

# SRI International

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## **EVALUATION OF NSF SUPPORT FOR UNDERGRADUATE RESEARCH OPPORTUNITIES: Follow-up Survey of Undergraduate NSF Program Participants**

### **Draft Final Report**

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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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The SRI Project Team

# CONTENTS

## EXECUTIVE SUMMARY

### I. OVERVIEW

Introduction.....	1
Major Study Components .....	1
Inventory of UROs.....	1
Site Visits .....	2
Initial NSF Program Participant Survey .....	2
Surveys of STEM and SBES Graduates .....	2
NSF Student Follow-up Survey .....	3
Initial NSF Survey and Follow-up Survey: Study Methods .....	3
Survey Design and Sampling Strategy .....	3
Survey Data Collection .....	4
Data Cleaning and Weighting .....	5
Differences between Respondents and Nonrespondents to the Follow-up Survey .....	6
Reporting.....	6

### II. NSF PROGRAMS INCLUDED IN THE STUDY

Research Experiences for Undergraduates (REU) Sites and Supplements .....	8
REU Sites.....	8
REU Supplements.....	11
NSF-Funded Research Centers .....	12
Research in Undergraduate Institutions (RUI) .....	12
Historically Black Colleges and Universities Undergraduate Program (HBCU-UP) .....	13
Tribal Colleges and Universities Program (TCUP) .....	13
Louis Stokes Alliance for Minority Participation (LSAMP) Program .....	14
Cooperative Activity with Department of Energy Education Programs (DOE).....	15
Grants for Vertical Integration of Research and Education in the Mathematical Sciences (VIGRE).....	15

### III. PROFILE OF UNDERGRADUATES WHO PARTICIPATED IN NSF-FUNDED RESEARCH

Demographic Characteristics .....	17
Academic Characteristics.....	18
Academic Status.....	18
Undergraduate Academic Major and Graduate Field of Study .....	18
High School Class Ranking and Undergraduate Grade Point Average (GPA) .....	20
Types of Undergraduate and Graduate Institutions .....	20

	Employment Characteristics of Nonstudents.....	21
	Overview of NSF Undergraduate Researcher Profile.....	22
<b>IV.</b>	<b>CHARACTERISTICS AND ACTIVITIES OF UNDERGRADUATE RESEARCH EXPERIENCES</b>	
	Types of Research Experiences .....	23
	Research Activities .....	24
	Awareness of NSF Program Support.....	26
	Mentor Race/Ethnicity and Sex .....	26
	Overview of Undergraduate Research Characteristics and Activities .....	27
<b>V.</b>	<b>STUDENT PERCEPTIONS AND RESEARCH OUTCOMES</b>	
	Availability of Research Opportunities .....	29
	Adequacy of Interactions with Mentors.....	30
	Overall Satisfaction with Undergraduate Research .....	31
	Gains in Understanding, Confidence, and Awareness.....	31
	What Research Taught Students about Themselves .....	34
	Importance of Undergraduate Research in Academic and Career Decisions and Interests.....	37
	Choice of Baccalaureate School .....	37
	Graduate School Decisions .....	37
	Career Decisions .....	37
	Changes in Interest in Various Careers.....	38
	Highest Degree Expectations.....	39
	Overview of Student Perceptions and Research Outcomes.....	41
<b>VI.</b>	<b>CORRELATES OF UNDERGRADUATE RESEARCH OUTCOMES</b>	
	Relationships among Outcome Measures.....	43
	Relationships between Outcomes and Research Experience Characteristics .....	47
	Relationships between Outcomes and Reasons for Participating in Research .....	47
	Relationships of Mentors' Race/Ethnicity and Sex to Undergraduate Research Outcomes .....	48
	Overview of Correlates of Undergraduate Research Outcomes .....	49
<b>VII.</b>	<b>STUDENT SUGGESTIONS FOR URO IMPROVEMENTS</b>	
	More or Better Interaction with Mentors .....	50
	Better Project Organization.....	51
	More Student Input/Independence.....	51
	Research Content Issues: More “Real” Research; Research on Important Issues.....	51
	More Effective Dissemination of Information about UROs.....	52
	More/Earlier UROs.....	53
	More Information about Graduate School and STEM Careers .....	53

## **APPENDICES (provided as separate documents)**

A. Survey questionnaire

B. Tables of survey responses by:

1. NSF program
2. Carnegie classification of baccalaureate institution
3. Undergraduate major
4. Academic status
5. Race/ethnicity
6. Sex

# EXECUTIVE SUMMARY

## INTRODUCTION

This report is one of several prepared by SRI International (SRI) under a contract to the National Science Foundation (NSF) to conduct a broad-based, nationwide evaluative study of NSF's support for undergraduate research. The purpose of the study is to understand better the demographic and academic characteristics of undergraduates who participate in undergraduate research opportunities (UROs) nationwide, why individuals choose to participate, the characteristics and components of UROs, and UROs' effects on students' academic and career decisions.

The major components of the study are listed below. Reports on the first five have already been submitted. The sixth component is the subject of this report.

- An inventory of UROs provided by public and private institutions in the United States.
- Site visits to selected research institutions that provide UROs.
- A 2003 survey of student and faculty participants in UROs funded by NSF.
- A 2003 survey of individuals ages 22 to 35 who have received a bachelor's degree in a so-called "hard" science, technology, engineering, or mathematics (STEM).
- A 2004 survey of individuals ages 22 to 35 who have received a bachelor's degree in a social, behavioral, or economic science (SBES).
- A 2005 follow-up survey of the undergraduates who participated in the 2003 NSF survey.

This executive summary describes the major results of the follow-up survey, which included approximately 3,300 individuals. The sample for this survey comprised all undergraduate respondents to the initial NSF program participant survey (henceforth, the initial participant survey or the initial survey). Respondents were asked about their current employment and academic status, the kinds of research experiences they had during all their undergraduate years to date, and the effects of those experiences on their decisions about careers and academic degrees. The major purpose was to assess medium-term outcomes of the students' 2002-03 research experiences.

Respondents to the initial NSF survey were selected through a stratified random sample of active NSF awards in which undergraduate research was a major component.<sup>1</sup> All undergraduates who participated in the initial survey were recruited for participation in the follow-up survey. Both surveys were administered online, with e-mail notification and reminders. Sample members with no e-mail addresses were sent hard copies of the questionnaire. A total of 4,560 individuals responded to the initial survey; 3,298 responded to the follow-up survey.

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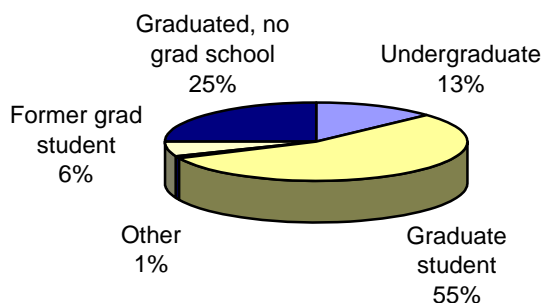
<sup>1</sup> See the initial survey report for a detailed description of the study methods: S.H. Russell, *Evaluation of NSF Support for Undergraduate Research Opportunities: 2003 NSF-Program Participant Survey*, report to the National Science Foundation. June 2005. Arlington, VA: SRI International. The report is available online at <http://www.sri.com/policy/csted/reports/university/index.html/#uro>.

## MAJOR SURVEY FINDINGS

### Academic and Employment Status

*Most respondents had attended or were attending graduate school.*

#### Academic Status of Follow-up Survey Respondents



Source: SRI International: NSF follow-up survey, 2005.

At the time of the initial survey, more than 6 in 10 undergraduate researchers were seniors. At the time of the follow-up survey, 13% were still undergraduates, and 55% were in graduate school. Among those in graduate school, 71% were expecting to obtain a PhD, 13% were expecting a master's degree, 13% were expecting an MD, and 8% were expecting some other degree. Among the few who were former graduate students, 62% had received a master's degree, and 38% had completed some graduate work but not received an advanced degree.

Among graduate students expecting a PhD, the most common fields were life sciences (21%), physics (14%), engineering (14%), and interdisciplinary sciences (13%). Among current graduate students not expecting a PhD, the dominant field was health sciences/medicine (40%); among former graduate students, the dominant field was engineering (37%).

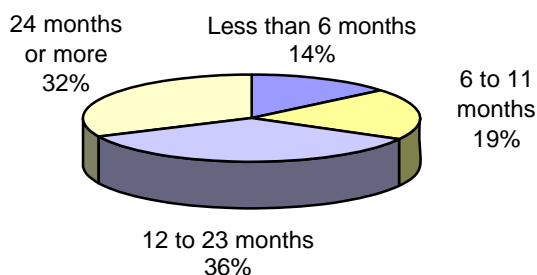
*Most employed nonstudents were using skills learned doing undergraduate research.*

At the time of the follow-up survey, two-thirds of the respondents were employed either full-time (43%) or part-time (22%). About 6 in 10 of these were also in school. Among those not still in school, half were employed by for-profit companies, other than for-profit medical or research organizations. The next-largest employment sectors were colleges or universities (15%), nonmilitary government (14%), and research organizations (11%). About 8 in 10 reported that their job was at least somewhat related to their undergraduate major and that they used skills learned doing undergraduate research in their job; more than 6 in 10 said their job involved science/math research or engineering (64%).

### Types and Duration of Undergraduate Research Experiences

*Most respondents had relatively long and varied research experiences.*

#### Duration of Undergraduate Research



Source: SRI International: NSF follow-up survey, 2005.

Two-thirds participated in research for 12 months or more, and more than 8 in 10 participated in research during both the summer and the academic year. Among baccalaureate degree recipients, those currently attending graduate school and expecting to obtain a PhD tended to have more research experience than others. For example, 40% of graduate students who expected to obtain a PhD participated in research for at least 24 months, compared with 26% of other graduates.

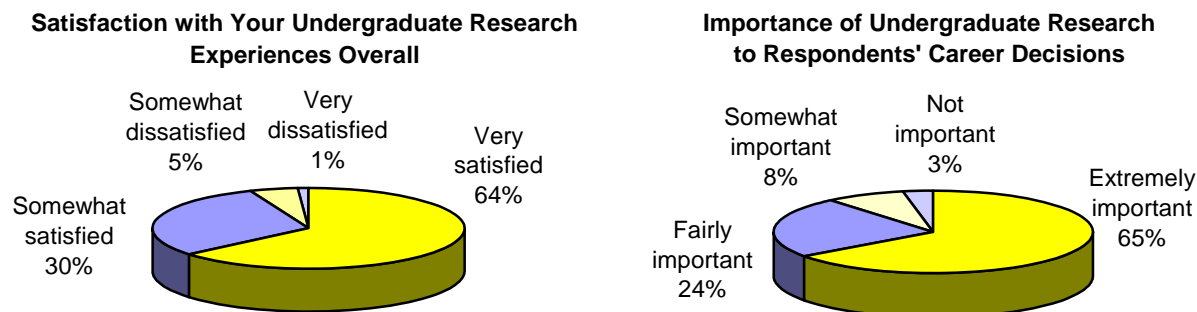
## Perceptions of Research Opportunities and Experiences

*Opportunities for research tended not to be important in selection of an undergraduate institution, but research experiences were important in graduate school decisions.*

At the time they first enrolled, about half of the respondents knew that their baccalaureate institution offered UROs, and of those, slightly more than half—or only about a fourth of all respondents—said that the UROs were fairly or extremely important in their decision to enroll. In contrast, a majority of PhD-bound graduate students said that their undergraduate research experiences had a strong influence on their graduate school decisions.

*Students had very positive perceptions of their research experiences.*

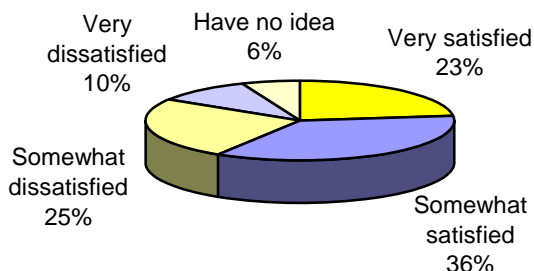
Most students were very satisfied overall with their undergraduate research experiences; felt that they had about the right amount of interaction, support, and guidance from their mentors; and felt they gained confidence in their research-related abilities, understanding of the research process, and awareness of academic and career options in STEM. Concomitantly, most felt that their interest in STEM and research careers increased as a result of their research experiences, and almost all reported that their research experiences influenced their career decisions.



Source: SRI International: NSF follow-up survey, 2005.

*Compared with satisfaction with research experiences, satisfaction with the variety of UROs and availability of information about UROs was relatively low.*

**Satisfaction with How Well You Were Informed about UROs at Places Other Than Your Own College**



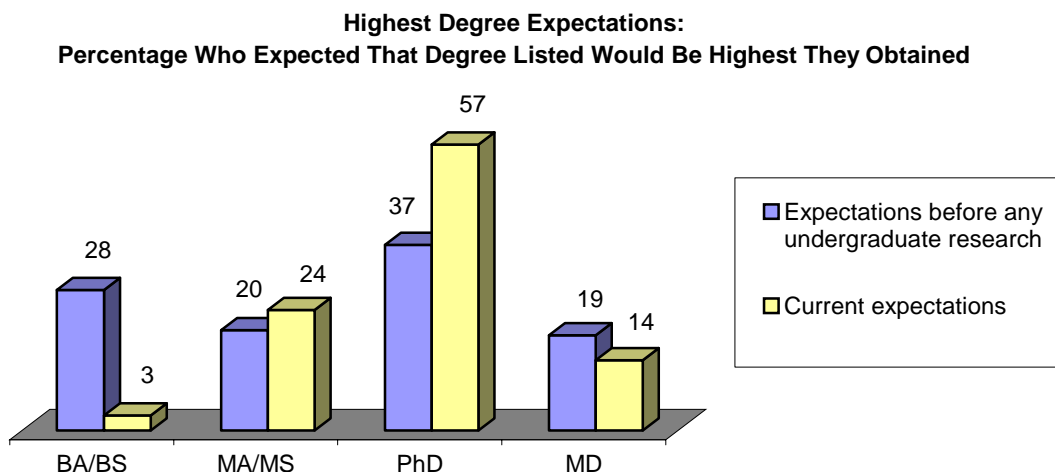
Source: SRI International: NSF follow-up survey, 2005.

Four in 10 respondents or fewer reported that they were very satisfied with the variety or relevance of the UROs at their school or with the availability of information about them. Satisfaction with the availability of information about UROs at places other than one's school was even lower, with only about a fourth indicating they were very satisfied.

## Highest Degree Expectations

*Academic degree expectations were higher after participation in undergraduate research.*

Comparing reports of highest degree expected before research participation and at the time of the survey, we found that the percentages of respondents who expected that a bachelor's degree would be their highest degree fell substantially and those who expected that an MD would be their highest degree fell slightly, whereas the percentage who expected a PhD increased substantially. Moreover, 29% had "new" expectations of obtaining a PhD (that is, they did not have pre-research expectations of obtaining a PhD, but they now expect to obtain one).



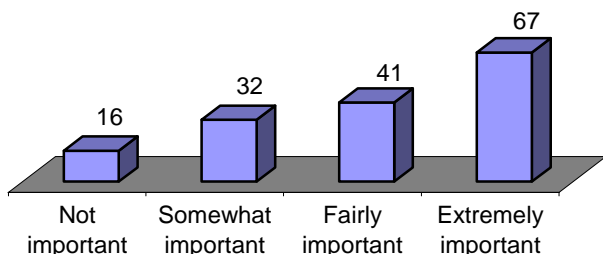
Note: PhD and MD categories include those who said "MD or PhD (not sure which)" or "MD and PhD (both)."  
Source: SRI International: NSF follow-up survey, 2005.

Chemistry, math, and physics majors were the most likely to expect to obtain a PhD; computer science and engineering majors were the least likely to do so. There were only small differences among racial/ethnic groups on these measures and no statistically significant differences between men and women.

## Correlates of Undergraduate Research Outcomes

*Expectations of obtaining a PhD were strongly related to increased interest in STEM and research careers and to the perceived importance of undergraduate research to one's career decisions.*

**Percentage Who Expect to Obtain a PhD within the Next 10 Years, by Importance of Undergraduate Research to Respondent's Career Decision**



Two-thirds of those who said research was extremely important to their career decision expected to obtain a PhD, compared with 16% of those who said research was not important to their career decision. Similarly, 48% of current PhD-bound graduate students said that their interest in a research career increased a lot, compared with 14% to 20% of other graduates. Surprisingly, however, expecting to

obtain a PhD was not strongly related to gains in STEM-related understanding, confidence, or awareness.<sup>2</sup> There also were no appreciable differences on these gains among the academic-status groups. Thus, for example, among those who had received their bachelor's degree, PhD-bound graduate students did not have appreciably higher gains than did those who had not been to graduate school.

***Students who became involved in the culture of research tended to have the most positive outcomes.***

Research experience characteristics that tended to be the most strongly related to the study's various measures of research outcomes were number of research activities, total duration of the research experience, gaining increasing independence, and mentoring other student researchers or leading a student research team, attending conferences, authoring or co-authoring a paper submitted for publication in a professional journal, and understanding the context of one's research. Generally speaking, however, these variables were more strongly related to perceived gains in confidence and understanding and to increased interest in STEM and research careers than to PhD expectations or academic status.

***Research participation seems most likely to be an effective motivator when it is done voluntarily and out of a genuine interest.***

Respondents for whom personal enthusiasm was an important reason for research participation and those for whom needing help with a career decision was important<sup>3</sup> tended to report higher gains and to be more likely to expect to obtain a PhD than did those for whom these were not important motivations. Engaging in undergraduate research for financial reasons, to meet academic requirements, or because of personal connections was not related to the outcome measures.

***Having a mix of mentors (in terms of their sex and race/ethnicity) was mildly beneficial for all students, not just women and minorities.***

Respondents who had both male and female mentors or both same- and different-race/ethnicity mentors tended to have slightly "better" outcomes (e.g., higher confidence gains) than did those who had either only "same" or only "different" mentors. Statistically significant differences were as common among men as among women and more common with non-Hispanic whites than with minorities.

***Talented, committed mentors probably play a key role in creating positive undergraduate research outcomes.***

Responses to the survey's structured questions about the amount and sufficiency of mentor interaction, support, and guidance were not appreciably related to PhD expectations or to increased interest in STEM or research careers. However, by a considerable margin, students' most common suggestions about how to improve undergraduate research programs had to do with increased and more effective faculty guidance, including a significant commitment of time, enthusiasm for mentoring, organizational skills, and an ability to develop or help students

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<sup>2</sup> As measured by indices that were derived from three or more attitude items asking the extent to which the respondent's undergraduate research experiences increased their confidence, understanding, and awareness on various STEM-related dimensions.

<sup>3</sup> These were indices created from questions in the initial survey that asked respondents to rate the importance of each of 21 factors in their decision to participate in undergraduate research.

develop interesting and doable projects. Some respondents suggested that mentors receive training or that mentoring guidelines be established.

## **SUMMARY OF URO EFFECTS**

This follow-up survey, conducted 2 years after the initial survey, confirmed the initial survey's findings of a variety of significantly positive effects of undergraduate research. As in the initial survey, there tended to be only small differences among racial/ethnic groups and few differences at all between men and women. Respondents—men as well as women and non-minorities as well as minorities—who had both male and female mentors or both same- and different-race/ethnicity mentors tended to have slightly “better” outcomes (e.g., higher confidence gains) than did those who had either only “same” or only “different” mentors. 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 papers, and so on—were the most likely to experience positive outcomes. Mentors who combine enthusiasm with research, interpersonal, and organizational skills are probably key.

# I. OVERVIEW

## INTRODUCTION

This report is one of several prepared by SRI International (SRI) under a contract to the National Science Foundation (NSF) to conduct a broad-based, nationwide evaluative study of NSF's support for undergraduate research. The purpose of the study is to understand better the demographic and academic characteristics of undergraduates who participate in undergraduate research opportunities (UROs) nationwide, why individuals choose to participate, the characteristics and components of UROs, and UROs' effects on students' academic and career decisions.

## MAJOR STUDY COMPONENTS

The major components of this study are:

- An inventory of UROs provided by public and private institutions in the United States.
- Site visits to selected research institutions that provide UROs.
- A 2003 survey of student and faculty participants in UROs funded by NSF.
- A 2003 survey of individuals ages 22 to 35 who have received a bachelor's degree in a so-called "hard" science, technology, engineering, or mathematics (STEM).
- A 2004 survey of individuals ages 22 to 35 who have received a bachelor's degree in a social, behavioral, or economic science (SBES).
- A 2005 follow-up survey of the undergraduates who participated in the 2003 NSF survey.

The focus of this report is the follow-up survey. Reports on each of the other study components have been prepared and submitted to NSF previously, and a report summarizing all the data collection efforts will be submitted in 2006. Each of the study components is described briefly below.

### Inventory of UROs

The first major task of the study was the compilation of an inventory of the kinds of UROs that are supported by NSF and other government and nongovernment entities in the United States.<sup>4</sup> The primary focus of the inventory was on undergraduate research in STEM, particularly the disciplines that are supported by NSF. The focus was also on programs and organizations that themselves fund UROs, as opposed to programs and organizations that provide such experiences for undergraduates with funding from other sources. The inventory is organized first by type of sponsoring organization: NSF, other federal agencies, foundations, and industry. Each organization's list is ordered by the amount of funding it provides for undergraduate research, insofar as it is possible to determine, and according to how specifically and/or determinably the programs provide an actual research experience. Finally, there is a cross-cutting element that distinguishes those programs that are generic (open to all groups) from

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<sup>4</sup> C.A. Ailes *et al.*, *Evaluation of NSF Support for Undergraduate Research Opportunities: Inventory of Undergraduate Research Opportunities*, report to the National Science Foundation. December 2003. Arlington, VA: SRI International.

those that are targeted, sometimes geographically but generally to racial/ethnic groups that are underrepresented in science and engineering careers.

## Site Visits

Primarily to help guide development of the survey questionnaires, SRI conducted site visits to 20 institutions that provide research opportunities for undergraduates.<sup>5</sup> Institutions were selected to provide diversity in terms of types of students served, academic field of research, geographic location, and types of NSF awards supporting undergraduate research. To include both summer and academic-year (fall to spring) participants, some visits were conducted during the summer and others were conducted during the regular academic terms. Interviews and focus groups were conducted with principal investigators (PIs), other faculty mentors, graduate student mentors, and undergraduates currently participating in research. For the most part, individual interviews were conducted with faculty, and group interviews were conducted with undergraduates and graduate students.

## Initial NSF-Program Participant Survey

Conducted in fall 2003 mostly through Web-based questionnaires, the NSF-program participant survey included more than 4,500 undergraduates, 800 graduate-student/postdoc mentors, and 2,200 PIs and other faculty mentors who participated in more than 1,000 active NSF awards between June 2002 and May 2003.<sup>6</sup> Respondents were asked about the undergraduate research experiences they had during either summer 2002 or the 2002-03 academic year (fall through spring). Undergraduates were asked about their reasons for participating, the kinds of activities in which they engaged, areas of satisfaction and dissatisfaction with the research experience, and perceived effects of the experiences. Graduate students, PIs, and faculty mentors were asked questions that paralleled many of those asked of the undergraduates, as well as questions on their attitudes about involving undergraduates in research and undergraduate mentoring needs.

## Surveys of STEM and SBES Graduates

The surveys of STEM and SBES graduates involved nationwide samples of approximately 3,400 and 3,200 individuals, respectively.<sup>7</sup> Respondents were limited to individuals ages 22 to 35 who have received a STEM/SBES bachelor's degree. Respondents were asked whether they had participated in any UROs and, if so, about the nature of those experiences and the effects of those experiences on their decisions about careers and academic degrees.

The overall purpose of these surveys was to provide a longer-term and broader perspective on the academic and career effects of undergraduate research than could be provided from a survey limited to current URO participants and to UROs sponsored by NSF. A sample derived from award- or institution-based lists of past participants in UROs was considered and rejected because of the difficulty and high cost of locating individuals and, especially, because those who are located in such efforts tend to be disproportionately in academia. In a study of the effects of

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<sup>5</sup> C.A. Ailes *et al.*, *Evaluation of NSF Support for Undergraduate Research Opportunities: Site Visit Report*, report to the National Science Foundation. October 2003. Arlington, VA: SRI International.

<sup>6</sup> The report is available online at <http://www.sri.com/policy/csted/reports/university/index.html#uro>.

<sup>7</sup> The reports are available online at <http://www.sri.com/policy/csted/reports/university/index.html#uro>.

UROs on career and academic decisions, such a bias would have seriously damaged the validity of the results.

## NSF Undergraduates Follow-up Survey

The 2005 follow-up survey is the focus of this report. The sample for this survey comprised all undergraduate respondents to the initial NSF-program participant survey (henceforth, the initial NSF survey or the initial survey). Respondents were asked about their current employment and academic status, the kinds of research experiences they had during all their undergraduate years to date, and the effects of those experiences on their decisions about careers and academic degrees. The major purpose was to assess medium-term outcomes of the students' 2002-03 research experiences and to compare those outcomes with the near-term outcomes reported in the initial survey.

To limit readers' need to refer back to the report on the initial survey, we have included in this report some of the information that was provided in the earlier report, such as descriptions of the survey methods, summaries of the NSF programs that were included in the study, and an overview of the academic and demographic characteristics of the undergraduates who participated in the programs.

## INITIAL NSF SURVEY AND FOLLOW-UP SURVEY: STUDY METHODS

### Survey Design and Sampling Strategy

**Initial survey.** The design for the initial survey called for surveying participants in NSF awards that were active either during summer 2002 or the 2002-03 academic year. At the outset, the survey included the following NSF programs:

- Research Experiences for Undergraduates (REU) Sites and Supplements
- NSF-sponsored research centers that include a significant undergraduate research component, identified by NSF as all Engineering Research Centers (n=18), all Materials Research Science and Engineering Centers (n=25), and 16 other centers, laboratories, and observatories<sup>8</sup>
- Research in Undergraduate Institutions (RUI).

Random samples of REU and RUI awards were selected for participation in the survey. Generally speaking, the sampling strategy was to obtain a diverse group of awards across the four types of awards, primarily undergraduate institutions (PUIs) vs. non-PUIs, and NSF directorates/divisions. All 59 centers were included.

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<sup>8</sup> Center for Adaptive Optics; Center for Cosmological Physics; Center for Ecological Analysis and Synthesis; Cornell High Energy Synchrotron Radiation Laboratory; Laser Interferometer Gravitational Wave Observatory; Nanoscale Science and Engineering Center: Science of Nanoscale Systems and Their Device Applications; Nanoscale Science and Engineering Center: Center for Biological and Environmental Nanotechnology; National Astronomy and Ionosphere Center; National Center for Network Engineering; National High Magnetic Field Laboratory; National Optical Astronomy Observatories; National Radio Astronomy Observatory; National Superconducting Cyclotron Laboratory; Science and Technology Center: The Nanobiotechnology Center; Sustainability of Water Resources in Semi-Arid Regions; and Synchrotron Radiation Center.

After the initial sample had been selected and SRI had begun collecting participant contact information, it was decided that the NSF programs listed below should also be included in the survey.

- Historically Black Colleges and Universities Undergraduate Program (HBCU-UP).
- Tribal Colleges and Universities Program (TCUP).
- Louis Stokes Alliance for Minority Participation (LSAMP) Program.
- Cooperative Activity with Department of Energy Education Programs (DOE).
- Grants for Vertical Integration of Research and Education in the Mathematical Sciences (VIGRE).

Accordingly, awards made by these programs that included undergraduate research between June 2002 and May 2003 also were included in the survey. The final sample of awards is presented in Table I-1.

**Table I-1**  
**Numbers of NSF Awards in Survey Sample and Population, by NSF Program and Directorate**

<b>NSF Directorate</b>	<b>REU Sites</b>	<b>REU Supp's</b>	<b>Centers</b>	<b>RUI</b>	<b>HBCU-UP</b>	<b>TCUP</b>	<b>LSAMP</b>	<b>DOE</b>	<b>VIGRE</b>	<b>All</b>
BIO	20	91	1	57	0	0	0	0	0	169
CSE	13	103	1	11	0	0	0	0	0	128
EHR	0	0	0	0	21	2	27	18	0	68
ENG	14	53	20	7	0	0	0	0	0	94
GEO	18	31	2	32	0	0	0	0	0	83
MPS	112	63	35	111	0	0	0	0	34	355
OD (OPP)	2	39	0	2	0	0	0	0	0	43
SBE	31	27	0	15	0	0	0	0	0	73
<b>Total sample</b>	<b>210</b>	<b>407</b>	<b>59</b>	<b>235</b>	<b>21</b>	<b>2</b>	<b>27</b>	<b>18</b>	<b>34</b>	<b>1,013</b>
<b>Total population*</b>	<b>459</b>	<b>1,155</b>	<b>59</b>	<b>338</b>	<b>21</b>	<b>2</b>	<b>27</b>	<b>18</b>	<b>34</b>	<b>2,113</b>

This table shows, for example, that 20 REU site awards in NSF's BIO directorate were included in the survey.  
 \*Total estimated number of awards that included undergraduate research during summer 2002 or the 2002-03 academic year.  
 Source: SRI International: NSF initial survey, 2003.

Within each sampled award, all undergraduates who participated in research between June 2002 and May 2003 were eligible for the survey, regardless of whether they themselves received funding from the sampled award. Also eligible were all faculty—including the PIs—graduate students, and postdocs who mentored undergraduate researchers under these awards between June 2002 and May 2003.

**Follow-up survey.** For the follow-up survey, the sample comprised all undergraduates who participated in the initial survey.

### Survey Data Collection

**Initial survey.** PIs of each award were contacted by e-mail and/or telephone to obtain names and contact information for undergraduates who had participated in faculty-mentored research

between summer 2002 and spring 2003. Names and contact information for these students' faculty and graduate-student/postdoc mentors also were obtained. In addition, for each individual named, PIs were asked to specify the time period (summer 2002, 2002-03 academic year, or both) during which the individual had participated in undergraduate research.

The next step in the data collection process was to e-mail a notification of the survey and its purpose to each sample member for whom we had an e-mail address. (The relatively few sample members for whom only a postal address was available were surveyed by mail.) On the basis of information provided by the PIs, each survey sample member was directed either to a questionnaire that focused on summer experiences or to one that focused on academic-year experiences. To make the two time-of-year respondent groups as close to the same size as possible—which was desirable for analysis purposes—all individuals who were identified as participating in both summer and academic-year programs were surveyed only about their academic-year experiences.

As an incentive, undergraduates were offered a \$20 Amazon.com gift certificate in return for their participation, and all respondents were promised a summary of the survey results. In each cover letter was a URL hyperlink, with an embedded respondent ID number, to the survey questionnaire. Reminders to complete the questionnaire were sent at approximately weekly intervals over an 8-week period between April and June 2003. By the time the survey was closed out, usable questionnaires were obtained from 76% of the undergraduates ( $n = 4,560$ ), 80% of the graduate students/postdocs ( $n = 822$ ), 95% of the PIs ( $n = 616$ ), and 81% of other (non-PI) faculty mentors ( $n = 2,140$ ).

**Follow-up survey.** In the initial survey, we told undergraduate respondents that we would be conducting a follow-up survey in 2005, and we asked them to provide information to help us locate them at that time: their own personal e-mail address and the name and contact information for someone who would be likely to know how to reach them in 2005. One or more of these pieces of information were provided by 4,367 respondents (96%). Late in 2004, we began a series of contact attempts by e-mail, postal mail, and telephone to confirm/update respondent contact information. These efforts focused mostly on attempting to obtain correct addresses for e-mails that “bounced.”

Survey data collection began in early May 2005. Procedures were the same as those used for the initial survey. Seven reminders were e-mailed to nonrespondents over the course of the next 3 ½ months. Ultimately, we received responses from 3,354 individuals, representing 74% of all undergraduates who responded to the initial survey and 80% of those for whom (as far as we knew) we were able to find a valid address.

## Data Cleaning and Weighting

**Initial survey.** One hundred eighty-four respondents were deleted from the initial database of 4,744 undergraduate respondents, 175 who participated in research for less than 5 hours per week and/or had not done any of the 15 listed research activities and 9 who were not undergraduates. The data file used for the initial survey report included 4,560 respondents.

**Follow-up survey.** Fifty-six respondents reported in the follow-up survey that they had not participated in any of the four major types of UROs (summer programs, academic-year research, research-based intern/co-op programs, or research-based junior/senior theses) or that they had done none of 15 listed research-related activities. These respondents were deleted from the

follow-up survey data file as well as the initial survey data file. The data files used for this report included 3,298 respondents to the follow-up survey and 4,504 respondents to the initial survey. Analyses comparing responses from the two surveys include only those individuals who responded to both surveys.

For both the initial and follow-up surveys, responses were weighted by the estimated number of participants in each NSF program and directorate (e.g., number of undergraduate participants in REU site awards made by NSF's Biological Sciences directorate).

## **DIFFERENCES BETWEEN RESPONDENTS AND NONRESPONDENTS TO THE FOLLOW-UP SURVEY**

Respondents to the follow-up survey differed appreciably from nonrespondents on a number of the questions in the initial survey, but the two groups were very similar on other items (Table I-2). Compared with nonrespondents, follow-up survey respondents were more likely to be non-Hispanic whites, to expect to obtain a PhD, to be REU site participants, and to have been interested in STEM since childhood; they had higher self-reported grade point averages; and they were younger. On the other hand, there were no or small differences on a number of the outcome measures, including gains in confidence, understanding, and awareness; overall satisfaction levels; and changes in interest in a career in research.

Despite the differences between respondents and nonrespondents, because the follow-up survey respondents comprised a large majority of respondents to the initial survey, the differences between the initial respondent group and those who responded to the follow-up survey were small. For example, there was a 16-point difference between follow-up respondents and nonrespondents in the percentages who were REU site participants (45% and 29%, respectively) but only a 4-point difference between follow-up respondents and initial respondents (45% and 41%, respectively).<sup>9</sup> 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.

## **REPORTING**

All survey results presented in this report are based on weighted data. Comparisons noted in this report are significant at the .05 level of significance. In essence, a difference that is found to be significant at the .05 level has a 95% probability that it did not occur simply by chance. Because of the large numbers of respondents for most of the analyses (which result in very small differences being statistically significant), the practical import of differences rather than the statistical significance tended to be the key driver in reporting findings.

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<sup>9</sup> Note that these percentages were calculated with the weights used for the initial survey; follow-up survey percentages reported in subsequent chapters are slightly different than those reported here, because the follow-up survey weights are slightly different than the initial survey weights.

**Table I-2**  
**Respondent Characteristics and Responses to Selected Initial Survey Questions,**  
**by Response vs. Nonresponse to Follow-up Survey**

	Follow-up Survey Nonrespondents	Follow-up Survey Respondents	All Initial Survey Respondents
<i>Number of respondents:</i>	1,207	3,298	4,504
<b>Selected items with relatively large differences between respondents and nonrespondents</b>			
NSF Program: REU sites	29%	45%	41%
NSF Program: LSAMP	21	11	13
Started undergraduate education at a 2-year college	17	9	11
Participated in hands-on research at other college/university than one's own	27	36	36
Interested in STEM since childhood	51	62	59
Cumulative grade point average 3.7 or higher	28	41	37
Expect to obtain a PhD	36	50	46
Age 23 or older	32	18	23
Race/ethnicity: black	15	9	10
Race/ethnicity: Hispanic/Latino	23	14	17
Race/ethnicity: non-Hispanic white	50	65	61
<b>Selected items with small or no differences between respondents and nonrespondents</b>			
Top quartile on increased confidence index	30	30	30
Top quartile on increased understanding index	29	26	27
Top quartile on increased awareness index	26	23	24
Top quartile on index of overall satisfaction with the research experience	21	21	21
Top quartile on index of personal enthusiasm as a reason to participate in undergraduate research	30	30	30
Participated in 12 or more research activities	18	21	20
Interest in a career in research increased	74	78	77

This table shows, for example, that 29% of those who did not respond to the follow-up survey were included in the initial survey as REU site participants.

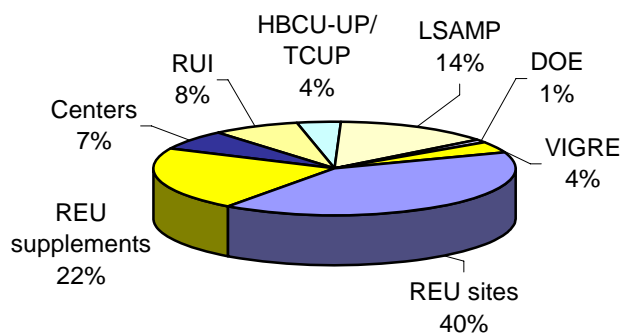
Notes: This table excludes the 56 individuals who were deleted because they reported in the follow-up survey that they had not participated in any of the four major types of UROs (summer programs, academic-year research, research-based intern/co-op programs, or research-based junior/senior theses) or that they had done none of 15 listed research-related activities.

All percentages here were calculated with the weights used for the initial survey; follow-up survey percentages reported in subsequent chapters are slightly different than those reported here, because the weights for the two surveys are slightly different.

Sources: SRI International: NSF initial survey, 2003; NSF follow-up survey, 2005.

## II. NSF PROGRAMS INCLUDED IN THE STUDY

**Figure II-1**  
**Distribution of 2002-03 Undergraduate Researchers,**  
**by NSF Program**



Source: SRI International: NSF initial survey, 2003.

SRI estimates that between June 2002 and May 2003, at least 14,000 undergraduates participated in hands-on faculty-mentored research in the NSF programs included in the study.<sup>10</sup> As shown in Figure II-1, the programs with by far the largest numbers of undergraduate participants were REU sites, with 40% of the total undergraduate participants, and REU supplements, with 22% of participants. The three targeted-minority programs<sup>11</sup>—HBCU-UP, LSAMP, and TCUP—together accounted for 18% of participants.

In this chapter, we provide a description of each of the NSF programs whose participants were included in this study, interweaving general portrayals of the programs with some of the data gathered about them in the NSF initial survey.

### RESEARCH EXPERIENCES FOR UNDERGRADUATES (REU) SITES AND SUPPLEMENTS

NSF established the REU program in 1987 with the goal of increasing the number of undergraduates participating in “hands-on” research. The program was conceived as an intervention to counteract the nation’s decreasing annual production of PhDs in science, technology, engineering, and mathematics (STEM) and make UROs available to all interested and competitive students who are U.S. citizens or permanent residents. REU activities are funded from the budgets of disciplinary programs within the various NSF directorates, and the overall management of REU is the responsibility of a committee of directorate or divisional representatives. The REU program has two components: sites and supplements.

#### REU Sites

SRI estimates that 459 sites were in operation as of September 2002.<sup>12</sup> Of these, 210 sites were included in the survey sample, and 180 (86%) provided participant contact information.

<sup>10</sup> This number is derived from the number of students whose names and contact information were provided to SRI. It is an underestimate to the extent that students whose names and contact information were *not* provided are not included.

<sup>11</sup> Targeted minorities are blacks, Hispanics/Latinos, American Indians, Alaska Natives, and Native Hawaiians or other Pacific Islanders.

<sup>12</sup> NSF-provided databases listed 478 active REU sites. A random sample of 219 sites was selected for inclusion in the survey. Of these, 210 were confirmed to be active during summer 2002 and to include undergraduate researchers. From these findings, we estimate that 459 sites involved undergraduate research during summer 2002.

As shown in Table II-1, a plurality of the site awards (41%) were funded by the Directorate for Mathematical and Physical Sciences (MPS), with the next-largest funding sources being the Directorates for Biological Sciences (BIO) (26%) and Engineering (ENG) (15%).

**Table II-1**  
**Percentage Distribution of Undergraduate Researchers across NSF Directorates, by NSF Program**

	REU Sites	REU Supp's	Centers	RUI	HBCU-UP	TCUP	LSAMP	DOE	VIGRE	All
<i>Number of awards:</i>	459*	1,155*	59	338*	21	2	27	18	34	2,113
BIO	26	47	<1	50	0	0	0	0	0	25
CSE	3	8	0	1	0	0	0	0	0	3
EHR	0	0	0	0	100	100	100	100	0	18
ENG	15	25	53	1	0	0	0	0	0	16
GEO	8	6	3	8	0	0	0	0	0	6
MPS	41	7	44	36	0	0	0	0	100	28
OD (OPP)	<1	3	0	0	0	0	0	0	0	1
SBE	7	5	0	3	0	0	0	0	0	4
Total	100	100	100	100	100	100	100	100	100	100

This table shows, for example, that 26% of REU site participants worked on research funded by NSF's BIO directorate.  
\*Estimated from NSF databases and information provided by award PIs, SRI International URO survey, 2003.  
Sources: National Science Foundation databases and program Web sites; SRI International: NSF initial survey, 2003.

REU site awards are unique among the programs included in this study in that they are typically given entirely for a stand-alone undergraduate research activity. They do not support other kinds of undergraduate activities (as do HBCU-UP, TCUP, LSAMP, DOE, and VIGRE), nor are they necessarily coordinated with the PI's own research activities (as are most REU supplement, center, and RUI awards).

Each site uses REU funds to host 6 or more students (an average of 12 in 2002) who conduct research within the STEM discipline or research area around which the site is organized. Almost always, REU site activities take place during the summer, typically during an 8- to 10-week period. They may be located at an academic or nonacademic institution (e.g., government lab or research institution), either in the United States or at a foreign location. The initial survey found that, in 2002, 84% of site participants were located at an academic institution, 18% were at a nonacademic institution, and 8% were in another country (Table II-2).<sup>13</sup> Most of the academic institutions are large research universities—in 2002, only 14% of the site awards, with 13% of site students, were made to primarily undergraduate institutions (PUIs).<sup>14</sup> REU sites are encouraged to involve students in research who otherwise might not have the opportunity, particularly those from institutions where research programs are limited. Accordingly, most students—77% in 2002—come from campuses other than the institution hosting the site.

<sup>13</sup> These percentages sum to more than 100 because some undergraduates worked in more than one location.

<sup>14</sup> In each program, the percentage of students whose home institution is a PUI corresponds closely to the percentage of that program's awards that were made to PUIs. Thus, the reader should consider the former statistic a close proxy for the latter.

**Table II-2**  
**Selected Characteristics of Undergraduate Researchers in 2002-03, by NSF Program:**  
**Percentage with Each Characteristic**

	REU Sites	REU Supp's	Centers	RUI	HBCU-UP/TCUP	LSAMP	DOE	VIGRE	All
<i>Number of respondents:</i>	1,825-1,861	656-673	607-625	434-440	162-164	365-375	74-75	328-338	4,460-4,560
Did research at home institution	23	90	47	92	78	80	36	79	57
Did research at another academic institution	61	5	48	6	19	15	19	20	34
Did research at non-academic institution	18	6	6	3	7	6	46	1	11
Did research in another country	8	5	2	8	4	8	1	2	6
Home institution is a PUI	40	7	20	91	54	38	37	6	35
Host institution for research is a PUI	13	3	0	92	38	30	8	0	19
Received stipend	99	77	97	74	93	91	96	91	90
Received academic credit	22	39	15	52	24	40	36	24	30
When started research project									
Before May 2002	7	30	15	30	11	19	0	8	16
May-August 2002	93	36	72	39	45	58	73	67	67
Sept-Dec 2002	< 1	18	3	16	23	9	21	11	8
After December 2002	< 1	14	8	13	20	13	5	13	8
Academic class									
Freshman	<1	2	2	1	3	1	1	1	1
Sophomore	5	7	8	10	20	14	31	11	8
Junior	27	24	27	26	37	29	37	29	27
Senior	68	66	63	63	40	56	30	60	64
Female	56	50	42	49	66	57	77	28	53
Race/Ethnicity									
American Indian	1	<1	1	0	7	3	1	0	1
Asian	7	11	16	9	2	1	23	14	8
Black	7	5	10	3	84	16	11	3	10
Hispanic/Latino	7	5	13	7	3	77	30	3	17
Pacific Islander	<1	<1	<1	<1	0	<1	0	0	<1
Non-Hispanic white	74	76	56	77	1	1	34	77	61
More than one race	3	3	4	3	3	2	1	2	3

This table shows, for example, that 23% of undergraduate respondents who participated in REU sites did so at their home institution.

Notes: "All" column includes respondents whose NSF program is unknown.  
 Research location columns sum to more than 100% because respondents could select more than one category.  
 Each academic class group includes both current and rising members of that class.  
 PUI = primarily undergraduate institution. Carnegie categories: associate's, baccalaureate, master's, and tribal colleges.

Source: SRI International: NSF initial survey (undergraduates), 2003.

As with other summer research included in the survey, the REU site research experience is typically a full-time responsibility, and students generally do not have other work obligations outside of the laboratory, library, or field research that they are conducting. The host institutions provide students with stipends and, additionally for nonlocal students, with housing for the summer. In 2002, 74% of site participants lived in the same residence hall or apartment building with other students in the program. The host institutions also generally augment students' research experiences with sponsored activities that expose the students to the culture and practical concerns of a career in academic or industrial research. Almost all sites—95% in 2002—also provide students with occasional recreational and cultural outings, such as picnics, non-research-related field trips, etc.

Slightly more than half of 2002 REU site undergraduate participants (56%) were female, and 74% were non-Hispanic white. Two-thirds (68%) were seniors.<sup>15</sup>

## REU Supplements

SRI estimates that 1,155 supplements involved undergraduate research as of September 2002.<sup>16</sup> Of these, 407 were included in the sample for the initial survey, with participant contact information provided by 329 (81%). BIO funded the largest number of these awards (47%), with ENG (25%) a distant second.

REU supplements are add-ons awarded to PIs of NSF research grants to involve undergraduates in their research. Supplements may be funded as an embedded feature in a new or renewal research proposal or as a supplement to an ongoing award. REU supplements included in the survey supported an average of about three undergraduates. Most REU supplement-funded undergraduate activity takes place during the academic year, while students are also attending classes, although the nature of the award results in considerably more flexibility of timing than is the case with REU sites. For example, the initial survey found that 90% of the supplement-sponsored undergraduates participated in research during the 2002-03 academic year, but 36% reported that they started their research project during the summer of 2002, and another 30% started *before* the summer. Thus, the experience is less intensive but of much longer duration than that of typical summer programs. Nine in 10 supplement-funded undergraduates (90%) participated in research at their home institution, and for almost all (93%), the home institution is a non-PUI. Almost 8 in 10 students (77%) received a stipend, and 4 in 10 (39%) received academic credit.

The demographic profiles of 2002-03 REU supplement participants were similar to those of REU site participants, although supplements included a somewhat lower percentage of women (50% vs. 56%) and a somewhat higher percentage of Asians (11% vs. 7%). The academic class distributions of supplement and site participants were virtually identical.

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<sup>15</sup> For summer researchers, the academic class designation is that of the student's rising class. For example, summer researchers designated as seniors were about to begin their senior year.

<sup>16</sup> NSF-provided databases listed 1,463 active supplements. A random sample of 534 supplements was selected for inclusion in the survey. Of these, 407 were confirmed to be active between June 2002 and May 2003 and to include undergraduate researchers. From these findings, we estimate that 1,155 supplements involved undergraduate research between June 2002 and May 2003.

## **NSF-FUNDED RESEARCH CENTERS**

Many NSF-funded centers and facilities offer REU site-like activities (typically funded as REU supplements) as part of their educational activities. Unlike REU sites, however, some of the centers also support undergraduate research during the academic year. As of summer 2002, NSF centers that supported undergraduate research included 18 Engineering Research Centers (ERCs), 25 Materials Research Science and Engineering Centers (MRSECs), and 16 other centers, laboratories, and other facilities, for a total of 59. All were included in the survey; 47 (80%) provided participant contact information.

The centers reported supporting an average of about 17 undergraduate researchers between June 2002 and May 2003. The initial survey found that essentially all undergraduates (97%) received a stipend, but few (15%) received academic credit. About 7 in 10 students (72%) began their participation during the summer. About half (48%) came from other schools, and about half of these, or 20% overall, came from PUIs. Once at the center, 62% of the students lived in a residence hall/apartment building with other students in the program. Almost all center undergraduate participants (89%) reported that social/cultural activities were provided for the group.

Undergraduate participants in centers in 2002-03 were less likely to be females than those in REU supplements and sites (42% vs. 50% and 56%, respectively) and more likely to be minorities. For example, 13% of center participants were Hispanic/Latino, compared with 5% and 7% in the REU programs. Academic class profiles were similar to those of the REU programs (63% of center participants were seniors, vs. 66% and 68% of REU participants).

## **RESEARCH IN UNDERGRADUATE INSTITUTIONS (RUI)**

SRI estimates that 338 RUI awards involved undergraduate researchers as of September 2002.<sup>17</sup> Of these, 235 were included in the survey, and 168 (71%) provided participant contact information. Almost all RUI participants worked on awards funded by NSF's BIO (50%) or MPS (36%) directorate.

The RUI program was initiated in 1987 to encourage PUI-based research and as an alternative to NSF's normal grant application procedures. It is seen as a way to partially "level the playing field" vis-à-vis proposals from major research universities. RUI objectives are to:

- Support high-quality research by faculty members at PUIs.
- Strengthen the research environment in departments oriented primarily toward undergraduate instruction.
- Promote the integration of research and education.

There is no separate program budget for RUI; all RUI proposals are reviewed and funded by NSF's regular disciplinary support programs.

In 2002-03, RUI awards supported an average of about three undergraduate researchers. As with REU supplements, the duration and timing of undergraduate RUI participation are flexible,

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<sup>17</sup> NSF-provided databases listed 345 active RUI awards. A total of 238 RUI awards were randomly selected for inclusion in the survey, of which 235 were confirmed to be active between June 2002 and May 2003 and to include undergraduate researchers. From these findings, we estimate that 338 RUI awards involved undergraduate research between June 2002 and May 2003.

and research takes place during both the academic year and the summer. Thirty percent of RUI undergraduate respondents to the initial survey began their research before May 2002, 39% began during summer 2002, and 29% began during the 2002-03 academic year. Almost all (92%) participated in research at their home institution, which, of course, was almost always a PUI. RUIs were the least likely of all the programs to provide stipends (received by 74% of participants) but the most likely to provide academic credit (received by 52% of participants).

The demographic and academic class profiles of RUI participants were almost identical to those of REU supplement students.

## **HISTORICALLY BLACK COLLEGES AND UNIVERSITIES UNDERGRADUATE PROGRAM (HBCU-UP)**

HBCU-UP is designed to promote sustainable improvement of STEM undergraduate programs at HBCUs as a means to broaden diversity and overall participation in the nation's STEM workforce. Funded by EHR, awards are made for comprehensive institutional approaches to strengthen teaching and learning in ways that improve access to, retention within, and graduation from STEM disciplines. As one component of the improvement plan, institutions may propose to provide stipends to students engaged in STEM-related research or training. Research experiences, internships, or cooperative education activities may be provided on campus or at off-campus locations.

As of the end of September 2002, 37 HBCU-UP sites were listed on NSF/EHR's Directory of Program Directors and Project Directors.<sup>18</sup> Of these, 21 involved UROs and were active between June 2002 and May 2003, and 13 (62%) provided participant contact information.

An average of about 22 undergraduate researchers were supported under each HBCU-UP award between June 2002 and May 2003. More than 9 in 10 (93%) reported in the initial survey that they received a stipend; 24% received academic credit.<sup>19</sup> Two-thirds of the undergraduates (68%) participated in research during the academic year. HBCU-UP participants were the most likely of all the programs to have begun their research in or after September 2002 (43% vs. 16% overall). Eight in 10 (78%) participated at their home institution.

In 2002-03, 84% of HBCU-UP participants were black. HBCU-UP also had a higher percentage of females than most other groups (66% vs. 53% overall) and higher percentages of sophomores (20% vs. 8% overall) and juniors (37% vs. 27%). Next to RUIs, HBCU-UP participants were the most likely to come from a PUI (54%) and to conduct research at a PUI (38%).

## **TRIBAL COLLEGES AND UNIVERSITIES PROGRAM (TCUP)**

TCUP promotes sustainable improvement of undergraduate STEM instructional programs at tribal colleges and universities and at institutions that serve Alaskan and Hawaiian natives. As with HBCU-UP, funding is provided by EHR to implement comprehensive plans designed to improve access to, retention within, and graduation from STEM disciplines. Among many other allowable activities, stipends may be provided to students engaged in STEM-related research or

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<sup>18</sup> <http://www.ehr.nsf.gov/ehr/hrd/hrddirlist.asp>

<sup>19</sup> Table II-2 and other tables in this report combine HBCU-UP and TCUP respondents. However, because there were only seven TCUP undergraduate respondents, their effect on this group's statistics is minimal.

training activities, including community service activities, such as helping the local community meet technology-related goals.

Not including planning grants and technical assistance awards, seven TCUP awards were active between June 2002 and May 2003. Two of these were found to include hands-on, faculty-mentored research for undergraduates and were included in the survey; one provided participant contact information. This award supported 16 undergraduate researchers, of whom 7 responded to the initial survey. Because of the small number, analyses did not break out TCUP respondents into a separate group. Instead, they were combined with the HBCU-UP respondents.

## **LOUIS STOKES ALLIANCE FOR MINORITY PARTICIPATION (LSAMP) PROGRAM**

Begun in the early 1990s, LSAMP aims to increase baccalaureate degree production at institutions having significant enrollment of minority populations that are underrepresented within STEM professional groups. Eligibility is limited to alliances of academic institutions that have exemplary records over several years of enrolling and retaining significant numbers of undergraduates from populations underrepresented in STEM disciplines. Alliances, in effect, are partnerships that can involve 4-year and 2-year institutions, firms, national research laboratories, and local, state, and federal agencies. Student participation in research is only one of many important components of LSAMP.

LSAMP is supported by NSF's Directorate for Education and Human Resources. As of the end of September 2002, 27 LSAMP projects were listed in NSF/EHR's Directory of Program Directors and Project Directors,<sup>20</sup> all of which were included in the survey and all of which included undergraduate research. Ten of the LSAMP projects (37%) provided participant contact information. Given this low level of participation, LSAMP-related results should be interpreted with caution.

Information provided by the participating projects suggests that undergraduate research receives very different amounts of emphasis in different LSAMP awards: the number of undergraduates identified as participating in research between June 2002 and May 2003 ranged from 4 in the All Nations LSAMP to 331 in the Puerto Rico LSAMP, with an overall average of about 70.

Almost all LSAMP undergraduate researchers receive a stipend (the initial survey found that 91% did so in 2002-03). Otherwise, as with REU supplements and RUI awards, there is considerable variability in the nature and duration of the LSAMP research experience. For example, most 2002-03 undergraduates (61%) participated in research during the academic year, but many also participated during the summer—19% began before summer 2002, and 58% began during the summer. The vast majority (80%) participated at their home institution, which was a PUI for about 4 in 10 students (38%). Among those students who participated in summer programs, relatively few LSAMP students (36% vs. an overall average of 67%) lived with other participants in a residence hall/apartment building or participated in planned social/cultural activities (66% vs. 90% overall).

About three-fourths (77%) of 2002-03 LSAMP participants were Hispanic/Latino (49% were Hispanics/Latinos from Puerto Rico, and 28% were Hispanics/Latinos from mainland United States), and 16% were black. Slightly more than half (57%) were females, close to the overall

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<sup>20</sup> <http://www.ehr.nsf.gov/ehr/hrd/hrddirlist.asp>

percentage (53%). Reflecting LSAMP's role as a "pipeline" program and thus its focus on early intervention, participants were somewhat less likely than those in most other programs to be seniors (56% vs. an overall average of 63%) and more likely to be sophomores (14% vs. 8% overall).

## **COOPERATIVE ACTIVITY WITH DEPARTMENT OF ENERGY EDUCATION PROGRAMS (DOE)**

EHR provides supplemental funding for undergraduates (as well as for faculty and preservice teachers) to participate in one of four DOE programs that provide hands-on research opportunities in national laboratories during the summer. The DOE programs are Science Undergraduate Laboratory Internships (SULI) and Community College Institutes (CCI), which target students at 4-year and 2-year colleges, respectively; Faculty-Student Teams (FaST), which provides research opportunities to teams of faculty members and up to three of their undergraduates; and Pre-Service Teacher (PST) Internships, intended for undergraduates preparing to become teachers in STEM disciplines. Students and faculty apply directly to the DOE programs.

As of September 2002, there were 18 cooperative DOE/NSF awards that included UROs; 16 of these (89%) provided participant contact information. Each of the 16 awards supported an average of about 8 undergraduate researchers between June 2002 and May 2003. None started before summer 2002, 73% started during the summer, and 26% started during the fall or later. Six in 10 (60%) participated only during the summer. Almost half of the undergraduates (46%) participated at a nonacademic institution, 36% participated at their home institution, and 19% participated at another academic institution.

DOE 2002-03 participants were by far the most diverse among all the programs in terms of race/ethnicity and academic class profile. About a third (34%) were non-Hispanic white, and 42% were underrepresented minorities. They had the lowest percentage of seniors (30%) of any of the programs and the highest percentage of sophomores (31%). They also had the highest percentage of females (77%) and by far the highest percentage of students from community colleges (23% vs. 1% overall). Including those from community colleges, 37% came from a PUI.

## **GRANTS FOR VERTICAL INTEGRATION OF RESEARCH AND EDUCATION IN THE MATHEMATICAL SCIENCES (VIGRE)**

Supported by MPS, the long-term goal of VIGRE is to increase the number of U.S. citizens and permanent residents who receive training for, and subsequently pursue careers in, the mathematical sciences. VIGRE is viewed as promoting the development of a diverse community of researchers and scholars at all levels, breaking through long-standing barriers that have served to compartmentalize scholarly activities. VIGRE thus helps provide a setting conducive to more meaningful educational experiences for undergraduate and graduate students. Every VIGRE proposal must describe a plan for integrating an undergraduate research experience program, a graduate traineeship program, and a postdoctoral fellowship program. Proposals must also discuss efforts for recruiting and retaining women and members of underrepresented groups.

Within VIGRE, the term "undergraduate research experience" is interpreted to include participation in faculty-directed projects; internships in industry, business, or government laboratories; and participation in interdisciplinary research teams. Such experiences may range

from group activities to one-on-one mentoring, and from academic-year projects to summer REU programs. The experiences are also expected to contribute in a significant way to the development of students' communication skills, with particular emphasis on the written and oral presentation of mathematical concepts. Internship experiences are particularly encouraged.

There were 34 active VIGRE awards as of September 2002 that included UROs, of which 27 (79%) provided participant contact information. Each of these awards supported an average of about 14 undergraduate researchers between June 2002 and May 2003. The initial survey found that two-thirds (67%) of VIGRE participants began during the summer, and 24% began in the fall or later. Six in 10 (60%) participated only in summer research. Eight in 10 (79%) participated at their home institution.

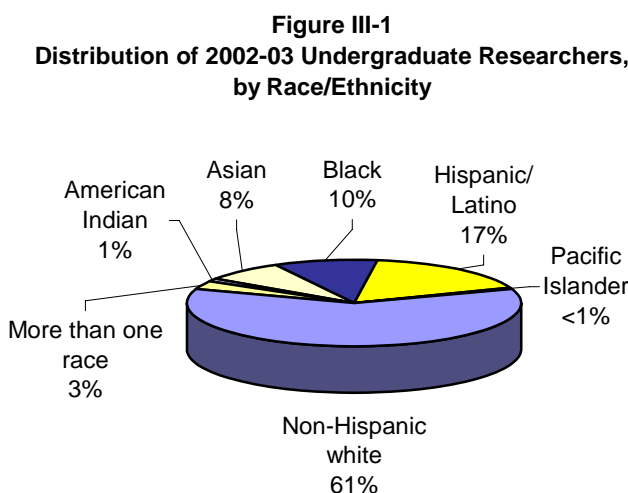
Compared with participants in the other programs, 2002-03 VIGRE participants were quite distinctive on several dimensions. They included the lowest percentage of underrepresented minorities (8% vs. 28% overall) and by far the lowest percentage of females (28% vs. 53% overall). Only 6% came from PUIs, and none conducted research at a PUI. Only their academic class profile was similar to those of most other programs, with 60% of participants being seniors.

### III. PROFILE OF UNDERGRADUATES WHO PARTICIPATED IN NSF-FUNDED RESEARCH

This chapter provides a broad description and discussion of the kinds of undergraduates who were engaged in NSF-funded research during summer 2002 or the 2002-03 academic year. Understanding who is served by undergraduate research programs is important to assessing the programs' overall role in STEM education.

#### DEMOGRAPHIC CHARACTERISTICS

The 2003 NSF initial survey found that undergraduate researchers in NSF programs were almost equally divided between men (47%) and women (53%). Six in 10 undergraduate researchers were non-Hispanic white, 17% were Hispanic/Latino, and 10% were black (Figure III-1).



Source: SRI International: NSF initial survey (undergraduates), 2003.

According to the Department of Education (ED), 49% of STEM bachelor's degrees in 2000-01, excluding social sciences,<sup>21</sup> were awarded to women; including social sciences, 55% of STEM degrees were awarded to women. The ED and URO numbers are not precisely comparable, but it appears that women were proportionally well represented among undergraduate researchers. The situation was similar for minority researchers. Excluding nonresident aliens, 75% of STEM bachelor's degrees in 1999-2000 were awarded to non-Hispanic whites, 9% to blacks, and 5% to Hispanics/Latinos.<sup>22</sup> These numbers suggest that, overall, historically underrepresented minorities

(American Indians, blacks, and Hispanics/Latinos)—especially Hispanics/Latinos—also were well represented as undergraduate researchers. The relatively high percentage of Hispanics/Latinos is due partly to the 185 Puerto Rican undergraduate respondents, who comprised 30% of all Hispanic/Latino respondents to the initial survey. Mainland U.S. Hispanics/Latinos comprised 10% of undergraduate researchers.<sup>23</sup>

<sup>21</sup> National Center for Education Statistics, *Digest of Education Statistics, 2002*. Data table 255. The following were included: agricultural sciences, biological and life sciences, computer and information sciences, mathematics, engineering and engineering-related technologies, health professions and related sciences, interdisciplinary biological and physical sciences, physical sciences, and mathematics/science education. Psychology, anthropology, archeology, economics, sociology, and general social sciences were included as social sciences.

<sup>22</sup> Ibid.

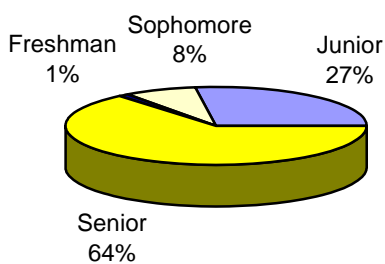
<sup>23</sup> NSF also considers persons with disabilities to be an underrepresented group, the inclusion of which is encouraged in all NSF-supported activities. Disability status was not included in the undergraduate survey because previous SRI surveys have found that self-reports of disabilities are unreliable.

As shown in Table II-2 in the preceding chapter, the representation of women and minorities in the various NSF programs varied dramatically, reflecting in part the differing mandates and foci of the programs. The percentage of women ranged from 28% of VIGRE participants to 77% of DOE participants, and the percentage of historically underrepresented minorities ranged from 6% of VIGRE participants to 94% of HBCU-UP/TCUP participants.

## ACADEMIC CHARACTERISTICS

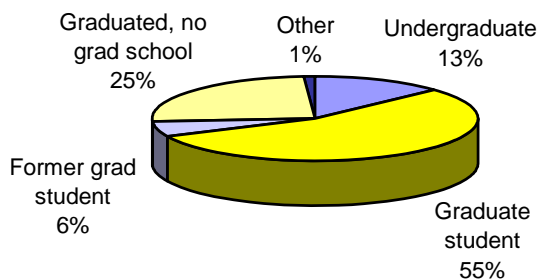
### Academic Status

**Figure III-2**  
Distribution of Initial Survey Undergraduate Respondents (2003), by Academic Class



Source: SRI International: NSF initial survey, (undergraduates), 2003.

**Figure III-3**  
Distribution of Follow-up Survey Respondents (2005), by Academic Status



Source: SRI International: NSF follow-up survey, 2005.

At the time of the initial survey, more than 6 in 10 undergraduate researchers were seniors (or rising seniors in the case of the summer students) (Figure III-2). The distribution was similar within each of the NSF programs except HBCU-UP/TCUP and DOE, both of which had considerably fewer seniors (40% for HBCU-UP/TCUP and 30% for DOE) and correspondingly more sophomores and juniors (see Table II-2). Even these programs, however, included almost no freshmen.

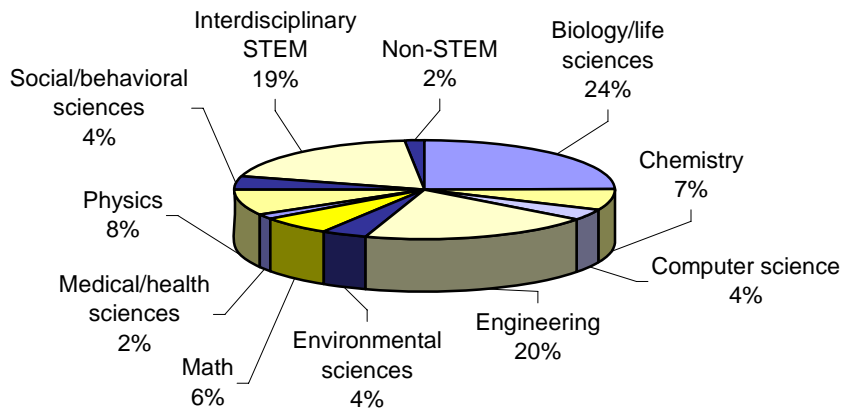
At the time of the follow-up survey, 69% of respondents were still in school: 13% were still undergraduates, and 56% were in graduate school. Another 6% had attended graduate school, and only a fourth had received their baccalaureate degree but had not attended graduate school (Figure III-3). Among those in graduate school, 71% were expecting to obtain a PhD, 13% were expecting a master's degree, 13% were expecting an MD, and 8% were expecting some other degree.<sup>24</sup> Among former graduate students, 62% had received a master's degree, and 38% had completed some graduate work but not received an advanced degree.

### Undergraduate Academic Major and Graduate Field of Study

The most common undergraduate majors reported in the follow-up survey were biology/life sciences, engineering, and interdisciplinary STEM fields, which comprised almost two-thirds of all respondents (Figure III-4). Among current and former graduate school students, the most common fields of study were biology/life sciences, engineering, and medical/health sciences (Figure III-5), but there were sizable differences in the representation of these groups, depending

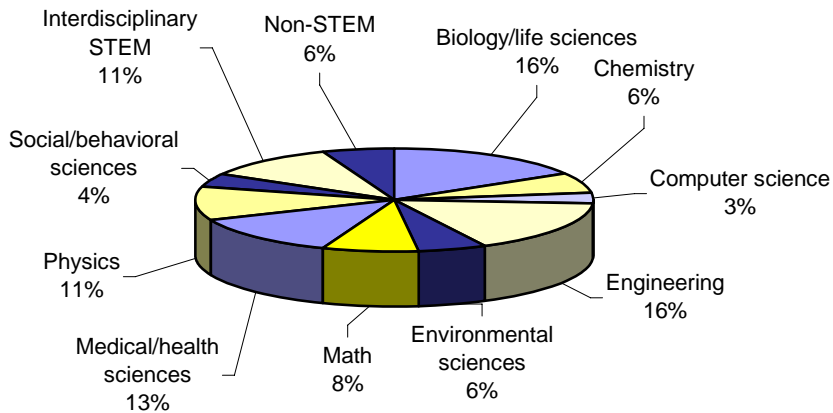
<sup>24</sup> Percentages expecting PhDs and MDs include those who were expecting to obtain both degrees (3%) and those who were not sure which of the two they would obtain (2%).

**Figure III-4**  
**Distribution of Follow-up Survey Respondents,**  
**by Undergraduate Major**



Source: SRI International: NSF follow-up survey, 2005.

**Figure III-5**  
**Distribution of Follow-up Survey Graduate Students,**  
**by Graduate Field of Study**



Source: SRI International: NSF follow-up survey, 2005.

on whether the respondent was currently in graduate school and whether he/she expected to obtain a PhD. Among current graduate students expecting a PhD, the most common fields were biology/life sciences (21%), physics (14%), engineering (14%), and interdisciplinary sciences (13%); among current graduate students not expecting a PhD, health sciences/medicine was the dominant field (40%); and among former graduate students, the dominant field was engineering (37%).

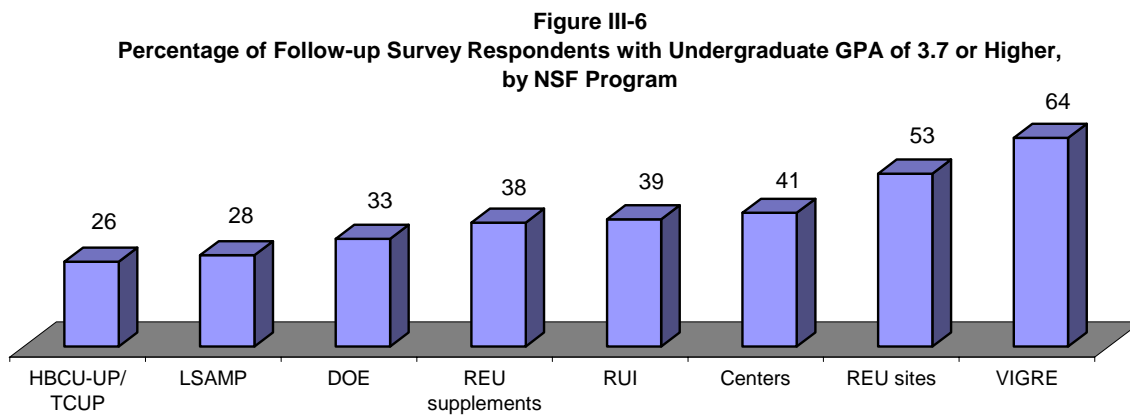
Six in 10 of those who attended graduate school stayed in the same field in which they had majored as an undergraduate. About a fourth (24%) made a within-STEM change (most commonly, from a multidisciplinary major to a more focused graduate field), and 12% moved from a nonmedical STEM field to a medical field (e.g., biology to medicine). Only 5% switched from a STEM field to a non-STEM field (e.g., biology to business), and fewer than 1% switched from non-STEM to STEM.

The fields whose relative sizes changed the most were interdisciplinary STEM, which decreased from 19% of undergraduates to 11% of graduate students, and medical/health sciences, which grew from 2% of undergraduates to 13% of graduate students. The former reflects the need for greater specialization in graduate school than as an undergraduate; the latter reflects the fact that most undergraduates who intend to go to medical school specialize in biological sciences rather than in medical/health sciences *per se*.

### High School Class Ranking and Undergraduate Grade Point Average (GPA)

Seven in 10 of the follow-up survey respondents reported that they were in the top 10% of their high school class, and another 19% said they were in the top 25%. The mean undergraduate GPA reported in the follow-up survey was 3.52 (on a 4-point scale), and 43% had GPAs of 3.7 or higher. Only 12% had GPAs lower than 3.0. As a point of comparison, the mean GPA reported in our survey of STEM graduates ages 22 to 35 was 3.30, and only 22% had GPAs of 3.7 or higher.

NSF programs differ considerably in the academic performance of their undergraduate participants (Figure III-6). The percentage of their participants with GPAs of 3.7 or higher ranged from 26% and 28% of those in the minority-focused pipeline programs (HBCU-UP, TCUP, and LSAMP) to 64% of those in VIGRE.



Source: SRI International: NSF follow-up survey, 2005.

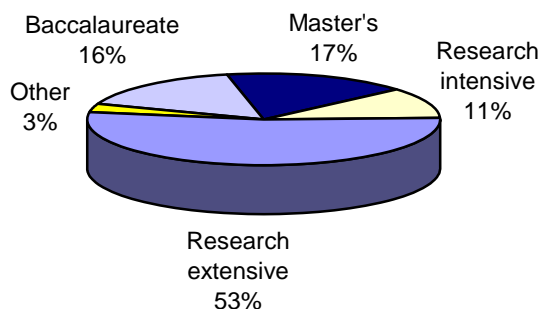
### Types of Undergraduate and Graduate Institutions

The undergraduate institution of almost two-thirds of follow-up survey respondents was a research university (Figure III-7), but, as discussed in Chapter II and shown in Table II-2, the types of schools that undergraduate researchers attended differed substantially among NSF programs, reflecting the varying program goals. In 2002-03, the percentage of students attending a primarily undergraduate institution (PUI)<sup>25</sup> ranged from 7% of REU supplement participants and 6% of VIGRE participants to 91% of RUI participants. Nine percent of follow-up survey respondents started college at a 2-year college.

Not surprisingly, among follow-up survey respondents who were attending or had attended graduate school, by far the largest group (72%) were in research-extensive universities. Fewer

<sup>25</sup> In the Carnegie classification, PUIs are master's, baccalaureate, and associate's colleges.

**Figure III-7**  
**Distribution of Follow-up Survey Respondents,**  
**by Carnegie Type of Their Undergraduate Institution**



Source: SRI International: NSF follow-up survey, 2005.

than 10% attended any of the other types of schools for their graduate work. However, students who had attended research-intensive universities as undergraduates were much more likely than those who had attended other kinds of schools to attend research-intensive universities as graduate students, and the analogous pattern was true for those who were undergraduates at master's colleges and universities. In both cases, about a fourth of those who were undergraduates at these types of schools also attended graduate school there.<sup>26</sup>

## EMPLOYMENT CHARACTERISTICS OF NONSTUDENTS

At the time of the follow-up survey, two-thirds of the respondents were employed either full-time (43%) or part-time (22%). About 6 in 10 of these (57%) were also in school. Among those *not* still in school, 51% were employed by for-profit companies, other than for-profit medical or research organizations. The next-largest employment sectors were colleges or universities (15%), nonmilitary government (14%), and research organizations (11%).

Predictably, employment sectors differed by undergraduate major. Majors with relatively high percentages of graduates employed in a given sector included the following:

- 82% of computer science majors and 64% of engineering majors were employed by for-profit companies (vs. 51% overall).
- 34% of life science majors were employed by colleges or universities, and 14% were employed by hospitals/medical centers (vs. 7% overall).
- 20% of social/behavioral science majors were employed by nonprofit organizations, other than medical or research (vs. 5% overall).

As evidence that the STEM workforce is not limited to those with PhDs, a large majority of nonstudents reported that their job was at least somewhat related to their (STEM) undergraduate major (48% said it was closely related, and 31% said it was somewhat related), that they used skills learned doing undergraduate research in their job (30% a lot and 45% somewhat), and that their job involved science/math research or engineering (64%). There were considerable differences in these various percentages across academic majors. For example, the percentage who reported that their current job was closely related to their major ranged from 26% of math and social/behavioral science majors to 74% of computer science majors. Also, 84% of engineering majors said their job involved engineering, and 50% of science majors said their job involved science research, but only 16% of math majors said their job involved math research.

<sup>26</sup> Attending graduate school at a master's institution does not necessarily mean that the highest degree a student expects to obtain is a master's. Among follow-up survey respondents who were attending graduate school at a master's institution, 74% expected to obtain a PhD (presumably by transferring to a doctorate-level institution for their advanced work).

## **OVERVIEW OF NSF UNDERGRADUATE RESEARCHER PROFILE**

Relative to their representation in STEM undergraduate majors, women and the traditionally underrepresented minorities were well represented among NSF undergraduate researchers. Most respondents reported that they had been in the top 10% of their high school class, and almost all had been in the top 25%. Similarly, most had relatively high undergraduate GPAs, with an average of 3.52. About 9 in 10 researchers were juniors or seniors at the time of the initial survey (in 2003), and a little over half were in graduate school at the time of the follow-up survey in 2005. Of current and former graduate students, about 7 in 10 were still in the same field as their undergraduate major. Among respondents no longer in school, about 8 in 10 said their job was at least somewhat related to their undergraduate major and that they used skills learned doing undergraduate research.

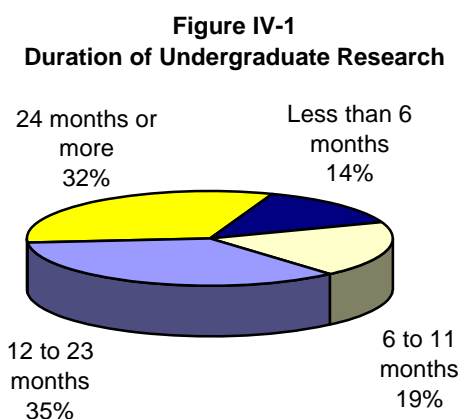
## IV. CHARACTERISTICS AND ACTIVITIES OF UNDERGRADUATE RESEARCH EXPERIENCES

In this chapter, we describe the characteristics of undergraduate research experiences and the activities that comprised those experiences. The relationships between these characteristics/activities and URO effects are discussed in subsequent chapters.

### TYPES OF RESEARCH EXPERIENCES

Follow-up survey respondents were asked whether they had participated in each of the five kinds of undergraduate research experiences listed below. (Respondents were instructed not to include a particular research experience in more than one category.)

- Summer research, other than intern or co-op program. A full-time hands-on research project for the summer with a professor or researcher. (Reported by 83% of respondents.)
- Hands-on research with a professor during one or more academic terms, while enrolled in classes. (Reported by 79% of respondents.)
- Intern or co-op program that involved hands-on research as its main component. Usually, a company or other organization pays you for working on a research project at their site. Sometimes you receive academic credit at your school for this research. May happen any time of year. (Reported by 32% of respondents.)
- A junior or senior thesis that involves hands-on research (other than library research) as its main component. (Reported by 39% of respondents.)
- Other kinds of hands-on research experiences with a teacher, professor, or researcher. (Respondents who selected this option were asked to describe their activities, which included being a research assistant, conducting research as part of a course, and so on.) (Reported by 5% of respondents.)



Source: SRI International: NSF follow-up survey, 2005.

Most respondents had relatively long and varied research experiences. The average (mean) duration of undergraduate research was 18.6 months, and two-thirds participated in research for 12 months or more (Figure IV-1). The vast majority (82%) participated in more than one of the five types of UROs listed above. According to the initial survey, 35% had also participated in science or mathematics fairs while in high school.

The average duration of undergraduate research reported in the follow-up survey was 4.3 months longer than that reported in the initial survey, 2 years prior. This relatively small change is due largely to the fact that 62% of the respondents were seniors

when they responded to the initial survey and thus had little time remaining as undergraduates.

There were large differences in research duration by academic major. Life science and interdisciplinary STEM majors had greater than average research experience: 41% and 36%, respectively, had 24 months or more experience. Majors whose research experience was less than average were engineering, social/behavioral, non-STEM, and, especially, mathematics. Among these groups, the percentage with 24 months or more experience ranged from 25% (engineering) to 13% (mathematics).

Predictably, among baccalaureate degree recipients, PhD-bound graduate students tended to have more research experience than others. For example, 40% of current graduate students expecting a PhD participated in research for at least 24 months, compared with 28% of other graduates. Hispanics/Latinos and students at doctoral/research-intensive universities also tended to have had more research experience than their respective counterparts. Slightly more than 4 in 10 of each of these two groups participated in research for at least 24 months, compared with 27% to 33% of their counterparts. There was no difference in research duration between men and women or between those who started college at a 2-year school and those who did not. All group differences generally paralleled those we found in the initial survey.

## RESEARCH ACTIVITIES

Research-related activities reported by more than two-thirds of follow-up survey respondents were as follows:

- Collected and/or analyzed data or information to try to answer a research question (88% said they did this).
- Understood how my work contributed to the “bigger picture” of research in that field (76%).
- Had input to or responsibility for decisions about what to do next (76%).
- Delivered an oral presentation describing my research and results (73%).
- Had a choice of projects to work on (72%).
- Prepared a final written research report describing my research and results (70%).
- Gained increasing independence over the course of the research (69%).

Activities reported by a third or fewer respondents were:

- Had primary responsibility for designing the project that I worked on (33%).
- Authored or co-authored a paper that was submitted for publication in a professional journal (30%).
- Mentored other students conducting research or led a student research team (24%).
- Did little or nothing that seemed to me to be real research (6%).

As one would expect, higher percentages of respondents reported most of the activities in the follow-up survey (which asked about activities in all UROs) than in the initial survey (which asked only about activities conducted during summer 2002 or the 2002-03 academic year (Table IV-1). The largest differences were on having a choice of projects to work on (reported by 72%

**Table IV-1**  
**Undergraduate Research Activities and Experiences Reported in the Initial and Follow-up Surveys**  
**(Listed in descending order of the “Follow-up Survey” column)**

**Number of respondents: 3,278 – 3,292\***

	<u>Initial Survey</u>	<u>Follow-up Survey</u>	<u>Difference</u>
Collected and/or analyzed data or information to try to answer a research question	86%	88%	2%
Understood how my work contributed to the “bigger picture” of research in that field	83	76	-7
Had input to or responsibility for decisions about what to do next	73	76	2
Delivered an oral presentation describing my research and results	65	73	8
Had a choice of projects to work on	56	72	16
Prepared a final written research report describing my research and results	61	70	9
Gained increasing independence over the course of the research	79	69	-10
Had input to or responsibility for decisions about research techniques/materials	60	65	5
Prepared/presented a poster presentation describing my research and results	48	64	16
Was able to complete my project	54	58	4
Provided input to designing my project	63	58	-5
Attended student conference(s) that included students from other colleges	34	44	9
Wrote a proposal describing the research I planned to do	32	41	9
Went on research-related field trip(s)	37	37	0
Attended professional conference(s)	30	36	6
Had primary responsibility for designing the project that I worked on	18	33	15
Authored or co-authored a paper that was submitted for publication in a professional journal	27	30	3
Mentored other students conducting research or led a student research team	not asked	24	
Did little or nothing that seemed to me to be real research	5	6	1

This table shows, for example, that in the initial survey, 86% of individuals who responded to both the initial and follow-up surveys reported that they collected/analyzed data as part of their research experience.

\*Only those individuals who responded to both the initial survey and the follow-up survey are included in this table.

Source: SRI International: NSF initial survey (undergraduates), 2003; NSF follow-up survey, 2005.

of respondents in the follow-up survey and by 56% of those same individuals in the initial survey), having prepared/presented a poster presentation (64% vs. 48%), and having primary responsibility for project design (33% vs. 18%).

Three experiences were reported by fewer respondents in the follow-up survey than in the initial survey: understanding how one’s work contributed to the “bigger picture” of research in the field (76% vs. 83%), having gained increasing independence over the course of the research (69% vs. 79%), and provided input to designing my project (63% vs 58%). Although we do not know why these declines occurred, at least the first two may be related to the fact that these

items were the only two in the list of “activities” that were a matter of judgment rather than of fact. The group who reported one or both of these experiences in the initial survey but not in the follow-up survey (that is, the group responsible for the percentage declines) had the following characteristics:

- They tended in the initial survey to have somewhat less positive perceptions of their research experiences than did those who reported one or both experiences in both surveys.
- In the follow-up survey, their perceptions were even less positive.
- They included somewhat more seniors than did the respondent group overall.
- They reported only about 2 more months of research in the follow-up survey than they did in the initial survey—about half the overall average.

## **AWARENESS OF NSF PROGRAM SUPPORT**

Respondents to the initial survey were selected on the basis of their participation in an NSF-sponsored program, but 22% of follow-up survey respondents were not aware that NSF had sponsored any of their undergraduate research activities. (We did not ask about respondents’ awareness of NSF support in the initial survey.) Respondents’ awareness of which program sponsored them varied a great deal across the programs included in the survey. By far the highest awareness was among REU site participants, of whom 82% were aware that they were sponsored by the REU program. Two-thirds (66%) of VIGRE participants and 59% of participants in NSF centers also reported that they were supported by REU, reflecting joint REU/VIGRE and REU/center sponsorship of many of these summer programs. (Some of these students may also have participated in other REU awards.) About half of the HBCU-UP students (53%) and LSAMP students (51%) were aware of sponsorship by their respective programs. Not surprisingly, the lowest level of program awareness was of REU supplements (29% awareness) and RUI awards (10%)—both of which provide awards that typically support only one or two undergraduates—although about 7 in 10 of each of these two groups were aware that NSF sponsored their work.

## **MENTOR RACE/ETHNICITY AND SEX**

About two-thirds of men had only male faculty mentors and about the same proportion of non-Hispanic whites had only non-Hispanic white faculty mentors; conversely, few women (14%) had only female mentors, and few targeted minorities (17%) had only same-race/ethnicity faculty mentors (Table IV-2). Half of women had at least one female faculty mentor, but only about a third of targeted minorities and a tenth of Asians had at least one same-race/ethnicity faculty mentor. Among women, Hispanics/Latinas were the least likely and Asians the most likely to have at least one female faculty mentor (42% and 52%, respectively had a female faculty mentor). Among targeted minorities, comparable percentages of black males, black females, Hispanic/Latino males, and Hispanic/Latina females had at least one same-race/ethnicity faculty mentor.

Interestingly, the incidence of females and Asians among graduate-student/postdoc mentors appeared to be considerably higher than their incidence among faculty, but the same was not true for targeted minorities: 63% of women had female graduate-student/postdoc mentors (vs. 48%

<b>Table IV-2</b>			
<b>Sex and Race/Ethnicity of Mentors, Relative to Respondents' Sex and Race/Ethnicity</b>			
	<u>Male Respondents</u>	<u>Female Respondents</u>	
<b>Faculty mentors</b>			
<i>Number of respondents:</i>	1,581	1,660	
At least one same sex as respondent	90%	48%	
Only same sex as respondent	65	14	
Only different sex than respondent	10	52	
Both male and female	25	34	
<b>Graduate-student/postdoc mentors</b>			
<i>Number of respondents:</i>	1,095	1,173	
At least one same sex as respondent	88%	63%	
Only same sex as respondent	48	26	
Only different sex than respondent	12	37	
Both male and female	40	37	
	<u>Targeted-Minority Respondents</u>	<u>Non-Hispanic White Respondents</u>	<u>Asian Respondents</u>
<b>Faculty mentors</b>			
<i>Number of respondents:</i>	727	2,051	254
At least one same race/ethnicity as respondent	36%	89%	11%
Only same race/ethnicity as respondent	17	68	1
Only different race/ethnicity than respondent	64	11	89
Both same and different race/ethnicity, relative to respondent	19	21	10
<b>Graduate-student/postdoc mentors</b>			
<i>Number of respondents:</i>	504	1,418	188
At least one same race/ethnicity as respondent	42%	79%	31%
Only same-race/ethnicity as respondent	19	44	8
Only different race/ethnicity than respondent	58	21	69
Both same and different race/ethnicity, relative to respondent	23	35	23

This table shows, for example that 90% of male respondents reported that at least one of their faculty mentors were men.  
Note: Includes only those who reported having each type of mentor (faculty or graduate-student/postdoc).  
Source: SRI International: NSF follow-up survey, 2005.

who had female faculty mentors); 31% of Asians had same-race/ethnicity graduate-student/postdoc mentors (vs. 11% for faculty mentors); and 42% of targeted minorities had same-race/ethnicity graduate-student/postdoc mentors (vs. 36% for faculty mentors). This is a reflection that the pool of female and Asian STEM researchers is growing more rapidly than is the pool of targeted minority researchers.

## **OVERVIEW OF UNDERGRADUATE RESEARCH CHARACTERISTICS AND ACTIVITIES**

About 8 in 10 follow-up survey respondents participated in summer research, and about the same proportion participated in research during the academic year. Two-thirds reported that they participated in research for at least 12 months, and a third participated for at least 24 months. Although respondents were selected in 2003 on the basis of their participation in an NSF program, in 2005, more than a fifth of the respondents were not aware that NSF had sponsored any of their activities.

The most common research-related activity was collecting/analyzing data to try to answer a research question, reported by almost 9 in 10 respondents. About three-fourths also said they understood how their work contributed to the “bigger picture” of research in that field, had input to or responsibility for decisions about what to do next, and delivered an oral presentation describing their research and results. Only 6% said they did little or nothing that seemed to them to be real research.

Most faculty and graduate-student/postdoc mentors were non-Hispanic white males. Only half of the female respondents had at least one female faculty mentor, and only about a third of targeted minority respondents had at least one faculty mentor who was the same race/ethnicity as they were.

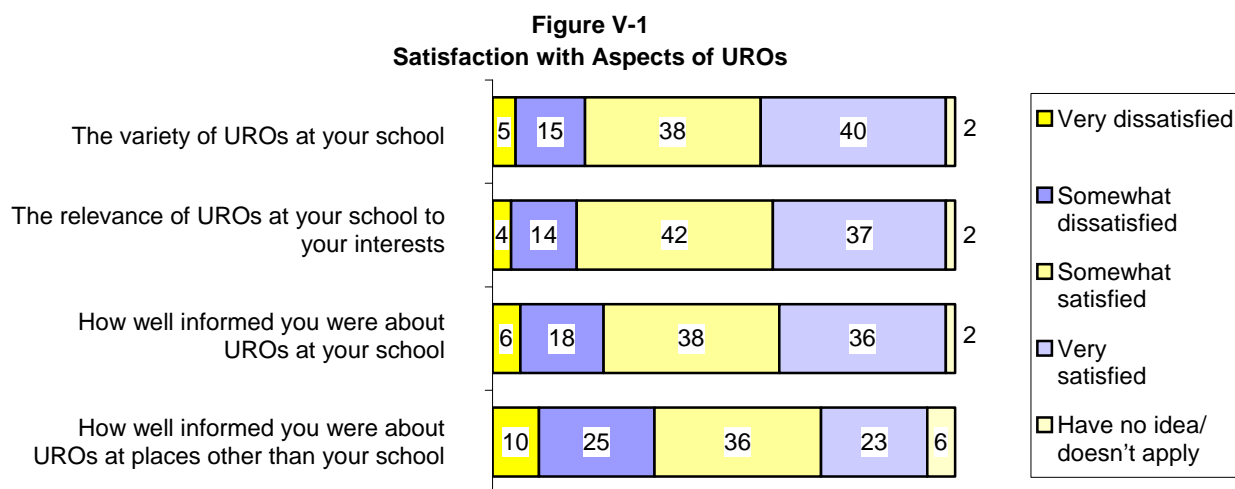
## V. STUDENT PERCEPTIONS AND RESEARCH OUTCOMES

The follow-up survey covered a variety of topics relating to respondents' perceptions of their research experiences and research outcomes:

- The variety, relevance, and information available about UROs.
- Adequacy of interactions with mentors.
- Overall satisfaction with undergraduate research experiences.
- Gains on various dimensions as a result of undergraduate research experiences (e.g., confidence in one's research-related abilities, understanding of the research process, awareness of STEM career options).
- What research taught students about themselves (e.g., "I learned a lot about my personal strengths and weaknesses," "I learned that I want to go for a PhD," "I learned that I have the ability to be a competent researcher").
- Importance of undergraduate research in academic and career decisions and interests.
- Expectations regarding the highest academic degree one was likely to obtain.

### AVAILABILITY OF RESEARCH OPPORTUNITIES

Only about 4 in 10 respondents were very satisfied with how well informed they were about the UROs at their own college or university, the variety of UROs at their institution, and the relevance of those opportunities to their research interests (Figure V-1). Even fewer—about a fourth—were very satisfied with how well informed they were about UROs at places other than their own school.



Source: SRI International: NSF follow-up survey, 2005.

Students at research-extensive universities were the most likely to be very satisfied with the variety of their school's UROs (44% vs. 33% to 39% at other types of schools) and with the relevance of UROs to their interests (40% vs. 31% to 34%), but they were the least likely to be

very satisfied with how well informed they were about their school's UROs (33% vs. 37% to 45%) and UROs at other places (17% vs. 25% to 32%). Students at baccalaureate colleges were distinctive in that they were the most likely to be very satisfied with how well informed they were about their college's UROs (45%). The dimension that produced the largest differences with regard to information about UROs at places other than one's own school was race/ethnicity. Hispanics/Latinos and, especially, blacks were more likely than Asians and non-Hispanic whites to be very satisfied (30% of Hispanics/Latinos, 41% of blacks, and 18% of Asians and non-Hispanic whites). Among Hispanics/Latinos, the relatively positive ratings were largely attributable to the women, but among the other racial/ethnic groups, men and women had equivalent ratings. There were no appreciable differences on these issues by respondents' current academic status or between men and women overall.

## ADEQUACY OF INTERACTIONS WITH MENTORS

More than two out of three respondents reported that they had received about the right amount of interaction, support, and guidance from faculty and (among those who worked with them) from grad students/postdocs. Of those remaining, almost all said they wished they had received more interaction/support/guidance; only 1% to 2% of those to whom each item was applicable said they wished they had received less. Students at baccalaureate and master's colleges were the most likely to think they had received about the right amount of support and guidance, whereas those at research-extensive universities were the least likely to think so (Table V-1). Interestingly, black women and white women were slightly less likely than others to wish that they had more interaction with their faculty mentor. There were no appreciable differences on these items by respondents' current academic status or mentors' sex or race/ethnicity.

	Baccalaureate	Doctoral/ Research- Extensive	Doctoral/ Research- Intensive	Master's	Other	All
<i>Number of respondents:</i>	609	1,737	290	540	76	3,280
Wish I had more	17*	29**	25	19*	24	25
Had about the right amount	75**	66*	68	77**	67	70
Wish I had less	1	1	2	1	2	1
Too varied to say	7**	3*	4	3	7	4
Have no idea/ doesn't apply	1	1	1	< 1	0	1

This table shows, for example, that 17% of follow-up survey respondents whose undergraduate home institution was a baccalaureate college reported that they wished they had received more support and guidance from their research faculty mentors.

Note: The "All" column includes 29 respondents with undergraduate home institutions of unknown Carnegie classification.

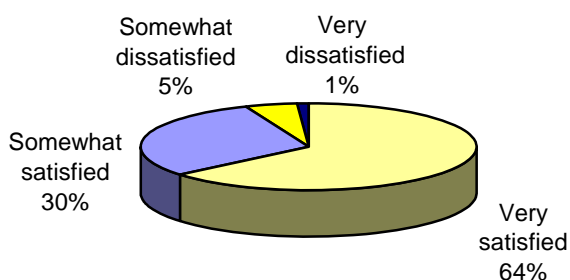
\*This group's percentage is reliably lower than that of all other groups combined ( $p < .05$ ).

\*\*This group's percentage is reliably higher than that of all other groups combined ( $p < .05$ ).

Source: SRI International: NSF follow-up survey, 2005.

## OVERALL SATISFACTION WITH UNDERGRADUATE RESEARCH

**Figure V-2**  
**Overall Satisfaction with Undergraduate Research Experiences**



Source: SRI International: NSF follow-up survey, 2005.

Most respondents (64%) were very satisfied with their undergraduate research experiences overall (Figure V-2). About half (48%) said it was “one of the best experiences of my life,” and almost half (43%) wished they had done more; essentially no one (2%) wished they had done less. Among respondents who had received their bachelor’s degree, current graduate students were more likely than those who had not attended or were no longer attending graduate school to be very satisfied (percentages very satisfied: 68%, 58%, and 53%, respectively).

## GAINS IN UNDERSTANDING, CONFIDENCE, AND AWARENESS

In both the initial and follow-up surveys, undergraduates were asked to rate the extent to which their undergraduate research experiences had increased their confidence, understanding, and awareness on various dimensions. The only difference between the two sets of items was that the initial survey asked specifically about effects of undergraduate research experiences during summer 2002 or the 2002-03 academic year, whereas the follow-up survey asked about the effects of all undergraduate research experiences.

Percentage distributions and mean responses to each item in the follow-up survey are presented in Table V-2. Areas in which respondents believed that they had made the most gains were those central to the focus of most undergraduate research experiences:

- Understanding of the nature of the job of a researcher (66% gained a great deal)
- Understanding of how to conduct a research project (60% gained a great deal).

Other areas in which at least half of the respondents reported that they had gained a great deal were:

- Understanding of how to deal with setbacks (54%)
- Skills/abilities in working independently (53%)
- Understanding of how to plan a research project (50%).

Areas with the fewest respondents reporting gains were:

- Awareness of the variety of STEM fields one could specialize in (33%)
- Awareness of STEM career options (30%).

**Table V-2**  
**Follow-up Survey Respondents' Perceptions of Gains on Various Dimensions**  
**as a Result of Their Undergraduate Research Experiences**  
**(Listed in descending order of mean rating)**

Number of respondents: 3,268 – 3,293

	Mean	How Much Each Increased:				
		Not at All	Some-what	A Fair Amount	A Great Deal	Have No Idea
Your understanding of the nature of the job of a researcher (U)	3.58	1%	6%	26%	66%	< 1%
Your understanding of how to conduct a research project (U)	3.46	2	10	28	60	< 1
Your skills/abilities in working independently	3.38	2	12	33	53	< 1
Your understanding of how to deal with setbacks, "negative results," etc. (U)	3.36	2	13	30	54	< 1
Your understanding of how to plan a research project (U)	3.28	3	16	31	50	< 1
Your confidence in your research skills generally (C)	3.26	3	13	37	46	< 1
Your confidence in your ability to succeed in grad school (C)	3.24	5	14	34	47	1
Your understanding of how scientific/math/engineering knowledge is built (U)	3.23	3	15	36	45	1
Your understanding of how to formulate a research question (U)	3.20	4	18	34	45	< 1
Your awareness of career paths of the faculty you worked with (A)	3.20	5	17	31	47	< 1
Your qualifications for jobs in related fields (C)	3.13	5	18	35	41	1
Your skills/abilities in working collaboratively with others	3.12	3	20	37	39	< 1
Your awareness of what graduate school is like (A)	3.06	7	19	33	40	1
Your awareness of the variety of science/math/engineering fields you could specialize in (A)	2.94	7	25	35	33	< 1
Your awareness of career options in science/math/engineering (A)	2.90	6	27	36	30	< 1

This table shows, for example, that 1% of follow-up survey respondents indicated that their understanding of the nature of the job of a researcher was not at all increased by their undergraduate research experiences.

Notes: Mean is calculated on a 4-point scale, where 1 = not at all, 2 = somewhat, 3 = a fair amount, and 4 = a great deal.

(U) = part of the "understanding" index.

(C) = part of the "confidence" index.

(A) = part of the "awareness" index.

Source: SRI International: NSF follow-up survey, 2005.

A factor analysis procedure was used to identify clusters of intercorrelated items. This procedure led to the creation of three indices, which we termed "increased understanding," "increased confidence," and "increased awareness."<sup>27</sup> For each index, respondents were grouped into four approximately equally sized categories on the basis of their mean rating on items in that index.<sup>28</sup> The lowest possible index score was 1.0, indicating that the respondent reported s/he

<sup>27</sup> Two items—your skills/abilities in working independently and your skills/abilities in working collaboratively with others—did not correlate highly with any of the other items nor with each other, so they were not included in an index.

<sup>28</sup> Because many respondents had the same scores, sorting into exactly equally sized quartiles was not possible.

had not gained at all on any of the dimensions in the index; the highest possible score was 4.0, indicating that the respondent reported s/he had gained a great deal on all dimensions in the index. For group comparisons and analyses of the relationships between the indices and other variables, we focused on the percentage of respondents with scores in the top category/quartile of each index, whom we term “high gainers.”<sup>29</sup> Below we present, for each index, the mean rating, the scores that comprised the high gainers group, the percentage of all respondents who were high gainers, and the items in the index.

*Increased understanding:* mean rating, 3.35; high gainers’ scores: 3.83 to 4.0 (32% of respondents).

- How to formulate a research question
- How to plan a research project
- How to conduct a research project
- How to deal with setbacks, “negative results,” etc.
- How STEM knowledge is built
- The nature of the job of a researcher

*Increased confidence:* mean rating, 3.21; high gainers’ scores: 4.0 (30% of respondents).

- Confidence in your research skills generally
- Confidence in your ability to succeed in grad school
- Qualifications for jobs in related fields

*Increased awareness:* mean rating, 3.03; high gainers’ scores: 3.6 to 4.0 (24% of respondents).

- Career paths of the faculty in the program (how they got to where they are now)
- What graduate school is like
- The variety of STEM fields you could specialize in
- STEM career options

Follow-up survey respondents reported marginally higher gains in understanding than did initial survey respondents (32% and 26%, respectively, were high gainers). Ratings on the confidence and awareness indices were virtually identical in the two surveys.

We looked at differences in follow-up survey ratings on the three “gains” indices sorted by the Carnegie classification of the respondent’s baccalaureate institution; whether the respondent began college at a 2-year school; and the respondent’s NSF program, academic major, academic class in 2003, race/ethnicity, and sex. Differences are summarized below. The patterns of group differences reported here are very similar to those found in the initial survey.<sup>30</sup>

- Interestingly, despite the reputed advantages of doctoral/research-intensive universities with regard to undergraduate research opportunities, respondents who attended these schools had lower than average gains on all three indices (25% were high gainers in

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<sup>29</sup> From a statistical perspective, the mean ratings provide a better metric for comparison. We chose to focus instead on percentages because we have found that percentages have greater intuitive meaning for most people than do means.

<sup>30</sup> Group differences are reported in more detail on pages 48-51 of the initial survey report, which is available at <http://www.sri.com/policy/csted/reports/university/index.html#uro>.

confidence). Those who attended doctoral/research-intensive universities or master's institutions had higher than average gains on all three indices (44% and 35%, respectively, were high gainers in confidence).

- On all three gains indices, LSAMP participants had above-average ratings, whereas VIGRE participants had below-average ratings. With regard to gains in confidence, for example, 41% of LSAMP participants were high gainers, compared with 15% of VIGRE participants. Center participants were distinctive in their below-average ratings on the understanding and confidence indices, but they had above-average gains in awareness.
- Majors in life sciences had above-average gains on all three indices (38% were high gainers in confidence); mathematics and physics majors had below-average gains (15% and 18%, respectively, were high gainers in confidence). The relative ratings of other majors were variable.
- Hispanics/Latinos tended to have above-average ratings, and non-Hispanic whites tended to have below-average ratings. For example, 40% of Hispanics/Latinos were high gainers in confidence, compared with 26% of non-Hispanic whites. The above-average Hispanic/Latino ratings were attributable mostly to women, whereas the below-average non-Hispanic white ratings were attributable mostly to men.
- Overall, however, there were no appreciable differences between men and women. There also were no appreciable differences among the 2002-03 academic classes (freshmen, sophomores, juniors, and seniors) or between those who started college at a 2-year school and those who did not.

Surprisingly, in spite of the many and sometimes large differences among subgroups on the dimensions noted above, there were only small differences in gains on the basis of whether they attended graduate school and their higher-degree expectations. We discuss this issue further in Chapter VI.

## **WHAT RESEARCH TAUGHT STUDENTS ABOUT THEMSELVES**

Respondents to the initial survey were asked to describe the most important thing they learned about themselves as a result of their undergraduate research experiences. From these responses, we developed a list of 28 possible “research effects” that reflected the range and variety of responses. Follow-up survey respondents were asked to indicate which of these 28 effects applied to them. Table V-3 lists the statements in descending order of the percentage of respondents who selected them.

The five statements selected most often were:

- I learned that you have to have patience with research (selected by 78% of respondents).
- I learned what the “world” of research is like (75%).
- I learned that there are different skills required for classroom success and research success (73%).

**Table V-3**  
**Perceived Effects of Undergraduate Research Experiences:**  
**Percentage of Respondents Who Selected Each Statement**  
**(Listed in descending order)**

**Number of respondents: 3,278**

I learned that you have to have patience with research. (D)	78
I learned what the “world” of research is like. (D)	75
I learned that there are different skills required for classroom success and research success. (D)	73
I learned that I have the ability to be a competent researcher. (C)	73
I learned how to apply concepts that I had learned in the classroom to a real situation. (C)	70
Undergraduate research helped me to be self-motivated. (A)	69
I learned that “real” research is much different from experience gained in lab classes. (D)	67
I learned a lot about my personal strengths and weaknesses. (A)	61
My knowledge and understanding of STEM increased a lot because of my undergraduate research. (C)	59
I learned how to work effectively with others. (A)	59
I learned what it takes to be a successful graduate student. (C)	52
I learned how to figure out for myself things that I needed to know. (A)	49
Undergraduate research was one of the best experiences of my life. (C)	48
Doing research made me better able to tackle complex problems. (A)	48
My research experiences taught me that I can do what I set out to do even if there are setbacks along the way. (A)	47
I learned better time management skills. (A)	43
I learned that I would like to continue research as a career in a field similar to my undergraduate research. (B)	42
I learned that I want to go for a PhD. (B)	40
I learned that I can do things I didn't think I could do. (A)	39
I learned that I am a good problem solver. (A)	39
I liked research better than I expected I would.	31
Doing research convinced me that I am more interested in graduate school than medical school. (B)	27
Undergraduate research helped me to be more dependable. (A)	27
My research experiences introduced me to a career I had never known existed.	23
Doing research helped me get better grades.	18
I learned that research is not for me. (E)	17
I learned that I do not have the patience for research. (E)	11
Doing research convinced me that I am more interested in medical school than graduate school.	9

This table shows, for example, that 78% of follow-up survey respondents indicated that they learned from their undergraduate research experiences that you have to have patience with research.

Notes: Letters in parentheses indicate the index (if any) to which the item belongs.

A = learned basic skills

B = helped grad school decision

C = gained professional competence

D = learned about the world of research

E = learned research is not for me

Source: SRI International: NSF follow-up survey, 2005.

- I learned that I have the ability to be a competent researcher (73%).
- I learned how to apply concepts that I had learned in the classroom to a real situation (70%).

The five statements selected least often were:

- My research experiences introduced me to a career I had never known existed (23%).
- Doing research helped me get better grades (18%).
- I learned that research is not for me (17%).
- I learned that I do not have the patience for research (11%).
- Doing research convinced me that I am more interested in medical school than graduate school (9%).

As with the gains items, a factor analysis was used here as the basis for the creation of indices, which we labeled as follows:

- A. Learned basic skills (10 items, selected by an average of 48% of respondents)
- B. Helped grad school decision (3 items, average 36%)
- C. Gained professional competence (5 items, average 60%)
- D. Learned about the world of research (4 items, average 73%)
- E. Learned that research is not for me (2 items, average 14%)

Table V-3 shows which items are in each index. Not surprisingly, given the rather close correspondence in subject matter, all these indices except “learned that research is not for me” correlated positively with the gains indices, and the patterns of results among the various analytical subgroups were generally similar. Among the academic-status groups, current undergraduates and PhD-bound graduate students tended to have higher scores than others on indices A through D. On index E—learned that research is not for me—PhD-bound graduate students had the lowest score (5%), whereas graduate students not expecting a PhD had the highest score (27%).

Some interesting findings on individual items were as follows:

- Women were more likely than men to select “I learned I can do things I didn’t think I could do” (44% vs. 32%) and “I learned that research is not for me” (20% vs. 14%).
- Among life science majors, 19% selected “Doing research convinced me that I am more interested in medical school than graduate school,” but 37% selected “Doing research convinced me that I am more interested in graduate school than medical school.”
- Sixty-four percent of Hispanics/Latinos selected “Undergraduate research was one of the best experiences of my life,” compared with 44% to 47% of the other racial/ethnic groups.

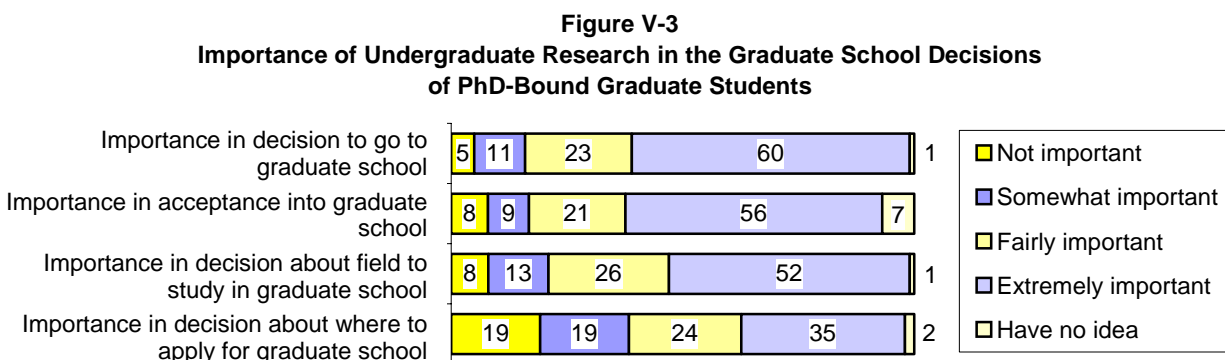
## IMPORTANCE OF UNDERGRADUATE RESEARCH IN ACADEMIC AND CAREER DECISIONS AND INTERESTS

### Choice of Baccalaureate School

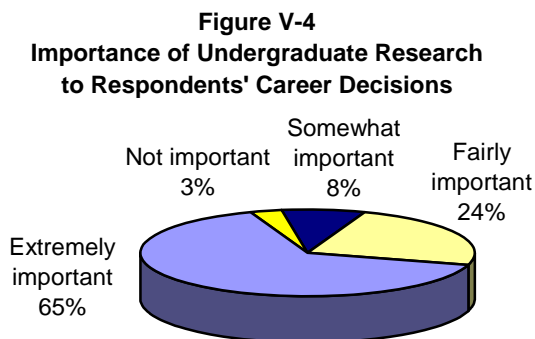
Nine in 10 respondents participated in undergraduate research at their own college/university. Of these, 52% reported that when they first enrolled as an undergraduate they knew that the school offered undergraduate research, and of these, 55% said that these UROs were fairly or extremely important in their decision to enroll. Thus, overall, UROs were important in the decision to enroll for only a fourth of the respondents. Respondents who were still undergraduates (and thus likely to have been freshmen or sophomores when we surveyed them 2 years earlier about their research experiences) were more likely than those who had received their bachelor's to have been aware of UROs when they enrolled (63% vs. 50%). Among those who were aware of UROs, there were no appreciable subgroup differences (by race/ethnicity, sex, type of school, and so on) in the importance of UROs to the decision to enroll.

### Graduate School Decisions

A large majority of PhD-bound graduate students reported that their undergraduate research experiences were fairly or extremely important in their decision to attend graduate school (83%), their decision about what field to study in graduate school (78%), and their acceptance into graduate school (77%); most (59%) also indicated that undergraduate research was important in helping them decide where to apply (Figure V-3).



Source: SRI International: NSF follow-up survey, 2005.



Source: SRI International: NSF follow-up survey, 2005.

### Career Decisions

Regardless of whether they were PhD bound, almost all follow-up survey respondents (89%) reported that their undergraduate research experiences were fairly or extremely important to their career decision (Figure V-4). Not surprisingly, however, those who expected to obtain a PhD rated undergraduate research as especially important: 8 in 10 said it was extremely important, compared with about half of other baccalaureate recipients and two-thirds of current undergraduates.

## Changes in Interest in Various Careers

In both the initial and follow-up surveys, respondents were asked how much their interest had changed in careers in science, math, or engineering; research; teaching; and medicine as a result of all their undergraduate research experiences. Respondents used a 5-point scale, where 1 = decreased a lot, 2 = decreased somewhat, 3 = no effect, 4 = increased somewhat, and 5 = increased a lot. A “have no idea” response option was also provided. Table V-4 summarizes follow-up survey responses to these questions.

	<i>Number of Respondents</i>	<i>Mean</i>	<i>Decreased Somewhat or a Lot</i>	<i>No Effect/ Have No Idea</i>	<i>Increased Somewhat</i>	<i>Increased a Lot</i>
Science, math, or engineering	3,285	3.89	7%	24%	39%	30%
Research	3,286	3.72	20	12	35	32
Teaching	3,270	3.56	9	43	28	20
Medicine	3,275	3.08	13	67	11	8

This table shows, for example, that 7% of undergraduates thought that their interest in a career in science, math, or engineering had decreased as a result of all their undergraduate research experiences.

Note: Mean is calculated on a 5-point scale, where 1 = decreased a lot, 2 = decreased somewhat, 3 = no effect/have no idea, 4 = increased somewhat, and 5 = increased a lot.

Source: SRI International: NSF follow-up survey, 2005.

About 7 in 10 respondents said that their interest in careers in STEM and research increased somewhat or a lot, and about 3 in 10 said that their interest increased a lot. About half of the respondents reported that their interest in a career in teaching increased, and interest in a medical career was almost as likely to have decreased (13%) as increased (19%).

Follow-up survey ratings were less positive, on average, than initial survey ratings, especially with regard to research careers. Among those who participated in both surveys, 45% reported in the initial survey that their interest in a career in research increased a lot, compared with 32% in the follow-up survey. Not surprisingly, those who gave lower ratings in the follow-up survey than in the initial survey were less likely than those whose ratings were unchanged or those who gave higher ratings in the follow-up survey to expect to obtain a PhD (44% vs. 65% and 61%, respectively) and more likely to report that they had learned that research was not for them (28% vs. 11% and 11%). However, the amounts and types of research they had participated in; their assessments of gains from their research experiences; and their satisfaction with research, their interactions with mentors, and so on, were not very different from those of other respondents. The decline in perceived effect may reflect a general tendency to see events in the immediate past as having greater import than they are seen to have from a longer perspective. Even given the decline, the overall perceived effect remained considerable.

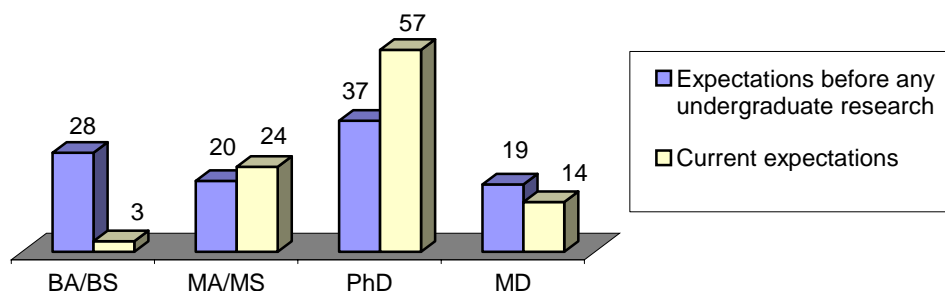
Group differences in increased career interests were generally similar to but less pronounced than those found in the initial survey. Those most likely to report increased interest in STEM,

research, and teaching careers were Hispanics/Latinos (both men and women), PhD-bound graduate students, majors in chemistry and environmental sciences, and, among nonstudents, those whose current job involved science or math research or engineering. There were no appreciable differences between men and women nor between those who started their college career at a 2-year school and those who did not. Not surprisingly, graduate students *not* expecting to obtain a PhD (40% of whom were in medical or health science fields) were the most likely to report increased interest in a career in medicine.

## HIGHEST DEGREE EXPECTATIONS

In both the initial and follow-up surveys, we asked, “Before your first undergraduate research experience, what was the highest degree you expected to receive?” and “What is the highest degree you expect to have 10 years from now?” As shown in Figure V-5, the percentages of follow-up survey respondents who expected that a bachelor’s degree would be their highest degree fell substantially and those who expected that an MD would be their highest degree fell slightly, whereas the percentage who expected a PhD increased substantially. Moreover, 29% had “new” expectations of obtaining a PhD (that is, they did not have pre-research expectations of obtaining a PhD, but they now expected to obtain one).<sup>31</sup> These patterns were comparable to those found in the initial survey.

**Figure V-5**  
**Highest Degree Expectations:**  
**Percentage Who Expected That Degree Listed Would Be Highest They Obtained**



Note: PhD and MD categories include those who said “MD or PhD (not sure which)” or “MD and PhD (both).”  
 Source: SRI International: NSF follow-up survey, 2005.

There were large differences in pre-research and current (as of the survey) PhD expectations among the academic-major groups. Chemistry, math, and physics majors were the most likely to have pre-research and current PhD expectations, whereas computer science and engineering majors were the least likely to do so (Table V-5). Despite the differences in pre-research and current expectations, however, there were few appreciable differences among the academic majors in the percentages with new PhD expectations. The single exception was that only 11% of non-STEM majors had new PhD expectations, compared with 29% overall.

<sup>31</sup> Percentages of those who expected a PhD or an MD include those who were not sure which of those two degrees they would obtain, as well as those who expected to obtain both degrees. Note also that the percentage of those with current expectations is not simply the sum of those with pre-research expectations and those with new expectations because some of those with pre-research expectations of obtaining a PhD no longer expected to do so.

**Table V-5**  
**Percentages Who Had Pre-Research, Current, and New Expectations of Obtaining a PhD,**  
**by Academic Major**

	Computer Sciences	Chemistry	Engineering	Environmental Sciences	Life Sciences	Mathematics	Physics	Social/Behav. Sciences	Interdisc.	Non-STEM	All
<i>Number of respondents:</i>	158	286	531	129	546	314	360	224	689	59	3,296
Pre-research expectations	23*	48**	20*	21*	39	51**	59**	32	44**	34	37
Current expectations	43*	72**	44*	48	56	70**	74**	52	60	30*	57
New expectations	29	34	31	32	29	29	25*	31	28	11*	29

This table shows, for example, that before they did any undergraduate research, 23% of undergraduate researchers in computer sciences expected that they would obtain a PhD.

Notes: Those with new expectations did not have pre-research expectations of obtaining a PhD but did at the time of the survey.  
 Percentages include those who were not sure whether they would obtain a PhD or an MD and those who expected to obtain both degrees.  
 The percentage of those with current expectations is not simply the sum of the two other groups because some of those with pre-research expectations of obtaining a PhD no longer expected to do so.

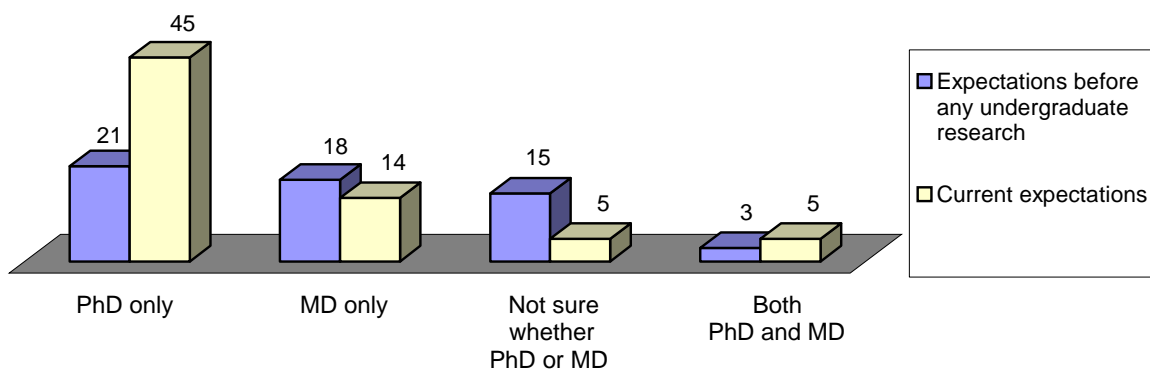
\*This group's percentage is reliably lower than that of all other groups combined ( $p < .05$ ).

\*\*This group's percentage is reliably higher than that of all other groups combined ( $p < .05$ ).

Source: SRI International: NSF follow-up survey, 2005.

Among life science majors, there was movement away from expecting to obtain an MD and toward expecting to obtain a PhD. The percentage who expected to obtain only a PhD<sup>32</sup> increased from 21% pre-research to 45% currently, whereas the percentage who expected only an MD decreased from 18% to 14%, and the percentage who weren't sure whether they would obtain an MD or a PhD decreased from 15% to 5% (Figure V-6).

**Figure V-6**  
**PhD and MD Expectations of Life Science Majors:**  
**Percentage Who Expected That Degree(s) Listed Would Be Highest They Obtained**



Source: SRI International: NSF follow-up survey, 2005.

<sup>32</sup> “PhD only” and “MD only” do *not* include those who were not sure which of the two degrees they would obtain or those who expected to obtain both degrees.

There were relatively small differences in PhD expectations among the racial/ethnic groups (Table V-6). Most notably, black and Hispanic/Latino men and Asian women had lower than average levels of pre-research PhD expectations, whereas Hispanic/Latina women were more likely than average to have current expectations of obtaining a PhD.

**Table V-6**  
**Percentages Who Had Pre-Research, Current, and New Expectations of Obtaining a PhD, by Race/Ethnicity and Sex**

	Asian		Black		Hispanic/Latino		Non-Hispanic White		All
	Male	Female	Male	Female	Male	Female	Male	Female	
<i>Number of respondents:</i>	122	158	102	177	183	204	1,118	1,043	3,296
Pre-research expectations	42	30*	27*	33	28*	37	41**	33	37
Current expectations	50	52	49	55	54	63**	61**	54	57
New expectations of obtaining a PhD	21*	30	34	34	36	34	29	26*	29

This table shows, for example, that before they did any undergraduate research, 42% of Asian male respondents expected that they would obtain a PhD.

Notes: Those with new expectations did not have pre-research expectations of obtaining a PhD but now do.  
Percentages include those not sure whether they would obtain a PhD or an MD and those who expected to obtain both degrees.  
The percentage of those with current expectations is not simply the sum of the two other groups because some of those with pre-research expectations of obtaining a PhD no longer expect to do so.  
The "All" column includes 131 respondents of multiple races and 60 of unknown race/ethnicity.

\*This group's percentage is reliably lower than that of all other groups combined ( $p < .05$ ).  
\*\*This group's percentage is reliably higher than that of all other groups combined ( $p < .05$ ).

Source: SRI International: NSF follow-up survey, 2005.

Correspondingly, respondents who started their undergraduate education at a 2-year college (31% of whom were Hispanics/Latinos) were much less likely than those who started at a 4-year institution to have pre-research PhD expectations (22% vs. 39%) but more likely to have new PhD expectations (39% vs. 28%). There was no difference between these two groups in the percentage with current PhD expectations.

There were no statistically significant differences in PhD expectations between men and women overall.

## OVERVIEW OF STUDENT PERCEPTIONS AND RESEARCH OUTCOMES

Most students were very satisfied overall with their undergraduate research experiences; felt that they had received about the right amount of interaction, support, and guidance from their mentors; and felt they had gained confidence, understanding, and awareness of the world of research. Concomitantly, most felt that their interest in STEM and research careers increased as a result of their research experiences, and almost all reported that their research experiences influenced their career decisions. Those currently in graduate school and expecting to obtain a PhD also reported that their undergraduate research experiences had a strong influence on their decisions about graduate school. In contrast, few students reported that UROs were important in their selection of a baccalaureate school. Compared with satisfaction with research experiences, satisfaction with the variety of UROs and availability of information about UROs was relatively

low. Satisfaction with the availability of information about UROs at places other than one's school was especially low.

Almost 6 in 10 respondents said that they expected to obtain a PhD, up from a little less than 4 in 10 who had such expectations before they were involved in undergraduate research activities. Chemistry, math, and physics majors were the most likely to expect to obtain a PhD; computer science and engineering majors were the least likely to do so. There were only small differences among racial/ethnic groups on these measures and no statistically significant differences between men and women.

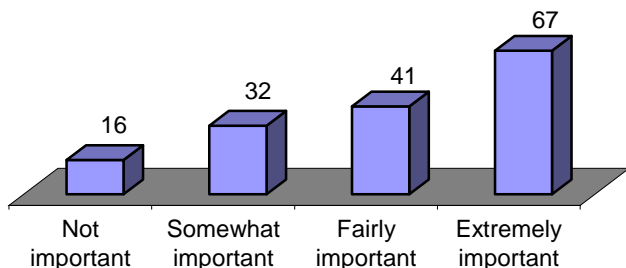
## VI. CORRELATES OF UNDERGRADUATE RESEARCH OUTCOMES

Outcome measures were related to one another to varying degrees. They also were quite strongly related to some of the characteristics of research experiences and to motivations for participating in research. Each group of relationships is discussed below. Study variables that were most strongly related to perceived increases in confidence are summarized in Table VI-1, those most strongly related to increased interest in a research career are shown in Table VI-2, and those most strongly related to respondents' current expectations of obtaining a PhD are shown in Table VI-3.

### RELATIONSHIPS AMONG OUTCOME MEASURES

Current and new expectations of obtaining a PhD were strongly related to increased interest in STEM and research careers and to the perceived importance of undergraduate research to one's career decision. For example, 67% of those who said research was extremely important to their career decision expected to obtain a PhD, compared with 16% of those who said research was not important to their career decision (Figure VI-1). Conversely, 77% of respondents who expected to obtain a PhD said their undergraduate research experiences were extremely

**Figure VI-1**  
Percentage Who Expect to Obtain a PhD within the Next 10 Years, by Importance of Undergraduate Research to Respondent's Career Decision



Source: SRI International: NSF follow-up survey, 2005.

important to their career decision, versus 49% of those who did not expect to obtain a PhD. Similarly, 48% of current PhD-bound graduate students said that their interest in a research career increased a lot, versus 14% to 20% of other graduates.

Perceived importance of research to career decisions and increased interest in STEM-related careers also were quite strongly related to gains in confidence and understanding: 37% of those who said research was extremely important to their career decision were high gainers on the

confidence index, compared with only 11% of those who said research was not or somewhat important to their career decision.

As noted in Chapter V, we were surprised to find that gains in confidence, understanding, and awareness were not strongly related to PhD expectations, and there were only small differences in gains on these dimensions among the academic-status groups. For example, among those who had received their bachelor's degree, 32% of graduate students expecting to obtain a PhD were high gainers in confidence, compared with 28% graduate students not expecting a PhD and 26% of those who were not graduate students. Similarly, 34% of those who expected to obtain a PhD in 10 years were high confidence gainers, compared with 25% of those who did not expect to do so—a difference that is in the expected direction, but certainly much smaller than one would have predicted. Differences on the understanding and awareness indices were even smaller. Thus, although perceived gains in STEM-related confidence,

**Table VI-1  
Top Follow-up Survey Correlates of Perceived Increases in Confidence**

	<b>Group with the Largest Percentage of High Confidence Gainers</b>		<b>Group with the Smallest Percentage of High Confidence Gainers</b>	
<b>Outcomes</b>				
Change in interest in a career in research as a result of undergraduate research	Increased a lot	46%	Decreased a lot	11%
Change in interest in a STEM career as a result of undergraduate research	Increased a lot	48	Decreased	18
Satisfaction with undergraduate research experiences overall	Very satisfied	40	Somewhat/very dissatisfied	11
Importance of undergraduate research to one's career decision	Extremely important	37	Not important	6
How much use undergraduate research skills in current job (excluding current students)	A lot	43	Not at all	16
<b>Research experiences/characteristics</b>				
Number of research activities	12 or more	45	Fewer than 7	13
Total duration of undergraduate research	24 months or more	39	Less than 6 months	17
Gained increasing independence	Yes	36	No	15
Mentored other student researchers or led student research groups	Yes	45	No	25
Did little or no real research	No	31	Yes	13
Who usually made decisions about what to do next	Respondent	38	Mentor	20
Understood how work contributed to "bigger picture"	Yes	34	No	17
Attended professional conferences	Yes	41	No	24
<b>Reasons for participating in research</b>				
Personal enthusiasm as a reason to participate in research	Very important	38	Not important	16
Needing help with a career/academic decision as a reason to participate in research	Very important	40	Not important	23

This table shows, for example, that 46% of follow-up survey respondents who reported that their interest in a career in research increased a lot as a result of their undergraduate research experiences were high gainers on the confidence index, vs. only 11% of those who reported that their interest in a research career decreased a lot.

Notes: "High confidence gainers" are those in the top 30% of ratings on the index of increased confidence. "Personal enthusiasm" and "needing help with a career/academic decision" are indices comprising three or more items. For each, the "very important" group consists of those in the top group (approximately the top quartile) of ratings on each index; the "not important" group consists of those in the bottom group/quartile of ratings.

Source: SRI International: NSF follow-up survey, 2005.

**Table VI-2  
Top Follow-up Survey Correlates of Increased Interest in a Career in Research**

	<b>Group with the Largest Percentage of Those Whose Interest in a Career in Research Increased a Lot</b>		<b>Group with the Smallest Percentage of Those Whose Interest in a Career in Research Increased a Lot</b>	
<b>Outcomes</b>				
Importance of undergraduate research to one's career decision	Extremely important	44%	Not important	2%
Expect to have a PhD 10 years from now	Yes	46	No	13
Satisfaction with undergraduate research experiences overall	Very satisfied	41	Somewhat/very dissatisfied	10
New expectations of obtaining a PhD	Yes	53	No	23
How much use undergraduate research skills in current job (excluding current students)	A lot	29	Not at all	13
Current job involves science research (excluding current students)	Yes	28	No	16
<b>Research experiences/characteristics</b>				
Total duration of undergraduate research	24 months or more	46	Less than 6 months	16
Number of research activities	12 or more	46	Fewer than 7	16
Attended professional conferences	Yes	43	No	26
Gained increasing independence	Yes	37	No	21
Did little or no real research	No	33	Yes	18
Mentored other student researchers or led student research groups	Yes	43	No	28
Prepared poster presentation describing research and results	Yes	37	No	12
<b>Reasons for participating in research</b>				
Personal enthusiasm as a reason to participate in research	Very important	45	Not important	13
Needing help with a career/academic decision as a reason to participate in research	Very important	38	Not important	23

This table shows, for example, that 44% of follow-up survey respondents who reported that undergraduate research was extremely important to their career decision also reported that their interest in a career in research increased a lot as a result of their undergraduate research experiences, vs. only 2% of those who reported that undergraduate research was not important to their career decision.

Notes: "Personal enthusiasm" and "needing help with a career/academic decision" are indices comprising three or more items. For each, the "very important" group consists of those in the top group (approximately the top quartile) of ratings on each index; the "not important" group consists of those in the bottom group/quartile of ratings.

Source: SRI International: NSF follow-up survey, 2005.

**Table VI-3  
Top Follow-up Survey Correlates of Expectations of Obtaining a PhD within the Next 10 Years**

	<b>Group with the Largest Percentage of Those Expecting to Obtain a PhD</b>		<b>Group with the Smallest Percentage of Those Expecting to Obtain a PhD</b>	
<b>Outcomes</b>				
Change in interest in a career in research as a result of undergraduate research	Increased a lot	83%	Decreased a lot	14%
Importance of undergraduate research to one's career decision	Extremely important	67	Not important	16
Change in interest in a STEM career as a result of undergraduate research	Increased a lot	70	Decreased	29
Change in interest in a career in teaching as a result of undergraduate research	Increased a lot	74	Decreased a lot	34
Change in interest in a career in medicine as a result of undergraduate research	Decreased somewhat	76	Increased a lot	39
Current job involves science research (excluding current students)	Yes	45	No	31
<b>Research experiences/characteristics</b>				
Total duration of undergraduate research	24 months or more	67	Less than 6 months	42
Number of research activities	12 or more	66	Fewer than 7	45
Who usually made decisions about what techniques/materials were used	Mentor and respondent together	60	Respondent	46
Mentored other student researchers or led student research groups	Yes	66	No	54
Delivered oral presentation describing research and results	Yes	60	No	48
Gained increasing independence	Yes	60	No	49
Authored/co-authored a paper submitted for publication in a professional journal	Yes	64	No	53
<b>Reasons for participating in research</b>				
Personal enthusiasm as a reason to participate in research	Very important	64	Not important	46
Needing help with a career/academic decision as a reason to participate in research	Very important	62	Not important	50
<b>Other</b>				
Overall undergraduate grade point average	3.9 or higher	47	Less than 3.0	27

This table shows, for example, that 83% of follow-up survey respondents who reported that their interest in a career in research increased a lot as a result of their undergraduate research experiences expected to obtain a PhD in the next 10 years, vs. only 14% of those who reported that their interest in a research career decreased a lot.

Notes: "Personal enthusiasm" and "needing help with a career/academic decision" are indices comprising three or more items. For each, the "very important" group consists of those in the top group (approximately the top quartile) of ratings on each index; the "not important" group consists of those in the bottom group/quartile of ratings.

Source: SRI International: NSF follow-up survey, 2005.

understanding, and awareness are valuable outcomes of UROs in and of themselves, they do not necessarily translate into more tangible outcomes, such as pursuit of an advanced degree.

## **RELATIONSHIPS BETWEEN OUTCOMES AND RESEARCH EXPERIENCE CHARACTERISTICS**

Characteristics of the research experiences that tended to be the most strongly related to research outcome measures were number of research activities, total duration of the research experience, gaining increasing independence, mentoring other student researchers or leading a student research team, attending conferences, authoring or co-authoring a paper submitted for publication in a professional journal, and understanding the context of one's research. Together, these characteristics and activities connote a deep involvement in the culture of research. In contrast, activities that tended to have the weakest relationship to outcome measures were likely to have been assigned activities, such as writing a proposal, collecting or analyzing data, and preparing a final report.

Generally speaking, research activities and characteristics were more strongly related to perceived gains in confidence and understanding and to increased interest in research and STEM careers than to PhD expectations or academic status. (Almost all variables were more strongly related to current PhD expectations than to new PhD expectations.) For instance, 36% of respondents who reported that they gained increasing independence over the course of their undergraduate research experiences were high gainers on the confidence index, versus only 15% who did not report increasing independence—a difference of 21 percentage points. By comparison, 60% of those who reported increasing independence expected to obtain a PhD, versus 49% of those who did not report increasing independence—a difference of only 11 percentage points.

## **RELATIONSHIPS BETWEEN OUTCOMES AND REASONS FOR PARTICIPATING IN RESEARCH**

The initial survey asked respondents to rate the importance of potential reasons for participating in research in general and for choosing a particular research program/project. Factor analyses of the items showed that most of the items clustered into five types of motivations. The items in each cluster were combined in the following indices:

- Help with a career/academic decision (e.g., “I wanted to know if science or engineering was for me.”)
- Enthusiasm for research (e.g., “I thought it would be fun.”)
- Meet academic requirements (e.g., “I needed/wanted the academic credit I could get from doing research.”)
- Financial reasons (e.g., “Doing research was more appealing than other kinds of jobs.”)
- Personal connections (e.g., “Someone I knew recommended it.”)

Respondents for whom enthusiasm for research was an important reason for participating in research and those for whom needing help with a career/academic decision was an important reason tended to report higher gains and to be more likely to expect to obtain a PhD than did those for whom these were not important motivations. For example, 64% of those for whom enthusiasm was important expected to obtain a PhD, compared with 46% of those for whom

personal enthusiasm was not important. Engaging in undergraduate research for financial reasons, to meet academic requirements, or because of personal connections tended not to be appreciably related to the outcome measures.

## RELATIONSHIPS OF MENTORS' SEX AND RACE/ETHNICITY TO UNDERGRADUATE RESEARCH OUTCOMES

We asked follow-up survey respondents about the sex of their faculty mentors relative to their own sex.<sup>33</sup> From their responses, we created three groups: “same only,” “different only,” and “some of both.” Then, separately for men and women, we compared the research outcomes reported by these three groups. For example, we compared confidence gains of female respondents who had only female faculty mentors (“same only”), those who had only male faculty mentors (“different only”), and those who had some faculty mentors who were female and some who were male (“some of both”). We also asked about faculty mentors’ race/ethnicity relative to that of the respondent. For this question, we conducted separate analyses for targeted minorities (blacks and Hispanics/Latinos) and non-Hispanic whites.<sup>34</sup> Here, for example, we compared confidence gains of targeted minorities whose mentors were all the same race/ethnicity as the respondent, those whose mentors were all a different race/ethnicity from the respondent, and those who had “some of both.” We also asked about the relative sex and race/ethnicity of the respondents’ graduate-student/postdoc mentors, if any. Thus, we had four respondent groups—men, women, targeted minorities, and non-Hispanic whites—for faculty mentors and four for graduate-student/postdoc mentors. This gave us a total of eight sets of comparisons on any given outcome measure; for each, we compared those with “same only” mentors vs. those with “different only” mentors vs. those with “some of both” mentors.<sup>35</sup> Below we summarize the findings regarding the relationships between these mentor groups and respondents’ overall satisfaction with undergraduate research; their gains in confidence, understanding, and awareness; their responses about what research taught them about themselves; changes in their interest in STEM-related careers; and their expectations of obtaining a PhD.

**Satisfaction with undergraduate research.** Among women, those who had “some of both” faculty mentors were somewhat more likely than those had only male faculty mentors to be very satisfied with their research experiences overall (70% vs. 61%); those who had only female faculty mentors were in-between (66% were very satisfied). There were no appreciable differences among men on these items on the basis of whether their faculty mentors were male or female. There also were no differences among targeted minorities or non-Hispanic whites on the basis of the race/ethnicity of their mentors, or differences among any of the groups on the basis of the sex or race/ethnicity of their graduate-student/postdoc mentors

**Gains in confidence, understanding, and awareness.** Respondents who had “some of both” mentors in terms of both sex and race/ethnicity tended to have slightly higher gains than did those who had “same only” or “different only” mentors. This pattern was more consistent for non-Hispanic whites and men than it was for targeted minorities and women. Among women, those who had only female faculty mentors had slightly higher confidence gains than did

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<sup>33</sup> We did not ask how many different mentors respondents had, but most respondents participated in multiple undergraduate research activities, so most probably had more than one mentor.

<sup>34</sup> Sample sizes were not large enough to present separate results for blacks or Hispanics/Latinos or to present results for Asians.

<sup>35</sup> The sizes of these groups are shown in Table IV-2, on page 27.

those who had only male faculty mentors. However, this advantage of female-only mentors was not evident on either the understanding or awareness gains indices or with regard to graduate-student/postdoc mentors for any of the three gains indices.

**What research taught students about themselves.** As described on pages 34 through 36, the questionnaire included 28 items that asked respondents what they thought their undergraduate research taught them about themselves. We collapsed these 28 items into several indices. For three of these indices—“learned basic skills,” “helped grad school decision,” and “gained professional competence”—we found statistically significant differences on most comparisons. In every case, respondents who had “some of both” mentors stood out as having higher than average scores. Interestingly, women *and* men who had only male mentors tended to have slightly lower than average scores.

**Interest in STEM and research careers.** There were only a few statistically significant differences on the comparisons regarding changes in interest in STEM and research careers. In each case, respondents who had “some of both” mentors showed stronger positive effects than did those with the “same only” or “different only” mentors.

**Current and new PhD expectations.** There were no statistically significant differences on any of the comparisons with regard to current PhD expectations. Non-Hispanic whites who had only different-race/ethnicity faculty mentors were somewhat less likely than others to have new PhD expectations, as were minorities who had only same-race/ethnicity graduate-student/postdoc mentors.

In sum, where there were differences, respondents who had “some of both” mentors tended to have slightly more positive outcomes (e.g., higher confidence gains) than did those who had either “same only” or “different only” mentors. However, there were no statistically significant differences on many of the comparisons. Differences that did exist were as common among men as among women, and they were more common with non-Hispanic whites than with minorities. Thus, our findings suggest that having a mix of mentors (in terms of their sex and race/ethnicity) has a mildly beneficial effect across *all* students, not just women and minorities. Further study of these issues, exploring how they interact with the intensity, duration, and nature of students’ relationships with their mentors would undoubtedly shed much useful light on this topic.

## OVERVIEW OF CORRELATES OF UNDERGRADUATE RESEARCH OUTCOMES

Broadly speaking, students who participated in research because they were truly interested and who became involved in the culture of research tended to have the most positive outcomes, in terms of gains in confidence and in understanding and awareness of the world of research, increased interest in STEM and research careers, and expectations of obtaining a PhD. Expectations of obtaining a PhD were strongly related to increased interest in STEM and research careers and to the perceived importance of undergraduate research to one’s career decision. Generally, research characteristics and activities were more strongly related to perceived gains in confidence and understanding and to increased interest in STEM and research careers than to PhD expectations or academic status. Also, gains in confidence, understanding, and awareness were not strongly related to PhD expectations, and there were no appreciable differences on the gains indices among the academic-status groups. Having a mix of mentors (in terms of their sex and race/ethnicity) appeared to have a mildly beneficial effect among *all* students, not just women and minorities.

## VII. STUDENT SUGGESTIONS FOR URO IMPROVEMENTS

In an open-ended question at the end of the questionnaire, follow-up survey respondents were asked, “If you were designing undergraduate research programs, how would you make them better than the programs you participated in?” About two-thirds of the respondents offered suggestions. The suggestions—some explicit, some implied—covered a wide range of topics.

Responses to the survey’s structured questions about the amount and sufficiency of mentor interaction, support, and guidance were not appreciably related to PhD expectations or to increased interest in STEM or research careers. However, by a considerable margin, students’ most common suggestions about how to improve undergraduate research programs had to do with increased and more effective faculty guidance. Other common suggestions related to better project organization, more student input and independence in the research process, more “real” research or research that is relevant to important issues, more effective dissemination of information about UROs, a greater number/variety of UROs and earlier opportunities to participate, and more information about graduate school and STEM careers. Illustrative direct quotes follow.

### More or Better Interaction with Mentors

Finding faculty who are not only bright people and good researchers, but who also have excellent interpersonal skills is the most crucial aspect to making these programs successful.

Guidance and direction from faculty is ABSOLUTELY necessary for undergraduate students to benefit from their research experience.

I think it’s important for programs to provide students lots of interaction with faculty advisors but also to challenge them and let them work on the problems.

Make sure that the professor is willing to really make a time commitment, not just sign up for free labor.

I think the advisor really makes the program what it is by simply being a good advisor and devoting a lot of attention to the students, as well as designing interesting yet doable projects.

My professor was not a very good advisor because he never spent the time to ensure I had a feasible project and people to talk to when I had questions. Undergrad research advisors should be given guidelines for how to mentor undergrads, especially those who have never done research before.

Be certain that graduate students understand that for REU programs the student should be as independent as possible and is not merely a research assistant for the grad student.

Feeling like you are part of the research team is essential, no matter how relatively small your contribution may be.

## **Better Project Organization**

It's better to talk with your advisor early on and let them know where your skills are so that they can guide you in learning some new skills and or change your role in the project appropriately.

Students should be provided with a summary of what their duties will entail before they are selected to participate in a particular research group.

I would add more structure to the programs and set deadlines for completion of checkpoints. This would be understood and agreed upon by both the overseer and the researcher.

Make sure that participating professors had a realistic and clear idea about what an undergraduate can accomplish in 10 weeks.

Create a weekly progress report for the students to fill out. They would include setbacks, accomplishments, and goals.

## **More Student Input/Independence**

Projects that I had a much larger role in determining my own path proved to be much more valuable to me.

I feel that having the students work more independently would prepare them more for the expectations of graduate school.

I think the best part was doing my own research, not somebody else's.

I did two REU programs and I would have wanted to be more involved with the creation and direction of the project. Instead, I did more what I was told. As a result, I often did not have as strong an understanding of its purpose (in the big picture).

Students usually need to start off with a set goal in mind but at some point I feel they should break away and formulate their own questions and design their own experiments. This didn't happen much for me at the UG level. Time constraints can be an issue but I think more independence is possible in most cases.

Improve programs that facilitate older undergrads mentoring younger ones (this would make the initial experience less intimidating while helping older students to gain skills in mentorship).

## **Research Content Issues: More "Real" Research; Research on Important Issues**

Give more background reading so students understand the importance of projects and applications.

One thing one of my professors/employers did was to always make sure that I had a copy of the theoretical paper that the experiment was being designed from. This really helped me to understand the big picture and the details that she and the grad students were ironing out.

Perhaps provide an intro to research at the beginning then have monthly meetings to discuss the research topics of each student, and find out if they have any questions or concerns as well as ensure the students have an understanding of what they are doing and how it fits into the grander scheme of things.

The key is to provide a project that will motivate students. Seeing the big picture with respect to the project is important for this.

I would make sure that they have a research project to complete over the semester, many times the professors just give the students busy work and not real research problems that they need to work on and write about.

Make sure the available projects are appropriate to undergraduates (stretch them intellectually but also apply to what they have learned or are learning to help them see the value of what they learn in class), and that the projects are an appropriate length for the time period of the program, so that the student can have a sense of accomplishment at the end.

### **More Effective Dissemination of Information about UROs**

The most frustrating thing about the program was how difficult it was to find out about what different positions were available, obtain more information, and determine whether or not the information on the web was up to date or not. The REU Web site and search engine really needs to be improved.

I would encourage universities to advertise research programs more.

Greater effort to make aware the research opportunities available with the university and also outside the university starting with freshmen year.

My university should have had an undergrad research fair and resources web page that collected advertisements and info about research opportunities at companies and other schools.

I would just try to publicize a bit more and perhaps allow for more research experiences abroad. ... If more opportunities like this were available I believe that many more people would give research a chance and find out that they just might like it!

There are some very simple things that universities could do to get undergrads involved. Professors could link current topics they are covering in their classes to research that they (or other faculty) are doing. Another simple thing university departments could do is to keep an updated list of current research opportunities that faculty have posted (those who need help in their lab, etc.), so students know where to look.

Offer a searchable database of research projects being completed at all research institutions across the country (so that prospective student researchers can find projects precisely suited to their interests).

Instead of professors and undergraduates getting matched up more or less randomly (based on who has openings when someone starts looking), maybe have a more formal program where all interested students and all faculty members with openings meet at a "research fair."

I would like to see more central access points to undergraduate research. ... I would have appreciated an office of student research or something where I could have talked to someone about how exactly one becomes a researcher and spoken to students that were doing research.

It would be far better to have a centralized web site where ALL interns would go to for information if they participate in NSF-sponsored activities. This could have greatly helped me to get into a better graduate school.

Perhaps let students currently doing research practice their presentations on first and second year classes.

UG advisors must be made aware and endorse such research opportunities.

Have professors send out ads to students, hang up more posters, etc.

I would design information sessions for new students so that they could get networked and understand all of their research options throughout their undergraduate career.

In one of the intro courses for freshmen, I would have a small talk about research opportunities inside and outside the undergraduate college/university. But I would also send a “reminder” to sophomores and juniors.

Have an on-campus coordinator to market all different types of research opportunities available early on in undergraduate career.

I would provide a bulletin every semester for the student body that listed available research opportunities.

I would advertise which professors were looking for assistants in a common location (e.g., a webpage that lists who wants people and what the student researchers will be doing).

Advertise REUs by emails to the department chairs of respective universities.

### **More/Earlier UROs**

You have to apply to 20 programs and hope to get accepted into one. Having an undergraduate research experience could be a turning point in the lives of young professionals interested in their fields; there need to be more opportunities out there so that tomorrow’s scholars know earlier in their careers that research is what they want to do.

To get quality researchers in appropriate fields, students need to be exposed to as many fields as possible. ... Even if this means less substance and more watching. ... Start in high schools.

Try to get students involved their second year of college. Make students more aware of their career options in the field they are researching.

If only I knew about such programs earlier. If possible, advertise more to students. EVERY student should know of such programs at the VERY beginning.

Have more [projects of specified types, such as social science projects, computer science and engineering projects, humanitarian/social/environmental projects, projects at small colleges, openings for other than just the top students, projects in earth sciences, and so on].

### **More Information about Graduate School and STEM Careers**

It would have been interesting to hear from scientists doing research in industry, or just to hear about other science-related jobs.

Spend more time educating students about what their options are after college and how to get there, specifically what they should be doing at school (other than passing the required classes) to help them get into grad school or find a job.

Have seminars about grad life and career paths with faculty members and post docs.

Make career options in science (other than JUST research) a more prominent part of the program.

I think that REUs should provide similar opportunities for students to discuss grad school and career opportunities with grad students and professionals in their field, beyond just the one researcher they work with.