Groups must complete their work and develop a brief (15 min.) presentation of possible ways to address the issues by 2:00pm.

K-12: (*North Carolina Room, 2nd Floor)*
Two-Year and Undergraduate: (*New York Room, 2nd Floor)*
Graduate: (*New Jersey Room, 2nd Floor)*
Post-Doc and Career Development: (*Massachusetts Room, 2nd Floor)*

2:00-2:15pm **Report from the K-12 Group** *(Grand Ballroom, 1st Floor)*

2:15-2:30pm **Report from the Two-Year and Undergraduate Group** *(Grand Ballroom)*

2:30-2:45pm **Report from the Graduate Group** *(Grand Ballroom, 1st Floor)*

2:45-3:00pm **Report from the Post Doctoral and Career Development Group** *(Grand Ballroom, 1st Floor)*

3:00-4:30pm **General Discussion of Recommendations and Plan of Action** *(Grand Ballroom, 1st Floor)*

4:30pm **Adjourn**

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Appendix B:

National Workshop Participants

June 12-13, 2003

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Ronald F. Abler
Secretary General
International Geographical Union

Brant Abrahamson
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Brookfield, IL

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Wanda Ward
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Patricia White
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Sociology and Cluster Coordinator
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National Science Foundation

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Appendix C:

National Workshop Breakout Sessions

June 12-13, 2003

National Science Foundation
Workshop on Improving Education in the Social, Behavioral, and Economic Sciences:
A National Dialogue

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June 12-13, 2003

Breakout Session Strategy and Work Plan

The purpose of the breakout sessions is to generate ideas and recommendations that can be incorporated into a report to the National Science Foundation on a plan of action to improve education and training in the social, behavioral, and economic sciences. Thursday's plenary sessions will put numerous ideas and proposals on the table. The Friday breakout sessions are intended to draw upon the expertise of all participants in developing substantive recommendations and plans for NSF. Come prepared to share ideas, work hard, and write effectively on Friday!

Participants will be divided into four groups at the end of the plenary sessions on Thursday and will meet from 5:15 to 6:00 p.m. to get acquainted and lay out strategies. Most of Friday will be devoted to breakout group deliberations. At the end of the day on Friday, each breakout group will present a fifteen-minute report in a plenary session.

The groups will be organized around the four educational levels that structure the workshop:

1. K-12 Education *(North Carolina Room, 2nd Floor)*
2. Two-Year and Undergraduate Education *(New York Room, 2nd Floor)*
3. Graduate Education *(New Jersey Room, 2nd Floor)*
4. Post Doctoral Education and Career Development *(Massachusetts Room, 2nd Floor)*

All breakout groups should address ways to increase diversity at all levels of the educational process. Also, each group is encouraged to address issues of alignment across educational levels.

Each breakout group will have a designated leader to moderate and guide discussion. We have provided a set of questions to structure each group's deliberations and report (see attached). This outline captures what we believe to be the key components of a plan of action and recommendations to be prepared for NSF. We ask that each group address the seven topics included in the attached generic outline. Each of these topics can be addressed from the vantage of initiatives directed to students, curricula, faculty, and organizational units (e.g., departments). We encourage consideration of these different vantages.

Each group will have a designated reporter who will be provided with a laptop. He or she should capture the group's discussion of the seven outline topics in the form of narrative text and recommendations. This material will be the basis for the reporter's brief comments Friday afternoon. More important, these documents are vital to the preparation of the final report to the NSF.

Breakout Group Discussion and Report Guide

1. What are the key needs for improving education and training in the social and behavioral sciences at your educational level?

2. Based on your collective knowledge, what are some of the best practices (at any educational level) that could make a difference for education and training at your level?

3. What are the impediments to overcome in order to improve social and behavioral science education at your level? Are there distinct opportunities or resources that usefully could be invoked?

4. From what you know about the National Science Foundation's programs, what funding mechanisms might be especially ripe for the fuller integration of the social and behavioral sciences into extant educational initiatives?

5. What initiatives or programs should the National Science Foundation consider establishing to improve social and behavioral science education at your level? What mechanisms or strategies are particularly promising over the next five to ten years (e.g., by discipline, by or across educational levels, or through centers, academic departments, or other organizational units)? Draft the key components of announcement(s) for NSF funding to foster those improvements (avoid operational details).

6. What are the most pressing needs and strategies for diversifying students, faculty, and the scientific workforce (or potential workforce) at your educational level?

7. What outreach strategies are needed to attract and recruit students of diverse backgrounds and aspirations?

8. What training mechanisms should be incorporated into programs to best reach diverse populations?

9. From the perspective of your group's educational level, what key points should be emphasized in the report and recommendations emanating from the workshop?

Improving Education in the Social, Behavioral, and Economic Sciences: A National Dialogue

Breakout Group Chairs and Reporters

K-12 Group
Chair: William Ouchi, University of California, Los Angeles
Reporter: Barbara Schneider, University of Chicago

Two-Year and Undergraduate Group
Chair: Myra N. Burnett, Spelman College, Chair
Reporter: Joseph Joyce, Wellesley College

Graduate Group
Chair: Bernice Pescosolido, Indiana University
Reporter: Edie N. Goldenberg, University of Michigan

Postdoctoral and Career Development Group
Chair: Robert Floden, Michigan State University
Reporter: Kenneth E. Foote, University of Colorado, Boulder

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