

## 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.*<sup>16</sup>

#### 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.<sup>17</sup>

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.<sup>18</sup>

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<sup>16</sup> National Academy of Sciences, *Reshaping the Graduate Education of Scientists and Engineers* (Washington, DC: National Academy of Sciences, 1995).

<sup>17</sup> 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.

<sup>18</sup> 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.<sup>19</sup> 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.<sup>20</sup> 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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<sup>19</sup> 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.

<sup>20</sup> 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.<sup>21</sup> 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.<sup>22</sup>

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.<sup>23</sup> 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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<sup>21</sup> 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.

<sup>22</sup> 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.

<sup>23</sup> 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.<sup>24</sup> 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

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<sup>24</sup> 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,<sup>25</sup> 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.<sup>26</sup> Currently, depending on the participating SBE program, funding ranges from \$5,000 to \$12,000, without stipend support.

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<sup>25</sup> 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.

<sup>26</sup> 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.

## **Education and Training**

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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.<sup>27</sup> 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

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<sup>27</sup> 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.<sup>28</sup> Systematic data, for example, on mentoring, monitoring student progress, career guidance, student-faculty interaction, curriculum strengths and weaknesses, professional development

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<sup>28</sup> 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.