

# SRI International

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## **EVALUATION OF NSF SUPPORT FOR UNDERGRADUATE RESEARCH OPPORTUNITIES: Draft Synthesis Report Executive Summary**

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### Disclaimer

Any opinions, conclusions, or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the United States Government.

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In addition to those SRI staff members listed on the cover, a number of SRI staff provided valuable assistance with various aspects of the study, including obtaining contact information for survey sample members, putting project reports on SRI's Web site, report editing, and project administration. We wish to thank the following current and past SRI staff for their contributions: Catherine Ailes, Denitsa Apostolov, Roland Bardon, Kathryn Baughman, John Benskin, Pernell Brice, Bob Coward, Hal Javitz, Julie Kautz, Klaus Krause, Jongwon Park, Steve Perakis, J. David Roessner, Charles Storey, Lori Szabo, Robin Skulrak, Adrian Tyler, and Lyra Vega.

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The SRI Project Team

## INTRODUCTION

A number of studies have assessed undergraduate research opportunities (UROs), but these are either dated or relatively small in scale, generally being focused on one or a few institutions, a single program, or even a single researcher's experiences. To provide a current and more comprehensive picture, NSF contracted with SRI International to conduct a broad-based, nationwide evaluative study of NSF's support for undergraduate research. The purpose of the study was to understand better the demographic and academic characteristics of undergraduates who participate in UROs nationwide, why individuals (faculty as well as students) choose to participate, the characteristics and components of UROs, the effects of UROs on students' academic and career decisions, and whether different kinds of research experiences are more effective with some types of students than with others (e.g., minorities vs. nonminorities, men vs. women).

The study included four Web-based surveys, conducted between 2003 and 2005 and involving almost 15,000 respondents:

- NSF initial survey: an NSF-program participant survey (undergraduates, graduate students, postdocs, and faculty).
- NSF follow-up survey: 2 years later, a follow-up survey of undergraduate participants in the NSF survey.
- STEM survey: a nationally representative survey of individuals ages 22 to 35 who have received a bachelor's degree in a ("hard") science, technology, engineering, or mathematics (STEM).
- SBES survey: a nationally representative survey of individuals ages 22 to 35 who have received a bachelor's degree in a social, behavioral, or economic science (SBES).

Despite the differences in the populations surveyed, the four surveys produced remarkably consistent results. Across the four surveys, four groups of undergraduates proved to have distinctive characteristics for a wide range of study variables.

- NSF researchers. These were the individuals who were undergraduate respondents to the NSF initial survey and who participated in the NSF follow-up survey.
- Sponsored researchers. These were respondents to the STEM and SBES surveys who reported that at least some of their research, as far as they knew, was sponsored by NSF, the National Aeronautics and Space Administration (NASA), or the National Institutes of Health (NIH). Sponsored researchers, especially those in STEM fields, tended to be more similar to the NSF researchers than to their nonsponsored counterparts. Sponsored researchers comprised 7% of STEM graduates and 5% of SBES graduates.
- Nonsponsored researchers. These were respondents to the STEM and SBES surveys whose research was not (as far as they knew) sponsored by NSF, NASA, or NIH. Nonsponsored researchers comprised 46% of STEM graduates and 47% of SBES graduates.

- Nonresearchers. These were respondents to the STEM and SBES surveys who did not participate in undergraduate research. Nonresearchers comprised 47% of STEM graduates and 48% of SBES graduates.

## MAJOR FINDINGS

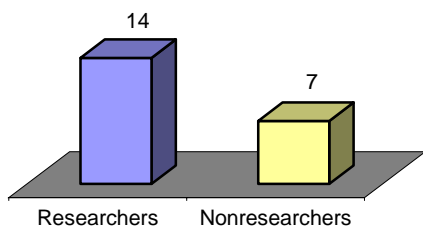
### Tracking Undergraduate Researchers

Respondents to the NSF follow-up survey differed significantly from nonrespondents on a number of the questions in the initial survey. For example, compared with nonrespondents, follow-up survey respondents were more likely to be non-Hispanic whites (65% vs. 50%), to expect to obtain a PhD (50% vs. 36%), and to have been interested in STEM since childhood (62% vs. 51%). Fortunately, the high response rate (74%) to the follow-up survey minimized the effect of these differences on the overall profile of undergraduate researchers. These findings point up both the difficulty of obtaining unbiased data in longitudinal studies and the importance of high response rates in minimizing the potentially biasing effects.

### Profile of Undergraduate Researchers

About half of STEM and SBES graduates reported that they participated in hands-on research while they were undergraduates; as noted above, 7% and 5%, respectively, were sponsored researchers. The efforts of NSF and other entities to encourage the representation of historically underrepresented groups, such as women, blacks, and Hispanics/Latinos, appear to have been effective. In all our surveys, SRI found that undergraduate researchers were demographically diverse, with women, blacks, and Hispanics/Latinos represented at rates at least equivalent to their rates in the college population. Also, rather surprisingly, rates of participation (as reported by STEM and SBES graduates) were not very different across the major types of 4-year institutions (doctoral/research extensive, doctoral/research intensive, master's, and baccalaureate). Also, those who began their undergraduate education at a 2-year school were as likely to participate in research as those who started at a 4-year school. There were, however, large differences in research participation rates across the various STEM disciplinary fields: from 34% in mathematics and 37% in computer sciences to 72% in chemistry and 74% in environmental science.

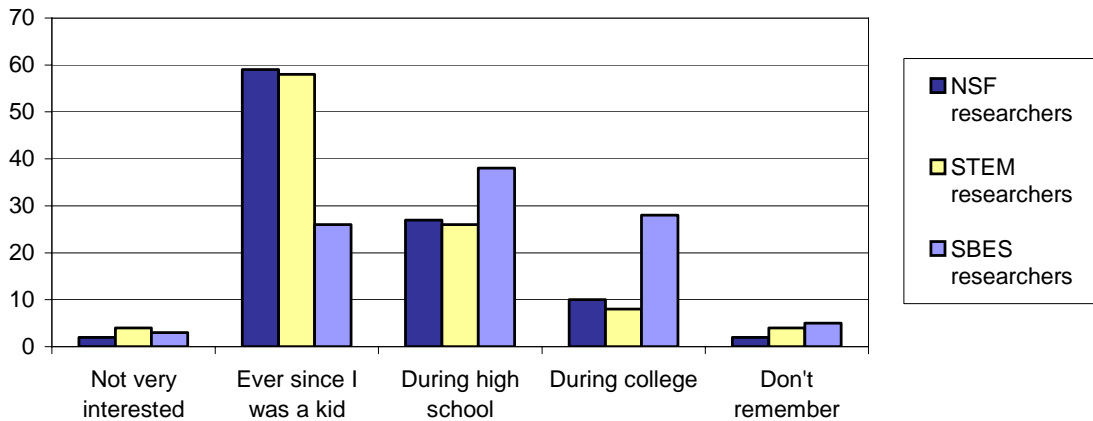
**Percentage of STEM Graduates Who Had Pre-College Expectations of Obtaining a PhD**



Source: SRI International: STEM survey, 2003.

Academically, undergraduate researchers were disproportionately juniors and seniors, and they tended to be high achievers, with relatively high grade point averages and early expectations of obtaining an advanced degree. The STEM survey, for example, found that those who participated in undergraduate research were twice as likely as those who did not do research to have pre-college expectations of obtaining a PhD. STEM and NSF researchers' interest in STEM was likely to have begun in childhood, suggesting that the most effective time to begin attracting students to STEM may well be while they are in elementary school.

### Origins of Researchers' Interest in STEM/SBES

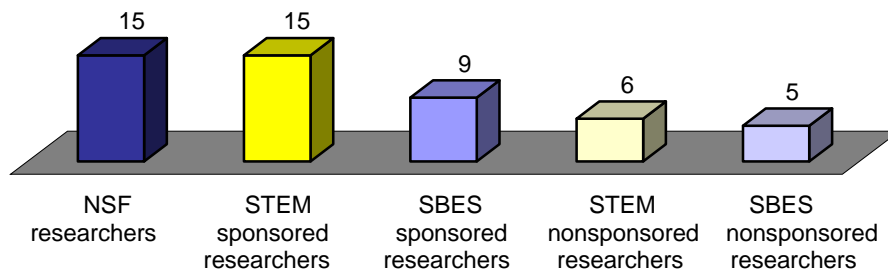


Sources: SRI International: NSF initial survey, 2003; STEM survey, 2003; SBES survey, 2004.

### Undergraduate Research Characteristics and Activities

NSF and other sponsored research was distinctive in its emphasis on summer research programs in which groups of undergraduates participated in 8- to 10-week summer programs, usually at schools other than their own. Most sponsored researchers also participated in research during the academic year. In contrast, few nonsponsored researchers participated in summer programs, and they were similarly unlikely to have participated in research at some location other than their own college or university. NSF and STEM/SBES sponsored researchers also tended to spend more time engaged in undergraduate research than did nonsponsored researchers and to have participated in a greater variety of activities. Among all groups, common research-related activities/experiences were collecting/analyzing data, having input to research decisions, having a choice of projects, and being able to complete one's project.

### Median Months of Undergraduate Research

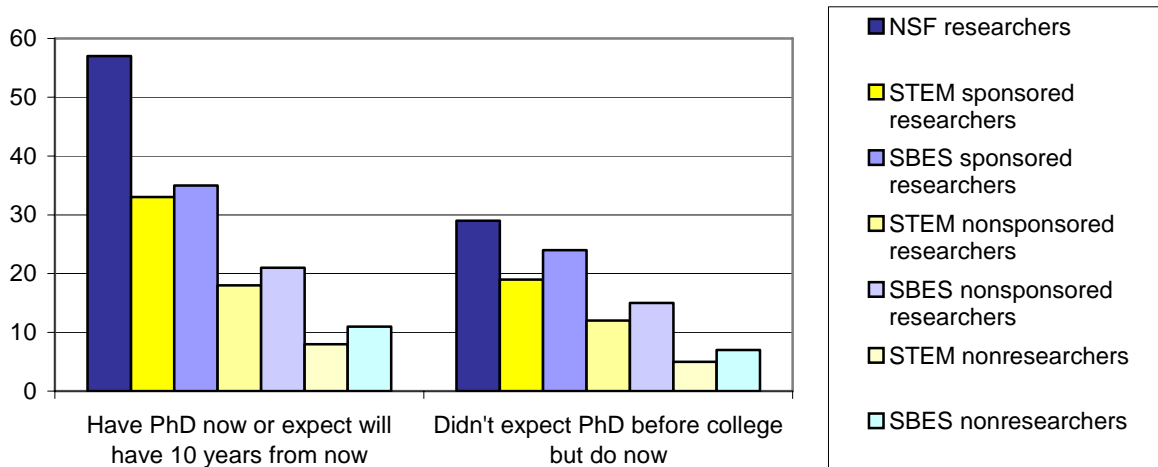


Sources: SRI International: STEM survey, 2003; SBES survey, 2004; NSF follow-up survey, 2005.

### Undergraduate Research Outcomes

The survey findings supported academicians' and researchers' widely held beliefs in the positive effects of UROs. UROs increased the likelihood of obtaining a PhD, and they had strongly positive effects on participants' understanding of the research process, confidence in their research-related abilities, awareness of academic and career options in STEM, and changes in interest in STEM/SBES careers. At the same time, we found support for anecdotal reports of how undergraduate research participation shows some students that research is not what they

**Percentage of Each Group Who Have/Expect a PhD**



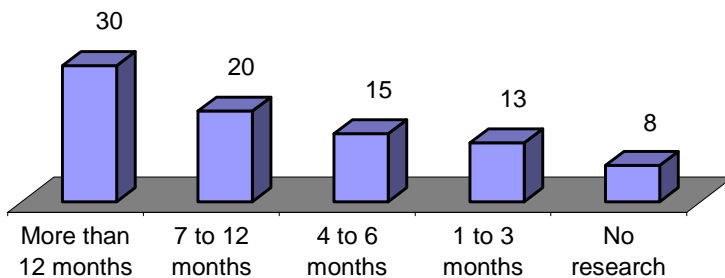
Sources: SRI International: STEM survey, 2003; SBES survey, 2004; NSF follow-up survey, 2005.

want to do after all: in the NSF follow-up survey, about one in six respondents reported that one of the things they learned from their undergraduate research was that “research is not for me.”

In contrast to their very positive reports of the research experiences themselves, researchers tended to believe that they were not very well informed about UROs, especially those at places other than their own school. The NSF follow-up survey also found that, when researchers first enrolled as undergraduates, only half were aware that the school offered undergraduate research, and, of those who were aware, only about half said that UROs were fairly or extremely important in their decision to enroll. These findings suggest that better dissemination of information about UROs is essential if undergraduate research is to achieve its greatest potential impact.

Broadly speaking, students who participated in research because they were truly interested and who became involved in the culture of research—attending conferences, mentoring other students, authoring journal papers, and so on—were the most likely to experience positive outcomes. Not surprisingly, the overall duration of research experiences and the variety of research activities also were strongly related to positive outcomes. For example, in the STEM survey, 30% of researchers with more than 12 months of research experience reported that they expected to obtain a PhD, compared with only 13% of those with 1 to 3 months of research experience.

**Percentage Who Expect to Obtain a PhD, by Duration of Undergraduate Research Experiences: STEM Graduates Survey**



Source: SRI International: STEM survey, 2003

Although we found little evidence of a relationship between mentors and research outcomes in our structured questions, by far the most common suggestions that students made about how to improve undergraduate research programs concerned increased and more effective faculty guidance. Thus, it seems likely that mentors who are able to combine enthusiasm with interpersonal,

organizational, and research skills play a key role in facilitating positive outcomes.

Key findings with regard to differences in research-experience effects were as follows:

- Effects tended to be stronger among sponsored than nonsponsored researchers. These differences were partly, but not entirely, explained by the longer duration of research participation by the former.
- We found no evidence of a superiority of summer programs over academic-year programs, or vice versa. (Note, however, that for most NSF researchers, this distinction is moot because they participated in research during both the summer and the academic year.)
- There were few appreciable differences in effects among graduates of different types of schools or between those who began their undergraduate education at a 2-year college and those who began at a 4-year school.
- Among racial/ethnic groups, effects tended to be strongest among Hispanics/Latinos and weakest among non-Hispanic whites, but most racial/ethnic-group differences were small. There were almost no differences on any of the study variables between men and women.
- There was no evidence that minorities benefited more from same-race/ethnicity mentors than from those of a different race/ethnicity or that women benefited more from female than from male mentors. However, over time, having a diverse group of mentors (in terms of their race/ethnicity and sex) appeared to be mildly beneficial to all respondents.

## **Mentor Perceptions**

Personal satisfaction—much more than career or research factors—appeared to be the driving force behind most faculty participation in undergraduate research. In the NSF initial survey, about 7 in 10 faculty mentors agreed that “I get a lot of personal satisfaction out of working with undergraduates doing research.” In contrast, fewer than 4 in 10 agreed that “Mentoring undergraduates is viewed favorably in my department’s tenure/promotion review process.” Lack of adequate financial support was seen as the greatest barrier to increasing the number of undergraduate researchers in NSF centers and Research Experiences for Undergraduates (REU) Sites.

## **RECOMMENDATIONS**

Our surveys provide strong evidence that undergraduate research programs help to keep students interested in STEM and SBES careers both inside and outside of academia and to motivate them to pursue advanced degrees. Nevertheless, there remains room for enhancement. Below is a summary of SRI’s suggestions.

- Survey findings suggest that the most effective time to begin attracting students to STEM may well be while they are in elementary school. If attempts to increase the U.S. STEM workforce are to be successful, it would appear that increased support of K-12 inquiry-based STEM curriculum and summer activities is essential.
- NSF should work to provide more and better information about UROs to potential participants:

- Improve the quality, quantity, timeliness, and accessibility of information about NSF-funded UROs that is available on the NSF Web site. For example, consider developing a comprehensive searchable Web-based registry of all NSF-sponsored UROs, classified by discipline, setting, and duration.
- Encourage colleges and universities to find ways to share information about UROs with their students and students from other schools.
- Provide information about UROs to NSF programs that target K-12 students, to promote early awareness of UROs.
- Given the strong positive relationship between the duration of research participation and positive research outcomes, we recommend that NSF encourage its PIs to find ways to include college freshmen and sophomores in their research programs.
- SRI's analyses suggest that being an active participant in the culture of research—as evidenced through choosing to participate because it seemed to be fun, gaining independence, attending conferences, understanding the “big picture,” and so on—was more strongly related to positive outcomes than having completed assignments such as research proposals, reports, or poster presentations. Accordingly, we suggest that NSF encourage PIs of undergraduate research projects to focus more on generating enthusiasm and involving undergraduates in the *culture* of research than on requiring them to complete specific research-related assignments.
- We suggest that NSF help to make mentoring more effective in several ways:
  - Encourage and fund mentor workshops for both new and experienced mentors.
  - Commission booklets on mentoring that can be sent to all grantees of undergraduate research projects.
  - Sponsor and publicize blogs on mentoring, accessible by all active grantees.
  - Use the Foundation's funding leverage to encourage colleges and universities to recognize mentoring as a factor in promotion and tenure decisions.
- NSF currently encourages REU PIs to evaluate what their participants have learned in their REU experience and how their perspectives on STEM have been expanded. PIs also would be well served by obtaining feedback directly related to how their projects might be improved. Accordingly, NSF should recommend that project evaluations include questions about participants' perceptions of project strengths and weaknesses and requests for suggestions about project improvements.
- NSF currently recommends that REU Site PIs track their participants beyond graduation to find out what effect the REU program had on them. We suggest that NSF discontinue this recommendation, for the following reasons:
  - PI efforts to track past participants are likely to produce biased, unscientific findings because participants who are easy to track are likely to be quite different from those who are more difficult to track.

- Most undergraduate researchers participate in a variety of research activities, so follow-up is unlikely to be able to reliably discern the unique effect of a single project.
- Career path information is better obtained through large-scale studies such as this one, with sample sizes that allow for a variety of multivariate analyses and subgroup comparisons.