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NATIONAL SCIENCE FOUNDATION'S INTERNATIONAL RESEARCH EXPERIENCES FOR UNDERGRADUATES:

A Comparative Analysis of the
IRES and **REU** Programs

April 2021

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Data

Data from this study is available to NSF licensees as a restricted-use file. For more information, please contact: eac@nsf.gov.

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Courtesy of the University of Texas at Austin IRES site in Slovakia

NATIONAL SCIENCE FOUNDATION'S INTERNATIONAL RESEARCH EXPERIENCES FOR UNDERGRADUATES: A COMPARATIVE ANALYSIS OF THE IRES AND REU PROGRAMS



The National Science Foundation's (NSF) International Research Experiences for Students (IRES) program and Research Experiences for Undergraduates (REU) program both provide U.S. students opportunities to engage in a research experience at an international site, with mentorship from foreign researchers. However, the programs differ in key ways. The IRES program, which serves both undergraduate and graduate students, offers these research experiences only in international settings. In contrast, the REU program, which serves only undergraduate students, offers its large share of research experiences in the United States, with only a few offered internationally.

NSF's Office of International Science and Education (OISE) commissioned Mathematica to conduct a formative evaluation of IRES. This evaluation included a survey of former NSF international research participants. The survey sought to learn about their demographic and background characteristics, program experiences, perceptions of the programs' impact on their professional careers, and educational and employment outcomes. The survey was administered to participants in all 15 IRES sites (Track I) awarded NSF funding in 2013. To serve as a comparison, the survey was also administered to participants in the 8 REU sites awarded funding in 2013 that provided research experiences in international locations (henceforth iREU).¹

This brief provides a descriptive portrait of international research experiences for undergraduate participants of the IRES and REU programs, highlighting findings that might inform NSF's strategic planning and program improvement efforts.² Companion reports examined the characteristics and experiences of all IRES student participants in this cohort (including graduate students) (Speroni 2020) and assessed the characteristics of the IRES program portfolio (Martinez et al. 2019).

The comparative analysis revealed several key findings (*differences flagged in italics*):

- **Both programs contributed to building the science, technology, engineering, and math (STEM) pipeline through international research experiences.**

Nearly all participants in both programs had earned a postsecondary degree within the 3 to 5.5 years since participating, and some had already obtained a graduate degree. These former undergraduate IRES and iREU participants were applying their STEM expertise in the professional workforce at comparable rates.

Overall, undergraduates in both programs were similarly likely to have produced at least one peer-reviewed publication, patent, or other scholastic product within since participating. *However, IRES undergraduate participants were less likely to have participated in research conferences and had fewer publications than their iREU counterparts.*

Most IRES and iREU participants reported that the programs had shaped their professional goals. *However, IRES undergraduate participants were more likely than iREU participants to indicate that the program encouraged them to pursue further education such as graduate school or postdoctoral research.*

- **IRES and iREU undergraduate participants engaged in somewhat different types of research activities during the experience.**
Student reports suggest a higher emphasis in REU sites on presentation and dissemination skills, such as applying for or presenting findings at conferences, and IRES on developing instrumentation, software, equipment, or data collection processes. Both programs provided students with comparable pre- and post-travel support.
- **Compared to national estimates, both programs had similar representation and underrepresentation among demographic groups.**

On average, women, Hispanics, and people with disabilities were well represented among participants, whereas African American and first-generation students appeared to be underrepresented in both programs.

- **Compared to each other, on average, IRES and iREU undergraduate participants had similar characteristics, with one exception.**

Undergraduate students participating in IRES were significantly more likely to be attending doctorate-granting institutions with high research activity compared to those participating in iREU.

Given the similarities in average outcomes associated with the IRES and iREU programs, the few differences observed, and the overlaps in programmatic offerings—this brief sets forth considerations for OISE staff to consider in thinking about the future of international research experiences.

Data and approach

A 2020 NSF survey of former international research participants is the primary source of data for this comparison of IRES and iREU international research experiences.

- The survey was administered to students in the 23 sites that received awards in the 2013 cohorts of IRES and iREU (15 IRES and 8 iREU sites). These awards provided research experiences for 244 IRES participants (143 undergraduates and 101 graduates) and 164 iREU participants (all undergraduates).
- Among undergraduate participants, the survey response rate was the same in both programs: 63 percent of the undergraduate participants responded to the survey (90 IRES respondents and 103 iREU respondents).
- The survey was administered online through Confront software in March 2020, about 3 to 5.5 years after students participated in the programs.

Given declining national trends in response rates (National Research Council 2013) and observed response rates (40%-53%) of similar, retrospective surveys³, the obtained response rate of 63% exceeded expectations.

A non-response bias analysis was not feasible because NSF award reports do not include demographic information of individual participants. However, the distribution of response rates across sites in either of the programs was similar, and all sites are represented in the analysis.

Methods. A descriptive analysis of means and percentages was used to describe programs and participants. Differences between IRES undergraduate and iREU participants were tested using a two-tailed test. Unless otherwise noted, only differences that are statistically significant at the .05 level are discussed.

IRES AND iREU SITES AND PARTICIPANTS

NSF has a long history supporting international education and training opportunities for future scientists and engineers that goes back at least to the creation of the REU program more than 30 years ago. Shortly after establishing the OISE in 2002, NSF expanded international research experience offerings with a new program: IRES. The REU program—a program primarily offering domestic research experiences—continued supporting a few international experiences after the inception of IRES. Today, NSF’s IRES and REU programs both engage U.S. undergraduate students in active high-quality collaborative research at international sites, though most international research opportunities are managed by the IRES program. The box below summarizes key characteristics of each program.

Sites

Institutions receiving IRES awards in 2013 were predominantly doctorate-granting institutions, whereas those receiving iREU awards were not.

Nearly all IRES awards NSF funded in 2013 were granted to four-year postsecondary institutions (14 of 15, Exhibit 1), except for one awarded to a professional

society. About three-quarters of the institutions were doctoral degree-granting institutions with extensive research activity—all are categorized with the highest and second-highest levels of research activity by the Carnegie Classification of Institutions of Higher Education. On the other hand, about 40 percent of institutions receiving iREU awards were doctoral universities (4 of 10, Exhibit 1).

Minority-serving institutions were represented among 2013 IRES awards and were not among iREU awards. The share of IRES institutions that were minority-serving institutions (MSIs) (2 of the 14 institutions of higher education, or 14 percent)⁴ and Hispanic-serving institutions (HSI) (7 percent) was similar to their representation among institutions of higher education nationally (15 percent were MSIs and 7 percent were HSIs in the 2018 Carnegie Classification of Institutions of Higher Education) and larger than that of iREU (0 percent MSIs). No awards in either program were made to Historically Black Colleges or Universities or tribal colleges, institutions that account for 2 and 1 percent in the nation, respectively (author’s calculations of data from the 2018 Integrated Postsecondary Education Data System).

Snapshot of IRES and REU programs



Operating since	• 2006	• 1987
Managed by	• NSF’s Office of International Science and Education	• NSF’s directorates
Offering	• International research experiences	• Largely domestic research experiences with a few international opportunities
Target population	• Undergraduate and graduate students	• Undergraduate students
Broadening participation (BP) designation^a	• BP emphasis	• BP emphasis
Annual budget^b	• Approx. \$12 million	• Approx. \$69 million
Total number of sites in 2013	• 15 international	• 8 international and 183 domestic
Award cost per participant^c	• \$16,564	• \$16,949

^a BP designation indicates that of 2021. BP emphasis programs encourage broadening access and success of people from underrepresented groups, but it is not an explicit goal of the program.

^b Annual budget is the 2019 fiscal year budget reported in NSF’s 2021 budget request to Congress.

^c Award cost per participant was calculated using NSF’s FastLane data. Specifically, for each award in the 2013 cohort of awards, the total award funding amount (from Fastlane) was divided by the total number of participants supported through the award (obtained from the NSF’s award annual and final reports). The average per-participant cost across all awards was then calculated.

Exhibit 1. Characteristics of institutions awarded IRES and international REU grants in 2013



IRES Institutions

- 93%** Four-year college or university (N=14)
 - Doctorate (N=11)
 - Master’s (N=2)
 - Baccalaureate (N=1)
 - 0%** Two-year college
 - 7%** Not an institution of higher education (N=1)
- MSI (2), HSI (1), HBCU (0), Tribal college (0)



iREU Institutions

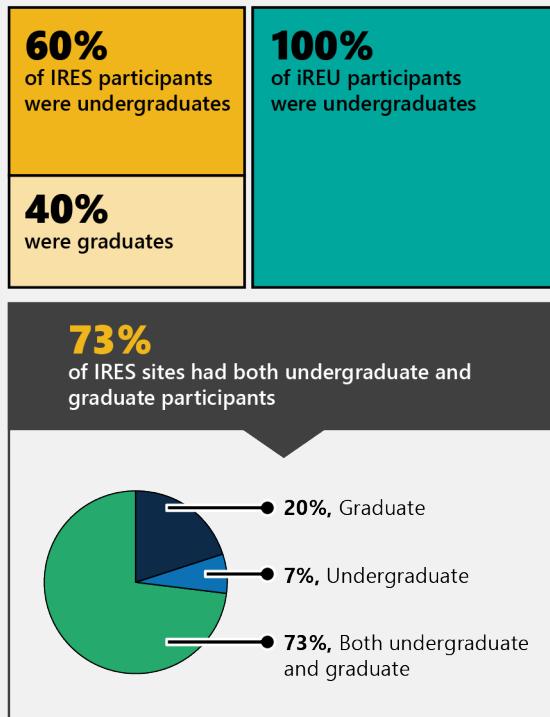
- 80%** Four-year college or university (N=8)
 - Doctorate (N=4)
 - Master’s (N=2)
 - Baccalaureate (N=2)
 - 0%** Two-year college
 - 20%** Not an institution of higher education (N=2)
- MSI (0), HSI (0), HBCU (0), Tribal college (0)

Source: Research.gov, 2013 IRES and iREU awards, 2016 Integrated Postsecondary Education Data System, and 2015 Carnegie data.
 Note: One iREU site was a collaborative agreement between three institutions. For this calculation, we included all three institutions.
 MSI = Minority serving institution; HSI = Hispanic serving institution; HBCU = Historically Black College or University.

The cost to NSF for each student participating in an international research experience was similar across programs. Although IRES awards varied in terms of total funding, so did the number of participants supported. Across IRES site awards in 2013, the average amount NSF awarded was \$16,564 per participant, similar to the average \$16,949 per participant across iREU sites.

The majority of IRES sites supported both graduate and undergraduate participants, providing opportunities for near-peer mentoring by students, which is not available in iREU sites. Sixty percent of IRES participants were undergraduate students (Exhibit 2). A large share of the IRES sites supported both graduate and undergraduate participants (73 percent), while far fewer involved only graduate students (20 percent) or only undergraduate students (7 percent). Thus, most of the IRES undergraduate participants traveled internationally as part of a cohort that included graduate students, an opportunity that is not available for iREU participants.

Exhibit 2. Participants’ student type and cohort composition



Source: Research.gov, 2013 IRES and iREU award reports, and 2020 NSF survey of former international research participants.

Participants

IRES and iREU undergraduate participants had similar demographic characteristics. Sites in both programs are encouraged to recruit students from groups traditionally underrepresented in STEM, including women, ethnic or racial minorities, and first-generation students. These programs often get the designation within NSF’s portfolio of investments of broadening participation (BP) emphasis. BP emphasis

programs encourage broadening access to people (and institutions serving high concentration of students) from underrepresented groups, but it is not an explicit goal of the programs. On average, the demographic characteristics of the undergraduate participants in both IRES and iREU were similar—across participants’ gender, race, ethnicity, veteran and disability status, and parental education (which

Exhibit 3. Demographic characteristics of participants and national benchmarks (percentages)

No average differences observed between IRES and iREU undergraduate participants are statistically significant.

Description	NSF program participants		National benchmarks	
	IRES undergraduate participants	iREU participants	Undergraduate students	People younger than 30 with at least a bachelor’s degree
Women	56	67	55	59
Race/ethnicity^a				
Hispanic	19	20	19	12
American Indian or Alaska Native, non-Hispanic	1	1	1	0
Asian, non-Hispanic	4	7	7	12
Black or African American, non-Hispanic	6	10	14	7
Native Hawaiian or other Pacific Islander, non-Hispanic	0	0	0	0
White, non-Hispanic	54	50	56	64
Two or more races, non-Hispanic	13	9	4	4
Do not wish to provide	2	4	NA	NA
Racial/ethnic underrepresented minority in STEM^b	30	36	n.a.	23
Disability^c	26	28	n.a.	27
Veteran status	0	2	n.a.	1
Highest level of parental education			NA	
Less than a bachelor’s degree	26	28		37
Bachelor’s degree	26	27		30
Master’s degree	27	23		22
Professional degree	8	13		5
Doctorate	10	10		5
Sample size^d	82-89	99-102	16,869,212	11,735
Source	NSF (2020)	NSF (2020)	IPEDS (2016) ^e	NSCG (2017) ^f

Source: 2020 NSF survey of former international research participants (2013 cohort of awards), and benchmark statistics (see notes for details).

Note: “Do not wish to provide” or “not applicable” were included in the analysis for all characteristics and ranged from 2 percent (for example, parental education) to 8 percent (for example, disability among IRES undergraduate participants) for the characteristics not shown.

^a Race and ethnicity are reported together and might not sum to 100 percent due to rounding.

^b Racial/ethnic underrepresented minority in STEM is defined as American Indian/Alaska Native, Black/African American, Native Hawaiian/Other Pacific Islander, or Hispanic.

^c Includes people who indicated they had slight, moderate, or severe difficulty with or were unable to do at least one of the following functions: seeing; hearing; walking; lifting or carrying; or concentrating, remembering, or making decisions.

^d Sample sizes are presented as a range based on the data available for each row in the table.

^e U.S. Department of Education, National Center for Education Statistics, IPEDS, Spring 2017, Fall Enrollment component.

Table 303.60: “Total fall enrollment in degree-granting postsecondary institutions, by level of enrollment, sex of student, and other selected characteristics: 2016”. Statistics calculated from https://nces.ed.gov/programs/digest/d17/tables/dt17_303.60.asp (undergraduate full time enrollment).

Table 306.50: “Total fall enrollment in degree-granting postsecondary institutions, by control and classification of institution, level of enrollment, and race/ethnicity of student: 2016.” Statistics retrieved from https://nces.ed.gov/programs/digest/d17/tables/dt17_306.50.asp?referer=raceindicators.

All percentages come from national enrollments in degree-granting institutions that grant associate’s or higher degrees and participate in Title IV federal financial aid programs.

^f NSCG 2017 public data file. Survey sample comprises people with a bachelor’s degree or higher. Estimates are weighted averages calculated by author, restricted to people younger than 30. Indicators for racial/ethnic underrepresented minorities and disability were constructed according to definition in superscripts b and c. Data downloaded from <https://ncesdata.nsf.gov/datadownload>.

IPEDS = Integrated Postsecondary Education Data System; n.a. is not available; NA is not applicable; NSCG = National Survey of College Graduates.

None of the differences between IRES undergraduate and iREU participants is statistically significant at .05 level, two-tailed test.

serves as a proxy for socioeconomic background; Exhibit 3).

For benchmarking purposes, Exhibit 3 presents national statistics of the population of undergraduates—the potential pool from which these NSF programs drew participants. Because not all demographic characteristics were available for undergraduate enrollees, Exhibit 3 also presents national statistics on young college graduates, that is, those younger than 30 who had at least a bachelor's degree. College graduates are different from those enrolled but are still relevant to this examination because most IRES and iREU program participants graduate from college within a few years after program participation (see section on participant outcomes.)

Compared to national statistics, both programs had a similar representation from most demographic groups underrepresented in STEM—including women, Hispanics, and people with disabilities. In both programs, about 20 percent of participants were Hispanic, a number that mirrors the national representation of Hispanics in the undergraduate enrollment population (Exhibit 3). Programs also had a similar (or favorable) representation of women when compared to the national population of female undergraduates. Similarly, people with disabilities—comprising about one-quarter of NSF program participants—were represented in these programs in shares similar to those observed in the national population of college graduates younger than age 30.

Both programs, however, could expand access among Black and first-generation students. Black or African American students appeared underrepresented when compared to the undergraduate enrollment nationally (14 percent); this was slightly more so for IRES (6 percent) than iREU (10 percent).⁵ In addition, only about a quarter of undergraduate participants in both programs were first-generation college students, meaning that neither parent had a bachelor's degree. This is about 10 percentage points lower than the proportion among national college graduates—a difference that is expected to be larger if comparable data were available for national undergraduate enrollees (instead of graduates). Put differently, participants of international research experiences came disproportionately from highly educated families.

Compared to the population of young college graduates, program participants were more likely to have at least one parent with an advanced degree (45 percent of IRES undergraduate participants and 46 percent of iREU participants compared to 32 percent of students in the 2017 National Survey of College Graduates [NSCG]).

IRES sites largely drew participants from their own institutions, whereas iREU recruited nationally. A distinguishing characteristic of the IRES program is that sites can recruit solely from within the awardee institution, whereas REU (and thus iREU) sites are required to recruit more broadly given the request that a “significant fraction of the student participants at an REU Site must come from outside the host institution or organization” (NSF solicitation 19-582). In the 2013 awards, two-thirds of IRES undergraduate participants were pursuing their degree at the award institution at the time of program participation, compared to one-fifth of iREU participants (Exhibit 4).

IRES undergraduate participants were significantly more likely than iREU participants to be attending a doctorate-granting institution. Recruitment practices, coupled with differences across programs on the types of institutions receiving awards, resulted in IRES undergraduate participants being more likely than iREU participants to be attending an institution offering extensive research opportunities. Specifically, IRES undergraduate participants were 24 percentage points more likely to be coming from a doctorate-granting university than iREU participants (66 versus 42 percent; Exhibit 4). Although NSF encourages sites in both programs to recruit participants from institutions with limited research opportunities, only the REU program solicitation provides specific guidance on what is expected of sites. The REU solicitation states that “at an REU site ... at least half of the student participants must be recruited from academic institutions where research opportunities in STEM are limited (including two-year colleges)” (NSF solicitation 19-582).



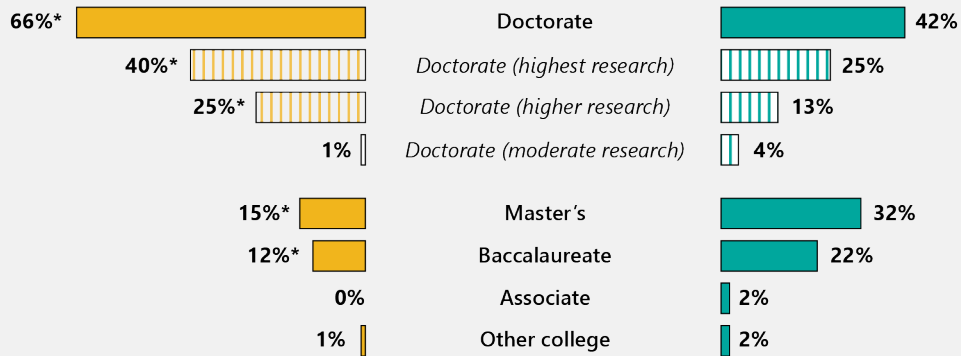
Both programs—IRES and iREU—could expand access among Black and first-generation students.

Exhibit 4. Participants' academic enrollment



66%* of IRES undergraduate participants and **18%** of iREU participants attended award institution

Participants' home institution (percentages)



Source: Research.gov (2013 IRES and iREU award reports), 2020 NSF survey of former international research participants (2013 cohort of awards), and 2016 Integrated Postsecondary Education Data System.

Note: One iREU site was a collaborative agreement between three institutions. For this calculation, the participant was considered to have a home institution different from the host institution if the student was not enrolled in any of the three institutions.

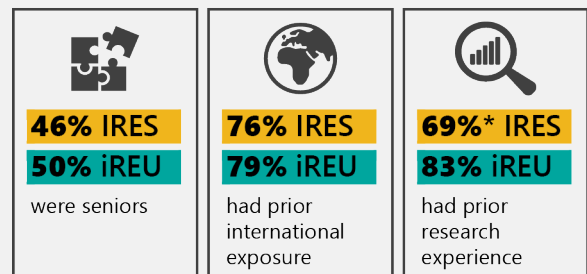
Other colleges include special focus colleges (two- and four-year) and tribal colleges.

* Difference between IRES undergraduate and iREU participants is statistically significant at the .05 level, two-tailed test.

Both programs involved undergraduate students with similar class standing and prior international exposure, though IRES was more likely than iREU to have participants with no research background.

At the time they participated in the international research experience, about half of the participants in both programs were seniors in college (46 percent of IRES undergraduate participants and 50 percent of iREU participants, Exhibit 5). In addition, more than two-thirds of participants in both programs had some international exposure before traveling with the NSF program (76 percent and 79 percent, respectively); most frequently they had visited another country for leisure, participated in a study abroad program, or lived outside of the United States for at least six months. Most undergraduate participants also had research experiences before the program (Exhibit 5), the majority involving multiple academic years or summers; however, IRES undergraduate participants were more likely than iREU participants to come to the program without prior research experience—31 percent versus 17 percent—despite disproportionately attending institutions with a high level of research activity.

Exhibit 5. Undergraduate participants' class standing and prior experiences



Source: 2020 NSF survey of former international research participants (2013 cohort of awards).

* Difference between IRES undergraduate and iREU participants is statistically significant at the .05 level, two-tailed test.



IRES was more likely than iREU to have participants with no research background (31% and 17%, respectively).

COMPONENTS OF THE RESEARCH EXPERIENCE

IRES and iREU undergraduate participants varied somewhat in the types of research activities they engaged in during their time abroad. Both IRES and iREU undergraduate participants reported performing various types of research activities as part of their international experience, with differences in the degree to which they engaged in 5 of the 13 types of activities the survey captured (Exhibit 6). IRES undergraduate participants were more likely to report developing instrumentation, software, equipment, or data collection processes (52 percent) as part of the experience than their iREU counterparts (33 percent). Although uncommon, IRES undergraduate participants were also more likely to engage in mentoring activities than iREU participants (19 versus 9 percent), as indicated by their response to whether they have “mentored other students conducting research or led a student research team.”

Instead, IRES undergraduate participants were less likely to report contributing to analysis and dissemination than iREU participants. For example, IRES undergraduate participants were less likely to report that they analyzed data (74 percent versus 88 percent) or presented their work to other students, faculty, or researchers in a seminar, conference, or other venue (70 percent versus 91 percent). In addition, a lower percentage of IRES undergraduate participants than iREU participants reported preparing samples or specimens (60 percent versus 79 percent), a difference that might be driven by the disciplinary focus of the awards NSF funded in 2013. (According to NSF award documents, half of iREU sites in 2013 were in biology and conservation and natural resources, compared to a third of IRES sites in those fields.)

Given differences in the types of activities emphasized, not surprisingly, IRES undergraduate participants differed from iREU participants when asked about what they had learned during the experience in the three following areas:

1. Presentation skills, including giving an effective oral presentation (61 percent versus 75 percent) and defending an argument when asked questions (50 percent versus 68 percent)
2. Dissemination skills, including applying for and participating in conferences (42 percent versus 73 percent)
3. Scientific methods, specifically, formulating a research hypothesis that could be answered with data (67 percent versus 80 percent)

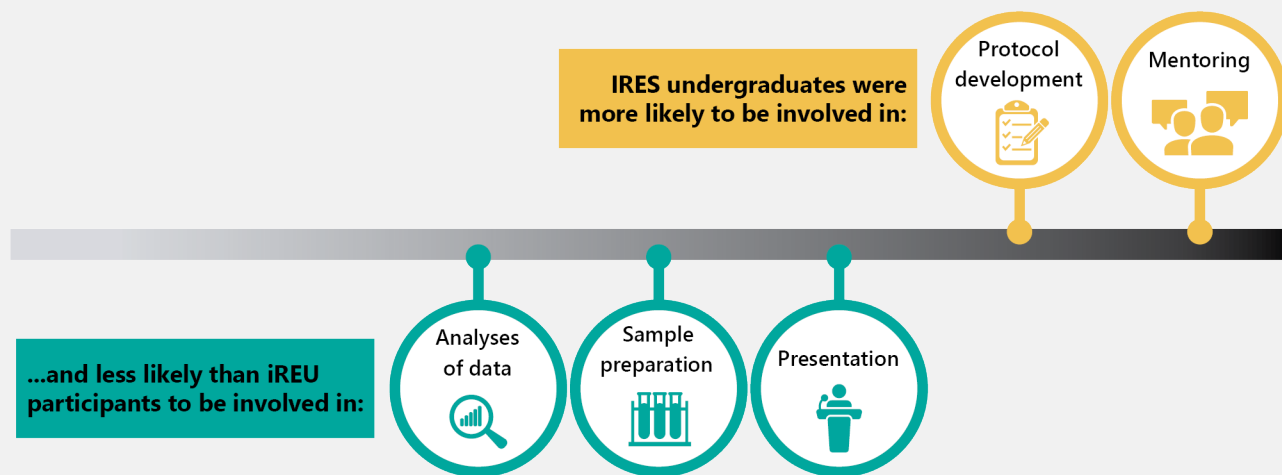
However, respondents reported similar learning gains in the other 11 of 15 research skills and knowledge the survey measured.

Participants in both programs reported receiving comparable support before and after they traveled abroad. Despite some variations in the research experience, more than 80 percent of participants in both programs reported receiving some form of support before and after their international research experience. IRES and iREU sites offered similar predeparture preparation, most commonly in the form of country orientations and training in research techniques, and least commonly in the form of foreign language instruction. Sites also offered similar post-travel follow-up for students such as providing academic advice, reference letters, and support finding other research experience opportunities—with one exception. iREU participants were more likely to report that they received assistance developing a publication or presentation based on the research they conducted while abroad (60 percent) than IRES undergraduate participants (44 percent).



IRES undergraduate participants were more likely to report developing instrumentation, software, equipment, or data collection processes as part of their experience—and were less likely to report that they analyzed data, presented their work, or later received assistance developing a publication or presentation based on their research abroad—than their iREU counterparts.

Exhibit 6. Activities of the international research experience



IRES undergraduate vs iREU participants

- | | |
|---|--|
| <ul style="list-style-type: none"> • Presented research (70 vs 91%)* • Developed protocols/instruments (52 vs 33%)* • Prepared sample or specimens (60 vs 79%)* • Analyzed data (74 vs 88%)* • Developed ideas or vision for the research (51 vs 63%) • Summarized results for dissemination (68 vs 79%) • Mentored other students (19 vs 9%)* | <ul style="list-style-type: none"> • Synthesized or fabricated materials (40 vs 50%) • Interpreted results (79 vs 88%) • Collected data in a lab (51 vs 57%) • Conducted fieldwork (42 vs 48%) • Planned follow-up work based on results (51 vs 54%) • Reviewed literature (83 vs 84%) |
|---|--|

Source: 2020 NSF survey of former international research participants (2013 cohort of awards).

Note: Activities are ordered by the absolute difference (largest to smallest) between IRES undergraduate and iREU participants.

* Difference between IRES undergraduate and iREU participants is statistically significant at the .05 level, two-tailed test.

PROGRAM SATISFACTION

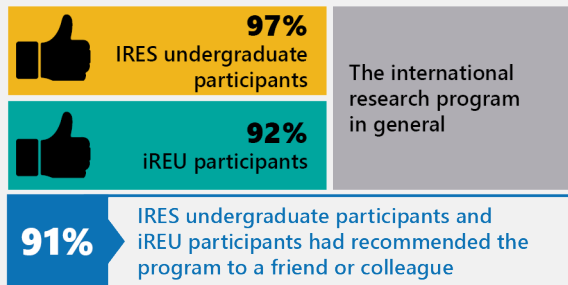
Undergraduate participants were equally satisfied with the IRES and iREU programs and had recommended the programs to their friends.

Overall, more than 90 percent of participants in both programs indicated they were somewhat or very satisfied with the program they participated in (Exhibit 7). Additionally, at least 80 percent of undergraduates in both programs were satisfied with each of the specific aspects of the international experience the survey covered, including support from faculty and other students, equipment, and social group activities. In both groups, 91 percent of undergraduate IRES and iREU participants reported that they have recommended the program to a friend or colleague.

Participants in both programs provided similar suggestions for how the international experiences could be improved.

When asked what changes might have made the program more impactful, 78 percent of IRES undergraduate and 71 percent of iREU participants identified areas for improvement in an open-ended response. Participants in both programs were most likely to provide recommendations related to the international research experience (IRES, 59 percent; iREU, 38 percent), followed by pre-experience activities (15 percent and 24 percent), post-experience activities (14 percent and 15 percent), and residential, travel, or financial experience (6 percent and 10 percent). IRES undergraduate and iREU participants provided similar suggestions for improving the research experience. (See box for common themes and illustrative quotes from undergraduate participants in both programs.)

Exhibit 7. Satisfaction with program



Source: 2020 NSF survey of former international research participants (2013 cohort of awards).

Note: Numbers in the top panel represent the percentage of participants who indicated they were somewhat or very satisfied with the international research program in general.

None of the differences between IRES undergraduate and iREU participants is statistically significant at the .05 level, two-tailed test.

PARTICIPANT OUTCOMES AND PERCEIVED IMPACTS

Participant outcomes

Nearly all undergraduate IRES and iREU participants had earned a postsecondary degree, including some who had already obtained a graduate degree since program participation. In the 3 to 5.5 years since they had participated in the international experience, nearly all participants had completed their bachelor's degree, and some had earned a graduate degree. IRES undergraduate participants were more likely than iREU participants to report "other" and indicate they were still pursuing a postsecondary degree, suggesting it might be too early to assess the full extent of their investments in

Common suggestions for improving international research experiences



More guidance and support

- IRES: "My project was largely independent and I only had one staff scientist to answer to. She was not always around, so I found myself struggling to make progress at times."
- iREU: "More one-on-one time with professors to develop and flesh out a research project that truly met my goals."

Longer experience

- IRES: "I always wished the program ran longer because two months was too short a time to gather significant results and publish a paper (though our team was really close!)."
- iREU: "I would have preferred that the program covered the entire summer. Unfortunately, we were in the UK for only seven weeks and while that is enough to explore the country, it is not enough to make any progress in your research project."

Language instruction

- IRES: "If I have a longer period of preparation before the IRES to study the language of foreign country, I would have a better experience living in the foreign country and gain more from the experience."
- iREU: "Taking a brief language course before the trip so that I could interact with the researchers and people of the country more."

More communication and planning before the program starts

- IRES: "Getting involved sooner—the introductory weeks over the summer were not enough time to gain background knowledge in the subject matter."
- iREU: "I would have benefitted from some contact from the host lab prior to my arrival so I could do background reading and prepare for the things I would be doing that summer."

Maintain relationships after program ends

- IRES: "There was no follow-up with the team regarding the impact of our visit with community members or how to maintain [the] relationship. I felt responsible to the relationships I had made and was not sure how to continue them once we returned."
- iREU: "The only thing that would have made this more useful would have been if there had been some sort of guidance on how to best keep in touch with advisors and keep an open line of communication after the program ended."

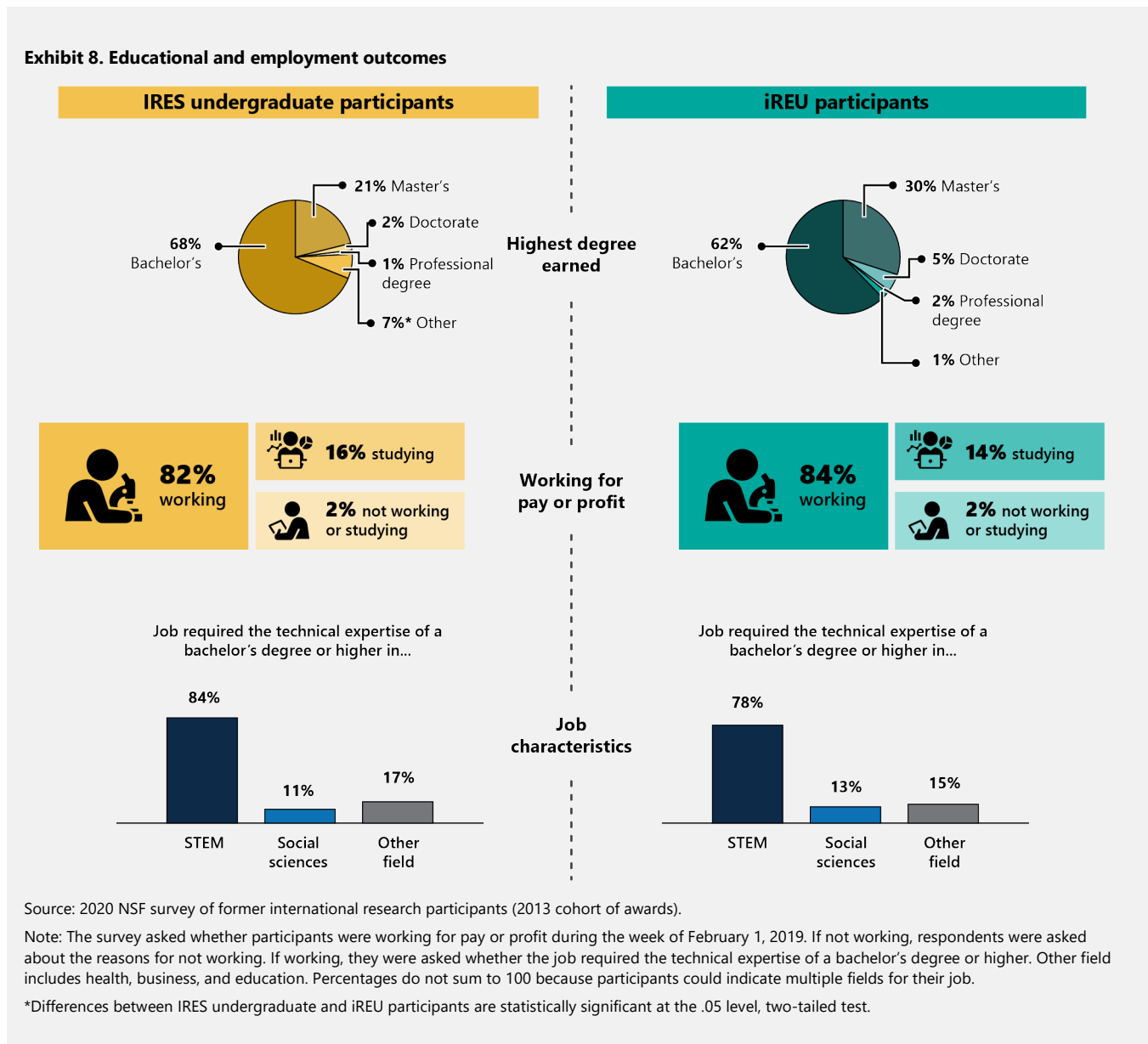
Continue research after program ends

- IRES: "I especially would have loved to further integrate the results gained abroad into my research at my home institution and to continue collaborating with the international research team."
- iREU: "It may have been more useful to me if I had been prepared to publish the data resulting from the study, or had a continuation of the project that could have completed the project."

education. Importantly, participants in both programs have applied to NSF's Graduate Research Fellowship at similar rates to support their graduate students (17 percent of IRES undergraduate participants and 15 percent of iREU participants).

Undergraduate participants in both programs were similarly applying their STEM expertise in the professional workforce. More than 80 percent of IRES undergraduate participants and iREU participants were employed for pay or profit at the time of the survey; this is just under the 88 percent employment rate among young college graduates nationally (author's calculation of the 2017 NSCG for people younger than 30 years old). NSF program

participants were substantially more likely to have a job that required the technical expertise of a bachelor's degree or higher in STEM fields—84 percent among IRES undergraduate participants and 78 percent among iREU participants (Exhibit 8) compared to the 32 percent in the nation. If not working, NSF program participants were continuing their studies and on the path to a potential career in STEM. In fact, NSF program participants were more likely to indicate that the reason for not working was because they were studying (88 percent of both IRES and iREU participants who were unemployed) than young college graduates in the nation (51 percent).



After the research experience, many participants in both programs were actively immersed in the scientific research enterprise, with some differences. To gauge research productivity, the survey asked participants whether they had produced different types of scholastic works after the experience, and if they did, the number of works produced and whether they were done in collaboration with a foreign researcher. Overall, IRES undergraduate and iREU participants were similarly likely to have produced at least one peer-reviewed publication, patent, or other scholastic product (Exhibit 9). IRES participants, however, were less likely to have participated in research conferences (70 percent versus 88 percent, Exhibit 9), and they had fewer total publications. IRES undergraduate participants had, on average, one publication in a peer-reviewed journal after program participation, while iREU participants had two.

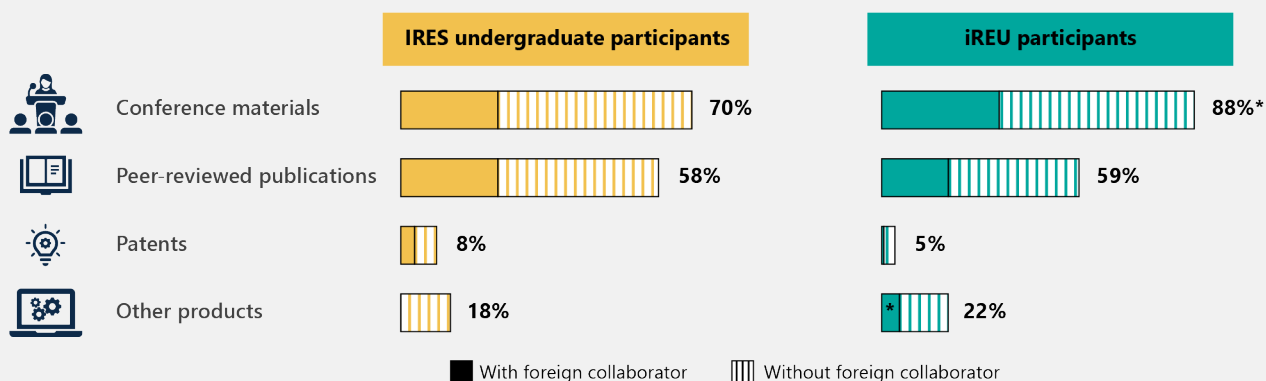
An important outcome of international programs is that students remain globally engaged in the scientific enterprise. Participants from both programs reported similar levels of collaboration with a foreign researcher in the production of scholastic work, including conference presentations, journal articles, or patents (Exhibit 9). However, iREU participants were more likely to collaborate with a foreign researcher in producing other scientific products (such as educational materials, software applications, or data sets).

Perceived program impacts

A fundamental goal of education and training programs like IRES and iREU is to contribute to the development of the next generation of STEM leaders. Due to limitations in available data⁶ the study was not designed to rigorously measure the impact of the programs—which would require comparing participants with non-participants. Instead, the survey included questions to gather respondents’ perceptions of the program’s impact on their professional career.

Participants in both programs reported benefitting from the program in a number of ways, but IRES undergraduate participants were more likely to assert the program encouraged them to pursue further education than iREU participants. Nearly all IRES undergraduate participants (97 percent) and most iREU participants (92 percent) said the program influenced their professional goals (Exhibit 10). Similar percentages of participants across programs also indicated that the program prompted them to consider opportunities they would not otherwise have considered, helped them make valuable professional connections, and made them more competitive for jobs, among other benefits. The only statistically significant difference between the programs is that IRES undergraduate participants were more likely to agree or strongly agree that the program encouraged them to pursue further education. As one IRES undergraduate

Exhibit 9. Contributions to research-related products since participating in the international research experience



Source: 2020 NSF survey of former international research participants (2013 cohort of awards).

Note: Figure shows the percentage of IRES participants who produced at least one work in each category after the international experience.

Other products are deliverables that have been disseminated to the scholarly community or public (for example, educational materials, software applications, datasets, etc).

*Difference between IRES undergraduate and iREU participants is statistically significant at the .05 level, two-tailed test.

Exhibit 10. Perceived effect of program participation

97% of IRES undergraduate participants and **92% of iREU participants** said that the program affected their professional goals.



Source: 2020 NSF survey of former international research participants (2013 cohort of awards).

Note: Exhibit shows the percentage of participants who indicated the statement applied to them (for program affecting professional goals) and the percentage of participants who indicated they agreed or strongly agreed (for each of the statements).

* Difference between IRES undergraduate and iREU participants is statistically significant at the .05 level, two-tailed test.

participant noted, “It was my first time working full time in a laboratory setting. This experience was the spark that got me interested in research as a career. I am now doing a Ph.D. in part due to my experiences here.”

CONSIDERATIONS

Both IRES and REU programs provide research opportunities in a wide array of disciplines supported by NSF. The main difference is that IRES is open to both undergraduates and graduates, and the research experience always occurs outside of the United States. In contrast, the REU program is exclusively for undergraduates, and the experience is primarily based in the United States, though there are a few international REU (iREU) sites. This brief, together with others developed as part of the formative evaluation of IRES, provides insights into potential ways NSF could refine or strengthen its international education and training efforts.

Now is an opportune time to reexamine NSF’s international human capital development investments. First, the number of international proposals submitted to the REU program has been declining since the inception of IRES (as reported by the NSF REU coordinator). If this trend continues, it might have the unintended effect of dwindling overall funding for international research experiences. Second, if approved, President Biden’s FY 2022 budget proposal will increase NSF’s funding, creating opportunities for the agency to rethink how to best use resources to run internal operations and leverage international collaborations to advance the sciences. [Given the similarities in participant characteristics, program experiences, and outcomes between the IRES and iREU programs, and overlaps in programmatic offering, this section sets forth considerations for the future of international research experiences supported by NSF. It also highlights areas for future research.](#)



Consider consolidating undergraduate international research experiences to improve operational efficiencies and capitalize knowledge.

Having two separate programs overseeing research experiences abroad presents overlaps in programmatic offerings within NSF and may not be conducive to leveraging knowledge to drive ongoing improvements.

For NSF, running a program involves releasing solicitations, conducting peer review of award proposals, and managing awards. Coordination within NSF across programs is critical to ensure that the unique factors associated with running international sites receive attention, as these sites involve different players, such as foreign researchers and institutions, and face challenges different from those faced by domestic sites, such as unique regulatory, bureaucratic, or administrative procedures in foreign contexts of implementation. Yet, coordination is logistically difficult with a program like REU, involving nearly 30 NSF program officers across NSF's seven research directorates.

Sponsoring international experiences for undergraduates through two different programs might also be confusing for NSF stakeholders. Based on interviews with NSF program officers, reviews of proposals with international research activities are handled in idiosyncratic ways. Some directorates in the REU program review proposals for international sites, while others forward those proposals to the IRES program. In addition, faculty submitting proposals and students navigating opportunities funded by NSF might be unaware of comparable NSF opportunities they could apply for.

Although this study was not designed to measure the relative effectiveness of each program, findings from this descriptive study point to enough similarities between undergraduate students, experiences, and outcomes to support different ways forward, including: (1) OISE expands its reach to manage all international experiences (those currently being offered under IRES and the REU program) or (2) the REU program absorbs all undergraduate research experiences, whether domestic or international. NSF would need to consider several factors when deciding where to place international experiences, such as:

- **The strategic value of education and training investments to OISE and of OISE to**

international experiences. NSF may want to reflect on the extent to which managing international experiences strengthens the strategic value of the office to NSF, bolstering the global presence or imprint of NSF by increasing its visibility or strengthening its leadership position in international collaborations. At the same time, NSF may need to consider whether important externalities are occurring within international efforts that would warrant OISE managing the experiences, such as knowledge gains or access to dissemination channels resulting from significant overlap in networks of U.S. principal investigators across international programs, tracks within a program, and collaborations around the globe.

- **The need or desire to continue to support international research experiences with or for graduate students.** Although the REU program could absorb the undergraduate component of IRES, it cannot accommodate the entire IRES (Track I) program without fundamentally changing its program structure—and name—known for its exclusive focus on undergraduates. Admittedly, as currently implemented, there is little evidence that near-peer mentoring is a distinguishing characteristic of an IRES site: Not all sites combine undergraduate and graduate students, and in those that do, only about half of graduate students reported mentoring other students conducting research as part of the experience (Speroni 2020). IRES does, however, offer numerous research opportunities for graduate students (about 40 percent of IRES participants are graduate students) and, although evidence to date is scarce, near-peer mentoring is believed to be beneficial for mentors and mentees (an empirical question for future study).



Increase participation from some underrepresented groups.

NSF emphasizes broadening participation among underrepresented groups, including women, ethnic and racial minorities, people with disabilities, veterans, students from low-income backgrounds, and, if undergraduate, students attending institutions with limited research opportunities. Findings from this study suggest that the IRES program has an adequate representation from several demographic groups underrepresented in STEM—including women, Hispanics, and people with disabilities—but

not of Black students and first-generation students. Findings also indicate that IRES undergraduate participants are coming disproportionately from institutions offering extensive research activities.

To further expand access to the program, IRES has at least two options: (1) change the composition of institutions receiving awards, while allowing recruitment of participants from the award institution, (which assumes that proposals from the target institutions are in the applicant pool and/or potential PIs at those institutions can be supported to submit meritorious proposals), or (2) encourage sites to recruit participants from outside their institutions. Of these, the latter is easier to implement, but both strategies would ensure the program contributes to broadening participation of both participants and institutions receiving NSF funding.

Some potential strategies for NSF to consider:

- **Be intentional about building diversity of the institutions funded into the program strategy.**

Institutions receiving IRES awards have largely been doctoral universities with extensive research activity, with few institutions serving high concentrations of minority students. Granting awards to a more diverse set of institutions would not only support NSF's goals of broadening participation of institutions receiving NSF funding but might also help recruit hard-to-reach populations. For example, African Americans appeared to be somewhat underrepresented compared to the population enrolled in college nationally, yet none of the IRES awards granted in 2013 included a Historically Black College or University (HBCU). Similarly, institutions offering limited research opportunities to students are underrepresented in the program, and those are the institutions that are more likely to have high concentrations of first-generation students and those from low-income backgrounds.

Diversifying the types of institutions IRES funds would likely require intentional outreach to support other types of institutions in their efforts to submit proposals to the program. As shown in a recent portfolio analysis that analyzed proposals submitted to, and awarded by, the 2018 IRES track I solicitation, the IRES program receives proposals disproportionately from doctorate-granting universities (Martinez et al. 2019).⁷ Outreach efforts might include providing

support to faculty and staff from minority-serving institutions (particularly HBCUs and tribal colleges) and institutions with limited research activity that might not be as familiar with NSF proposal submission processes.

- **Encourage and support institutions—particularly doctoral institutions without large minority populations—to recruit participants from outside their institutions.** Although not common among IRES sites, open and competitive applications to an international research program are feasible, and the NSF's Education and Training Application (ETAP) facilitates them. ETAP, a new data system currently being pilot tested, enables sites to leverage an online common application designed and supported by NSF and a national pool of prospective candidates already looking for training opportunities funded by NSF. IRES could consider revising the language of the solicitation to explicitly encourage some sites to recruit from outside their institutions and offer the possibility of using NSF's pilot system to achieve this recruitment goal and also support the Agency's efforts to collect high quality data among participants in its programs.
- **Consider ways to further support sites' recruitment efforts.** Increasing participation of some students, such as first-generation or other economically disadvantaged groups, in a program that requires students to travel internationally presents unique challenges. NSF could consider ways to support outreach efforts, which may include facilitating communities of practice for international research to promote knowledge sharing of best practices in recruiting hard-to-reach populations, and offering additional financial support to low-income students.



Promote a community of practice for international research. Participants identified several areas for program

improvement, including providing longer research experiences (most REU and IRES experiences last 8 to 10 weeks), having well-defined research questions or plans before traveling (to use the limited time in the research experience more effectively), and receiving more guidance and oversight to make the most of the limited time abroad. Others also suggested additional support to continue the research and

maintain the relationships when back in the United States. The comparative analysis also highlighted the possibility of emphasizing presentation and dissemination skills as part of the IRES experience. Regardless of how international research programs are managed within NSF, whether under one or separate programs, a community of practice among principal investigators would facilitate knowledge sharing to address common implementation challenges. NSF could consider expanding its role in leading or facilitating site collaboration to help promote best practices in research experiences. This could occur among international sites and, if possible, both international and domestic ones to capitalize on the universal aspects of supporting research experiences for undergraduates.



Support a prospective impact evaluation of research experiences and research studies to assess the efficacy of different programmatic features. Despite the

growth of undergraduate research experiences, the evidence of their effectiveness is suggestive, at best. Reviews of the empirical literature conclude that there is a dearth of sound evidence on the impact of these programs, both domestic (Seymour et al. 2004; Boylan 2006; Sadler et al. 2010; Lynn et al. 2015; National Academies of Sciences 2017) and international (Martinez et al. 2019). Of the few studies that can convincingly support causal claims of the effect of research experiences, none focuses on the NSF programs. Therefore, it is unclear whether a summer experience such as those funded by the NSF REU or IRES programs can have a catalytic or lasting impact on students. Furthermore, very little empirically based research attempts to get inside the “black box” to identify program elements that are

correlated with successful outcomes that would advance our understanding of what constitutes an authentic research experience (National Academies of Sciences 2017).

Although participants’ self-reflections on program impacts included in this study provided useful formative feedback, this study was not designed to establish a causal link between students’ career trajectories and their experiences in the IRES or iREU programs. Put differently, any observed differences in outcomes, or lack thereof, between IRES and iREU participants is not evidence that one program is more effective than the other. In addition, the descriptive results indicate little variation in ultimate outcomes between undergraduate participants in IRES or iREU. Those results, coupled with methodological limitations created by the small number of sites in the study, do not warrant further analysis of available data to assess which site characteristics or activities (such as near-peer mentoring) might help improve student outcomes.

Instead, NSF might benefit from conducting or supporting a rigorous study of the impact of research experiences—domestic and international—and of the relative efficacy of different program components. Such studies would not only be helpful to NSF, but also enable the agency to contribute critical knowledge to other government agencies and private sector organizations that support similar experiences. As it expands over the next few years, ETAP will provide a robust source of data (and potential site participants in a rigorous, experimental or quasi-experimental, evaluation design) to support such studies.



Courtesy of the University of Central Florida, REU site Citizen Science Geographic Information Systems in Belize

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¹ For ease of exposition, the term *iREU program* is used throughout this brief. However, iREU is not an NSF program. Rather, it is a subset of awards made by the REU program.

² The 2013 IRES cohort is not necessarily representative of all IRES awards. A separate report reviews the entire portfolio of IRES awards since program inception (Martinez et al. 2019). Similarly, the findings on the iREU awards are not representative of the REU program. Only 8 sites of the 191 awards the REU program made in 2013 were international and therefore included in this analysis.

³ Martinez et al. (2015) surveyed participants in the NSF Partnerships for International Research and Education (PIRE) program up to 10 years of participation and had a response rate of 40 percent among those who participated as undergraduates. Fitzsimmons (1990) surveyed undergraduate participants in the NSF REU program after 3 years of participation and obtained a response rate of 53 percent.

⁴ One IRES institution was considered an MSI due to being an Asian American and Native American Pacific Islander-Serving Institution (AANAPISI). Today, this institution is also considered Hispanic-serving.

⁵ Although many IRES students reported two or more races, none of the IRES students who reported two or more races indicated being Black or African American. (Multi-racial respondents were predominantly Asian and White, followed by American Indian/Alaska Native and White, and a few Asian and Native Hawaiian or other Pacific Islander.)

⁶ This study was retrospective and NSF only collected information on participants, not applicants, to these programs. This limitation will be overcome in the future through a new data system, the NSF Education and Training Application, that is currently being pilot tested. For the present study, benchmarking to national data was used to provide a point of reference, whenever possible.

⁷ Specifically, of the 161 institutions that submitted a proposal in response to the 2018 IRES solicitation, 138 (83 percent) were from a doctorate-granting university, and 126 (78 percent) were from a doctorate-granting university categorized with the highest and second-highest levels of research activity by the Carnegie Classification of Institutions of Higher Education (Martinez et al. 2019).