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Executive Summary

The National Science Foundation's (NSF) Emerging Frontiers in Research and Innovation (EFRI) and Engineering Research Center (ERC) programs are long-standing programs within the NSF's Directorate for Engineering (ENG) portfolio that fund fundamental research at top research institutions. In 2011, EFRI began offering a supplemental funding opportunity for grantees called Research Experience and Mentoring (REM) with the explicit goal of increasing and improving the engagement of students in their research experiences. REM supplemental awards are intended to last up to 12 months, with full-time research programs taking place during the summer and additional mentorship opportunities throughout the academic year. The ERC program followed suit in 2018 and began offering supplemental funding to ERC grantees. The specific goals of the REM program are:

- To provide research experiences and mentored opportunities for high school students, STEM teachers, undergraduate STEM students, faculty, and veterans who may not otherwise become engaged in a research project;
- To engage participants from underrepresented groups;
- To enhance careers of participants in STEM;
- To enhance EFRI- or ERC-supported research; and
- To build partnerships with local, underserved institutions.[1]

In January 2021, NSF's Office of Emerging Frontiers and Multidisciplinary Activities asked the IDA Science and Technology Policy Institute (STPI) to conduct an evaluation of the REM program. The goal of the REM evaluation was to understand the outcomes and impact of the REM supplement and assess the career and educational outcomes of the research participants (RPs) who engage in the program. STPI aligned the evaluation towards the REM program goals. In addition, STPI sought to better understand:

- The effects of mentoring on the RPs, and
- The effectiveness of diverse and flexible cohorts.

[1] The REM Dear Colleague Letter encourages partnerships with one or more of the following types of institutions: inner-city schools or other high-needs K-12 schools; community colleges that serve underrepresented populations; and 4-year colleges that serve underrepresented populations.

To understand the REM program's progress towards meeting these goals, STPI collected program information from the following sources: a STPI-designed survey of RPs; program documentation such as Dear Colleague Letters, award proposals, and annual and final reports; REM project data provided by EFRI and ERC program officers; interviews; and bibliometric analysis.

Findings

- **Goal 1: To provide research experiences and mentored opportunities for high school students, STEM teachers, undergraduate STEM students, faculty, and veterans who may not otherwise become engaged in a research project:** The evaluation of the program indicates that REM is reaching the population it is intending to serve and offering experiences that students and high school teachers participating may not otherwise have found.
- **Goal 2: To engage participants from underrepresented groups:** The REM program appears to be meeting its goals of providing research experiences and mentored opportunities to REM participants from underrepresented groups.
- **Goal 3: To enhance careers of participants in STEM:** The RPs surveyed reported very positive and satisfactory REM experiences. Though the survey is not fully representative of the RP population, the results indicate the REM program provided a very positive contribution towards RP's STEM career aspirations.
- **Goal 4: To enhance EFRI- or ERC-supported research:** Although we were unable to assess the full extent to which EFRI-supported research was enhanced by RPs, many RPs contributed to research outputs including journal articles, conference proceedings, and conference presentations.
- **Goal 5: To build partnerships with local, underserved institutions:** Through the analysis of REM applications, we found that REM proposals discussed developing partnerships through institutional outreach with the local community. For the most part, REM awardees who had multiple sequential supplements partnered with the same institutions for subsequent years.
- **Goal 6: The effects of mentoring on the research participants:** We found that RPs were mentored and reported receiving good or excellent mentorship. RPs reported that mentors provided advice on the direction of their research, and received advice regarding college and career prospects. RPs also reported forming professional relationships with mentors.
- **Goal 7: The effectiveness of diverse and flexible cohorts:** RPs formed working relationships with the other RPs and learned from one another during

their summer experiences. That said, we did not gather enough information to assess the extent to which REM supplements implemented a cohort approach.

- **Additional Finding 1:** In order to set up the evaluation, we invested a considerable amount of effort into collecting common data across the EFRI and ERC projects as well as the REM supplements. The information collected by the program was not always consistent nor was it sufficient to conduct an evaluation. Building in consistent data collection practices regarding mentors, mentor training, roles of mentors, frequency of mentoring interactions, and other relevant information could offer much greater insight into the program's effectiveness.
- **Additional Finding 2:** About 10 to 15 percent of EFRI projects and 20 percent of ERC projects seek REM supplemental funding. Of those EFRI projects that are awarded a REM supplement, about half seek a subsequent supplement.

Recommendations and Considerations

- **Create a data collection mechanism**: To better understand the REM program's outcomes, NSF needs to collect more timely RP data. The REM program could develop a mechanism for assembling an ongoing roster, including contact information. In addition, the REM program could benefit from systematically collecting information from annual and final reports regarding the research contributions of REM participants and partnerships. The REM program could also collaborate with the Research Experiences for Undergraduate Program which has worked to improve their data infrastructure on participants served.
- **Mentor training improvements:** While RP survey respondents were positive about their mentoring experience, the REM program may want to consider obtaining more information on how mentors are trained and how mentoring is conducted. One approach is to consider defining minimum mentor training requirements that are the same across REM supplements and aligned with research on effective approaches for mentor training.
- **Facilitate RP engagement:** NSF should consider facilitating more opportunities for RPs to engage with NSF and other NSF programs. In addition, the EFRI and ERC PIs may want to consider establishing more cohort-building activities during the REM summer experience to help build a sense of community. Lastly, some RPs surveyed suggested that they would appreciate if the program fostered RP connections post-REM through a listserv, LinkedIn groups, etc.
- **Engage with REM supplement awardees:** The REM program could consider identifying an annual target for the number of EFRI and ERC projects awarded REM supplements. As for those REM PIs that do not reapply for a REM

supplement, it may be worth understanding their decision process to determine why they are not seeking additional years of REM funding.

Contents

1. Introduction

A. Background

The National Science Foundation's (NSF) Emerging Frontiers in Research and Innovation (EFRI) and Engineering Research Center (ERC) programs are long-standing programs within the NSF's Directorate for Engineering (ENG) portfolio that fund fundamental research at research institutions across the United States. Started in 2007, the EFRI program funds interdisciplinary teams of researchers supporting fundamental discovery at the frontiers of engineering research and education[2] with about $2M of support over a 4-year granting period. ERCs are large institutional awards ranging from $25M to $50M over 5 to 10 years with the goal of supporting convergent research, education, and technology translation at U.S. universities. Both programs have goals to increase participation of underrepresented groups in the field of engineering, including women, persons with disabilities, and underrepresented minorities. Given the focus of ERCs on institutional change, NSF added an explicit goal for ERCs to create more inclusive cultures within their research institutions in 2018.[3]

In 2011, EFRI began offering a supplemental funding opportunity for grantees called Research Experience and Mentoring (REM) "to create carefully mentored research opportunities for people who might not otherwise become engaged in a research project, and to utilize contributions and talents of these participants to make further progress toward research goal." ERC followed suit in 2018 and began offering supplemental funding to ERC grantees. In January 2021, the IDA Science and Technology Policy Institute (STPI) commenced an evaluation of the REM program. The goal of the REM evaluation is to understand the outcomes and impact of the REM funding and assess the career and educational outcomes of the research participants (RPs) who engage in the program.

B. REM Supplement Details

REM supplemental awards are intended to last up to 12 months, with full-time research programs taking place during the summer, and additional mentorship opportunities throughout the academic year. EFRI, ERC, and IUCRC[4] awardees are

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2 Emerging Frontiers in Research and Innovation Program: https://www.nsf.gov/pubs/2020/nsf20614/nsf20614.htm

3 For more information, see: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf19503&org=NSF

4 First offered in FY2022; however, this evaluation covers supplements awarded from 2011 to 2021.

eligible to apply for a REM supplement. There were 116 supplements funded between 2011 and 2021, which is the focus of this evaluation. Traditional NSF grant programs provide funds to support participants such as faculty, graduate students, post-doctoral associates, and research scientists. However, a unique feature of REM is the reach beyond the traditional participants on a typical NSF grant. REM defines "research participants" to include high school students; science, technology, engineering, and mathematics (STEM) teachers; undergraduate STEM students; faculty from community colleges and other institutional faculty; and veterans.

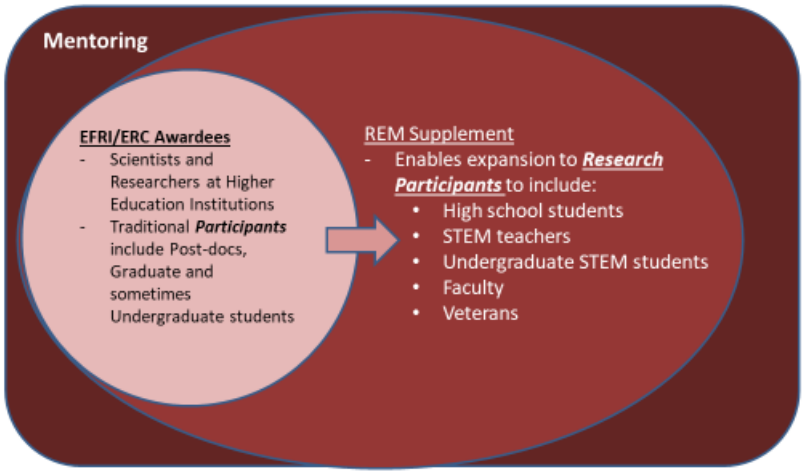

Figure 1. Comparison of REM Definition of "Research Participants" with Participants in Parent EFRI and ERC Awards

A REM supplement is typically $100,000 over a 1-year period. The funds are used to pay RP stipends for the research they conduct over the 6- to 10-week summer session in an EFRI or ERC laboratory under the guidance of a mentor, to provide mentor training to those mentoring the RPs, and to support additional mentoring activities into the academic year.

C. REM Program Goals

The Dear Colleague Letters (DCLs) lay out the program background and goals. These goals were echoed in conversations with NSF program staff. STPI set out to evaluate the extent to which the program was meeting its goals. The REM program has five main goals outlined in the DCLs, and two additional goals described by staff from the Division of Emerging Frontiers and Multidisciplinary Activities (EFMA):

1. To provide research experiences and mentored opportunities for high school students, STEM teachers, undergraduate STEM students, faculty, and veterans who may not otherwise become engaged in a research project;
2. To engage participants from underrepresented groups;

3. To enhance careers of participants in STEM;
4. To enhance EFRI- or ERC-supported research; and
5. To build partnerships with local, underserved institutions.[5]

In addition, the EFMA office asked STPI to better understand:

- The effects of mentoring on the RPs, and
- The effectiveness of diverse and flexible cohorts.

D. Outline of Report

In this report, STPI presents the findings from the evaluation of the REM program. Chapter 2 outlines the methods used in the evaluation. Chapter 3 summarizes the program data collected during the course of the evaluation. Chapter 4 discusses findings related to the composition, educational and career pathways, cohorts, and effects of mentoring on the RPs. Chapter 5 presents findings related to the mentoring component of the REM program. Chapter 6 discusses findings related to RPs' impact on research and discusses partnerships developed through the REM supplements. Finally, Chapter 7 summarizes the overarching findings and offers options for the EFMA office to consider regarding future management of the program.

[5] The REM DCL encourages partnerships with one or more of the following types of institutions: inner-city schools or other high-needs K-12 schools; community colleges that serve underrepresented populations; and 4-year colleges that serve underrepresented populations.

2. Methodology

STPI used multiple methods to evaluate the extent to which the REM program met its goals by collecting and analyzing data from five sources:

1. Survey of RPs;
2. Reviewing program documentation such as DCLs, award proposals, and annual and final reports, including any REM project-level data;
3. Analysis of REM data provided by EFRI and ERC programs;
4. Interviews with NSF staff, RPs, mentors, principal investigators (PIs), partner institutions, and other relevant stakeholders; and
5. Bibliometric analysis based on papers that PIs listed as products of the EFRI and ERC awards in the annual and final reports.

1. Survey

The main focus of the RP survey designed by STPI was to understand: (1) the extent to which RPs can point to the REM experience as something they know, (2) the impacts of the flexible cohort model, (3) the impacts of the mentoring by trained mentors, and (4) the RPs' persistence in STEM education or careers. REM program staff estimate that on average each supplement trains approximately 7 RPs, so there is an expected sampling frame of approximately 700 RPs (assuming that some RPs participate in multiple years). Given the diversity of participants (10 years' worth of supplements, participants who could have been K-12 teachers, university faculty, high school students, undergraduates, or graduate students), the survey needed to be designed to allow RPs multiple paths through it depending upon their experiences, although it was expected that some questions would be common across groups of participants or even all of them. Many measures are taken from the Undergraduate Research Student Self-Assessment (URSSA) tool and have been validated.

The survey required OMB clearance; STPI staff developed the 60-day *Federal Register* notice and 30-day notice for use by NSF personnel as part of the clearance package. Through the OMB clearance process, RPs were limited to those that participated in 2017–2021. Ultimately, the survey was fielded to the 381 RPs for whom contact information was acquired, with 126 RPs responding and 118 reporting participation in the REM program. The final response rate for the survey was 33 percent. Figure 2 illustrates the sampling frame and response rate. Appendix A contains the survey.

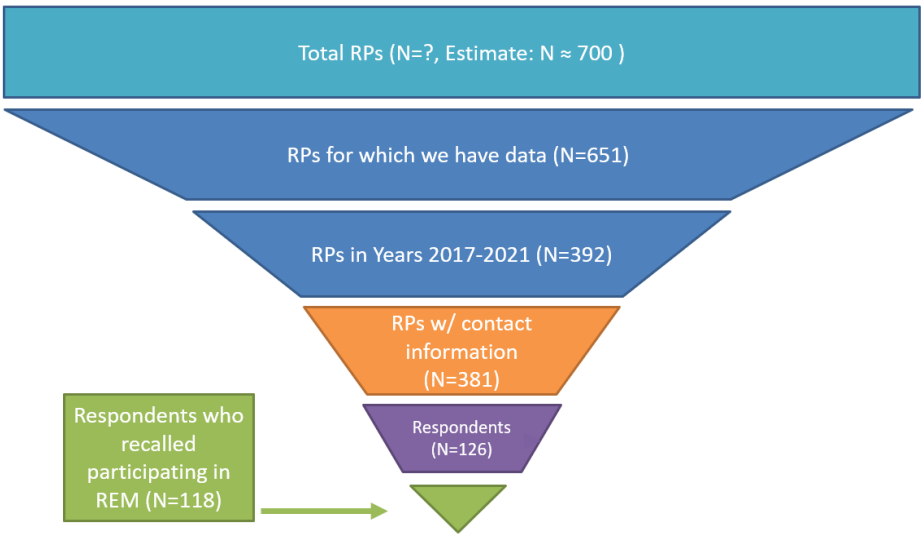

Figure 2. Survey Sampling Frame

2. Program Documentation

STPI analyzed the DCLs to understand how the REM program communicated its goals to the community and whether they had changed over time. In addition to the DCLs, EFMA staff provided STPI access to NSF's e-jacket system, which contains award proposal and reporting data. This access allowed us to review and gather necessary evaluation data from REM supplement proposals and EFRI and ERC progress reports. The ERC program also maintains a reporting infrastructure (ERCWeb) that served as a source for REM-related documentation and information on REM participants. Information that was gleaned from the documentation includes:

- Descriptions of mentorship activities and approaches;
- Identification of partnerships strategies; and
- Publications of EFRI and ERC awards for use in bibliometric analyses.

3. REM Project and RP Data

To gather data on RPs, we first needed to identify the universe of REM awards. EFRI project data were collected by conducting an award search within the NSF database. Specifically, NSF systems allow for an award search to be conducted using a program solicitation code (see Appendix B) within the MyNSF web portal. Using these program solicitation codes, STPI found all associated projects. The data returned from this search contained EFRI project award numbers, project titles, and the institution with which the project was affiliated. These award numbers were cross-referenced with the public NSF award database to return additional information for each award such as the PI information and the award end date. ERC data was collected using the ERCWeb portal, which provided

a list of all active and expired ERC awards. This information was then cross-referenced with award data in the public NSF award database. Finally, the EFMA office provided additional REM supplement data.

To assess RP impacts of the REM program on research, we explored EFRI and ERC publications reported to NSF. Specifically, we used the NSF Solr Application Programming Interface to obtain all publications reported by the EFRI and ERC awardees that had received a REM supplement. We then compared the authors of these publications against the lists of RPs reported to STPI by the PIs.

Once the REM parent awards were identified, we collected RP and mentor data in three steps. First, we began by collecting data on RPs and mentors provided in EFRI annual reports. Using an internally developed algorithm, STPI extracted a list of all individuals associated with each EFRI project. This information included the individual's name, contact information, role, funding source, and other miscellaneous data. Next, we used the funding source and individual's role, both of which could indicate whether an individual was affiliated with the REM program to develop an initial list of potential RPs and mentors. These data were then placed into an Excel spreadsheet with additional information about the EFRI project and specific REM supplement. With respect to ERC projects, STPI attempted to collect RP and mentor information from the annual reports. However, the process did not produce significant findings as REM affiliates are listed with less specific information in ERC annual reports than EFRI reports.

Once STPI had collected an initial dataset of individuals affiliated with each award, data provided by the EFRI and ERC programs—which may have included attendance at the annual Emerging Researchers National (ERN) conference or the poster session for REM students—were then cross-referenced with the working list of RPs and mentors to add any initial REM affiliates missed in step one. The result was a large but incomplete list of REM RPs and mentors.

Following the initial data collection steps, STPI stratified the RP data by project and sent an individualized list of participants and mentors to each of the REM PIs, asking them to confirm the information collated thus far and to add in names and contact information of RPs and mentors. This resulted in a total of 651 identified RPs. Not all PIs confirmed the data, nor were they able to provide the names and email addresses for the RPs when there was no data. As a result, the list of RPs is incomplete. Based on the average number of RPs per REM supplement and the number of supplements for which data was missing, we estimate a total number of about 700 RPs. For a more detailed discussion of REM RP and mentor data, see Appendix C.

4. Interviews

STPI conducted interviews with individuals relevant to the design and administration of the REM program, including past and present REM program officers. In addition to these interviews, the study team interviewed a group of RPs, mentors, and PIs to better understand their experiences with the REM supplement and the impact it had on their education, careers, and research. Because these interviews did not proceed through an OMB clearance process, a maximum of nine interviews per group was conducted. Interviews with RPs were intended mostly to test concepts for inclusion in the survey, though any insights interviewees provided regarding participation in REM were captured. Interviews with mentors and PIs were used to collect qualitative data regarding the impact of the REM program. Results are intended to serve as anecdotal reports and used to elucidate valuable features of the REM program and to identify unanticipated benefits of participation.

5. Bibliometric Analyses

Using NSF's database, STPI staff gathered the list of publications of EFRI and ERC awards that received at least one REM supplement. Using the RP data gathered in this process, STPI then crosswalked the publications against the list of RPs to identify publications in which RPs have played a role. The analyses identified whether RPs played a leading role (e.g., as first authors).

Due to the delay in release of many publications, STPI did not constrain the publications to the years in which REM participants were affiliated with the program. For this same reason, comparisons in publication counts across years of an EFRI/ERC project cannot be conducted.

6. Logic Model

Based on our analysis of the DCLs and initial consultations with NSF program staff, we have developed a logic model for REM (Figure 3). The logic model uses a standard input-activity-output-outcome framework. The section of the logic model germane to the RPs has green-outlined boxes; the section related to mentors has light blue-outlined boxes; the partnerships section has purple-outlined boxes; the section related to award management has grey-outlined boxes; and the section related to research has yellow-outlined boxes. The logic model identifies aspects of the program's desired theory of change (shown in red). The theory of change reflects how the STPI study team views the reasoning and basis for the REM supplement to make the impacts outlined in the goals of its program. The logic model was used as a tool to reflect on and understand the program's design.

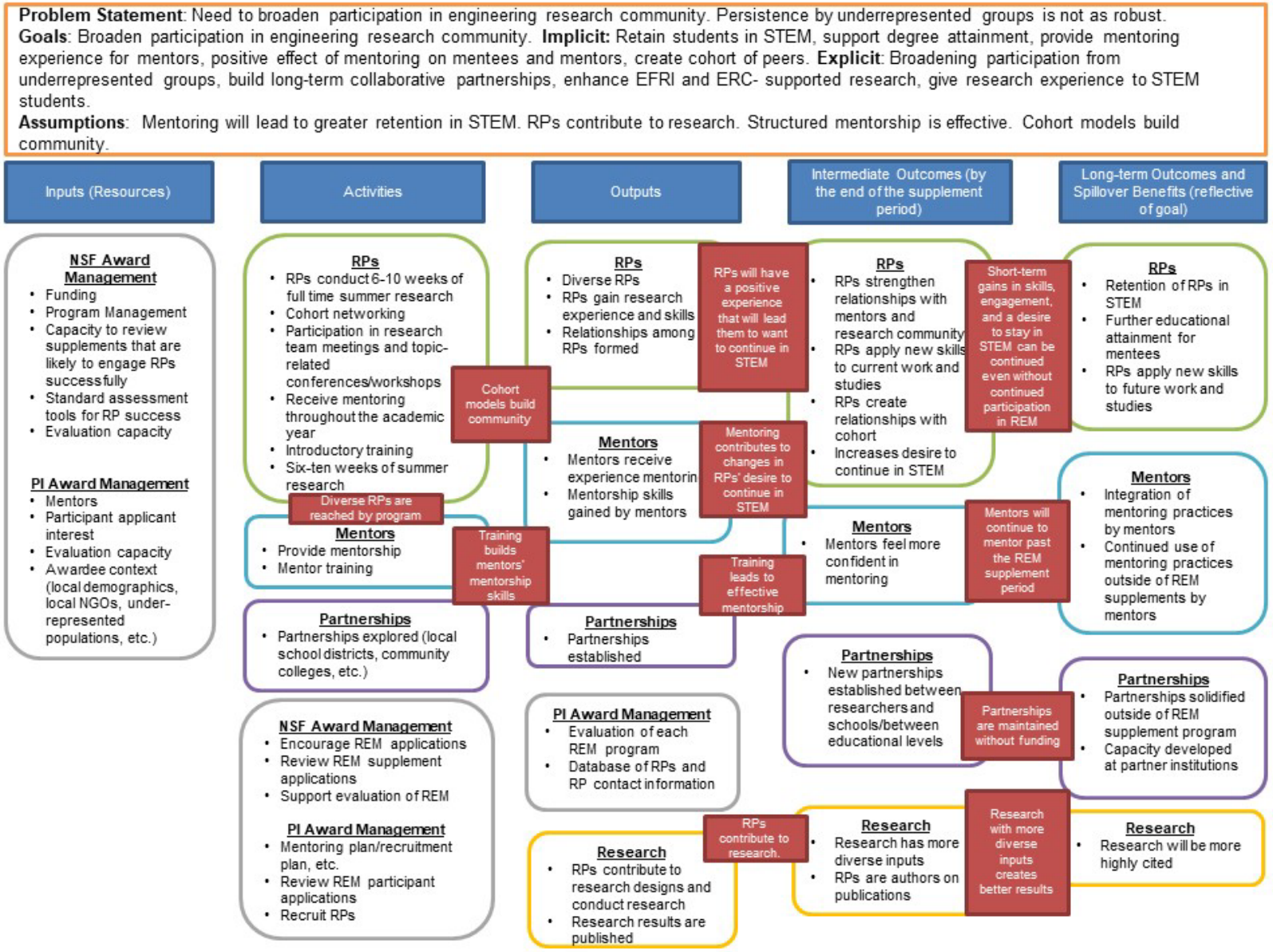

Figure 3. EFRI REM Logic Model

7. Limitations

STPI was unable to ascertain outcomes and impacts for some aspects of the REM program mostly due to data limitations.

First, we had access to limited program data. As such, the names of RPs, mentors, contact information, demographic information, and other relevant information was limited. Given the absence of an RP database, the STPI study team had to manually develop a survey sampling frame by compiling a full and accurate listing of RPs to be contacted. The process for building the RP list and validating the data is described in Appendix B.

Second, because REMs are supplements to EFRI and ERC awards, the annual reports contain minimal information about the supplements. There are no annual and final reports dedicated to each REM. REM applications contained information of proposed REM activities—not actual—and provided varying levels of detail regarding their REM programming.

Third, OMB clearance restrictions limited us to surveying RPs who participated between 2017 to 2021. As a result, we did not have longitudinal data and could not test for long-term effects of mentoring or RP career outcomes.

Fourth, the response rate for the RP survey was 33 percent, resulting in low statistical power. Because NSF does not maintain a roster of REM participants, we were not able to confirm that all RPs were reached. Furthermore, some of the contact information for RPs was incorrect and outdated. To the extent that RPs did respond, responses were distributed differentially over time and across populations, potentially biasing results. Regarding demographic analyses, cell sizes were too small for statistically relevant conclusions to be drawn for some subpopulations. Survey results were not representative of the REM population as a whole given the low response rate.

Fifth, we relied on bibliometric data to inform the extent to which RPs contributed to research products, but we did not have the full names of all RPs, and relied on annual reports for the list of research products. As such, a full listing of research contributions from RPs was not obtained.

Finally, there was limited insight into mentors for the program. As it was not feasible to survey PIs and mentors given OMB clearance restrictions, the study had a limited ability to investigate the role of mentorship from the mentors' perspective.

3. REM Supplement Data

This chapter details program data for the REM supplements and for the EFRI and ERC projects that served as the basis for the supplements. Terms used throughout this chapter are defined below:

- *Projects* refer to EFRI and ERC awards that are eligible to apply to the REM program.
- *Supplements* are the REM awards given to EFRI and ERC projects.

With respect to specific projects, this chapter distinguishes between *new* and *active* EFRI and ERC projects.

- *New* projects are those that have been awarded in the specified year. *New* projects are counted exactly once in the year that they were awarded.
- *Active* projects are those that have not necessarily been awarded in that particular year, but are active in their period of performance at that time.[6] During the years in which the REM supplement is offered to EFRI and ERC projects, the number of active parent projects is equal to the number of projects eligible to receive the supplement.

An additional category of *first-time* supplements is used to illustrate when a project is first awarded a REM supplement because supplements are only active for 1 year, but EFRI/ERC projects are eligible to reapply. Should the EFRI or ERC receive a REM supplement in its final year, the EFRI/ERC project is awarded a no-cost extension. This is one reason EFRI and ERC projects continue to be active through the supplement period. All active EFRI and ERC projects are eligible to apply for the REM supplement.[7]

A. EFRI and ERC Award Data

We begin by analyzing the eligible EFRI and ERC awards that received a REM supplement—that is, the number of EFRI/ERC projects that have received a REM supplement over the total number of projects. This calculation depends upon the number of active projects in any given year, regardless of the year in which the projects were

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6 EFRI projects are typically awarded for 4 years. ERC projects are awarded for 5 years, with the option to extend for another 5 years.

7 There are examples where an EFRI project continues to be active beyond its initial 4 years because it has received, and continues to receive, a REM supplement.

initially awarded. Figure 4 shows the distribution of active projects for both EFRI and ERC in the years that the projects were eligible to receive the REM supplement. EFRI was the first program to offer the REM supplement in 2011 followed by the ERC program in 2018.

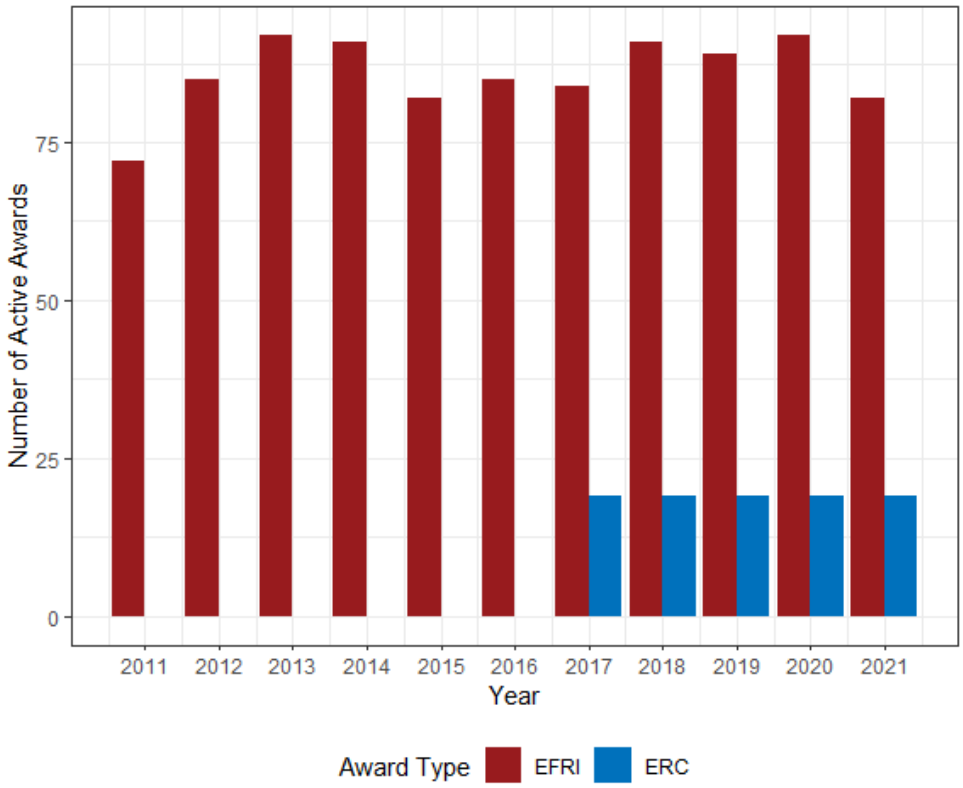


Figure 4. Distribution of Active EFRI and ERC Projects Between 2011 and 2021

The number of eligible EFRI projects ranged from 73 to 84 projects each year while ERCs held steady at 18 ERC projects. The next section details how many and what percentage of these awardees sought out the REM supplement.

B. REM Supplement Data

The number of REM supplements ranged from 5 to 10 for EFRI projects from 2011 to 2021, and 4 to 7 ERC projects from 2018 to 2021 (Figure 5). In total, 215 unique EFRI projects and 23 unique ERC projects were eligible to apply. EFRI REM supplements were awarded to 10–15 percent of eligible EFRI projects each year, while 21–42 percent of ERCs were involved in REM in any given year.

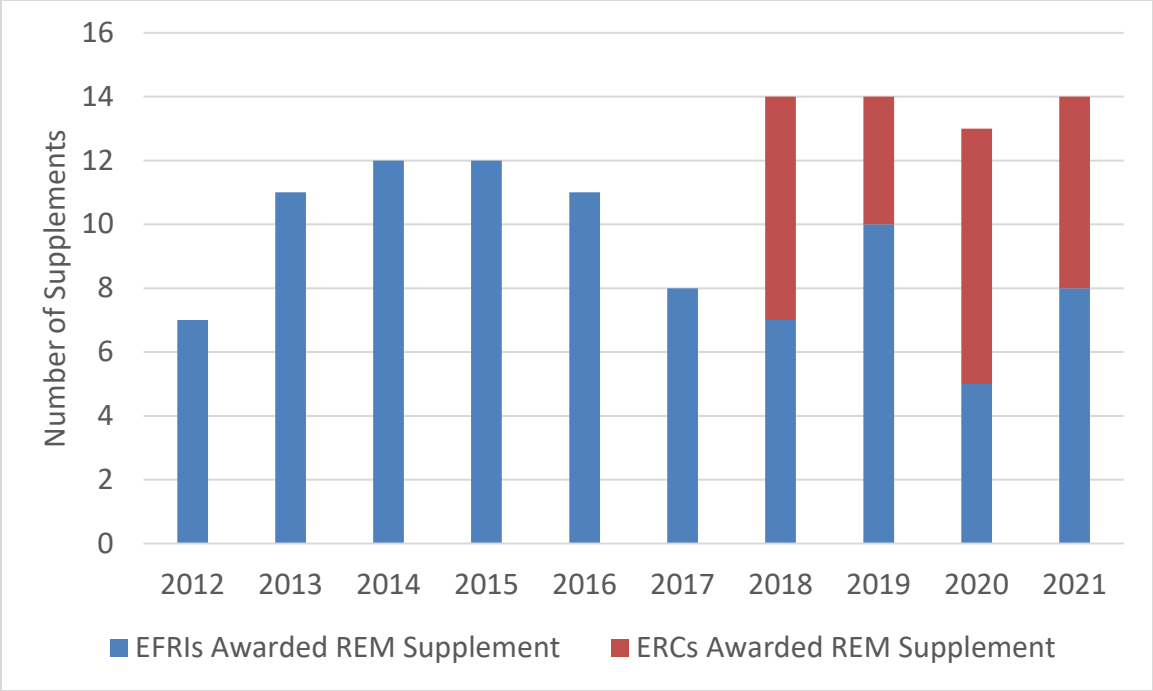


Figure 5. Number of EFRI and ERC REM Supplements over Time

In total, 116 REM supplements have been awarded. Across the two programs, 55 unique projects (23 percent) applied for a REM supplement and nearly all applicants (93 percent) for the REM supplement were accepted (Table 1). Second, a higher percentage of ERC awardees have applied for REM supplements than have EFRI awardees. Since 2011, 20 percent of eligible EFRI projects have applied for the REM supplement, and 43 percent of ERC projects have applied for the supplement.

Table 1. Aggregate EFRI/ERC REM Supplement Data

	EFRI	ERC	Total
Total Number of Projects	215	23	238
Number of Projects That Have Applied for the REM Supplement	44 (20 %)	11 (48 %)	55 (23 %)
Number of Projects That Have Been Awarded the REM Supplement	42 (20 %)	10 (43 %)	52 (22 %)
Number of REM Supplement Applications	97	28	125
Number of REM Supplements Awarded	91	25	116
Average Number of REM Supplements per Project	2.2	2.5	2.2

1. Distribution of EFRI Awards by Number of Supplements Received

We analyzed the supplement awardees to identity patterns among EFRI awardees with existing supplements versus new supplements. Figure 6 is a heatmap, which shows the number of years in which a given EFRI project is eligible to receive a supplement by the number of supplements received. The number in each tile and the corresponding color indicates the number of EFRI projects that were eligible for X number of years, and have received Y number of supplements. For example, five EFRI projects received 3 years of funding for the REM supplement. These five awardees were eligible for 6 years.

Another finding is that of the EFRI projects that have received REM supplements, about half (20 of the 42 EFRI projects that have received supplements or 47 percent) have only received one supplement and did not request another supplement in subsequent years. Of those 20 EFRI projects, 19 were eligible to receive the REM supplement for more than 1 year.

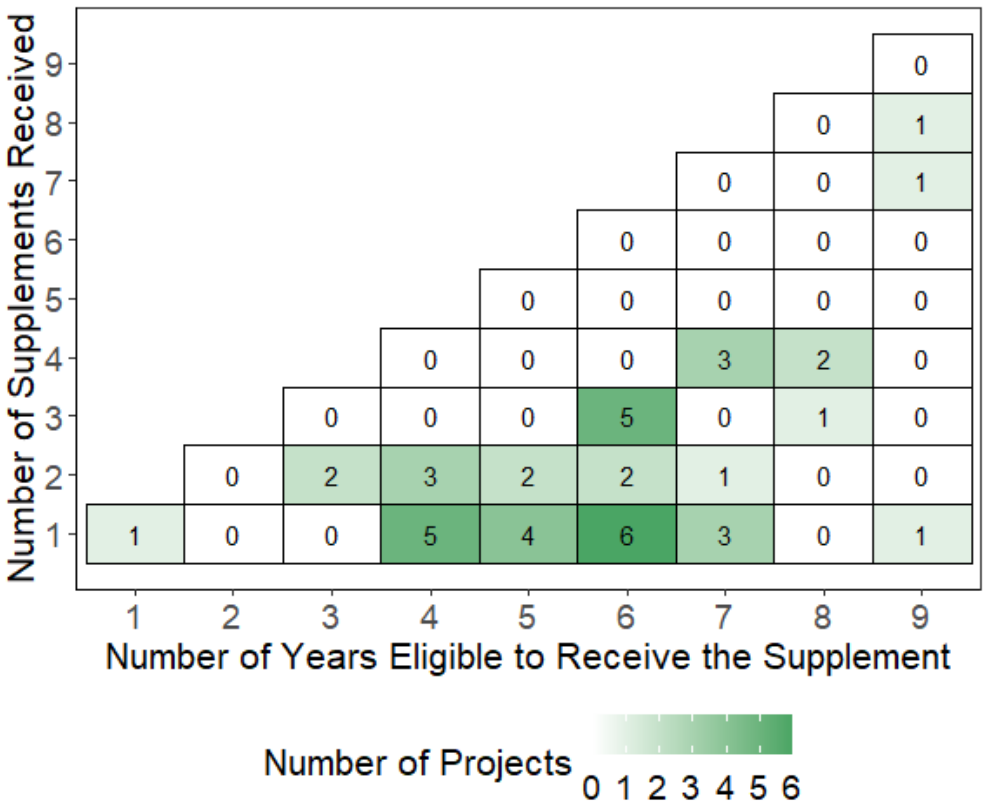


Figure 6. Number of EFRI Awards That Have Received at Least 1 REM Supplement Plotted by Number of Supplements

2. Distribution of Supplements by Year of Project Cycle Awarded

Figure 7 shows the distribution of REM supplements across the year of the EFRI/ERC project in which the supplement was awarded. The data show that a significant portion of

REM supplements was awarded in the third and fourth years of the project's lifespan. Furthermore, numerous EFRI awards were awarded supplements in years beyond the initial length of the program.

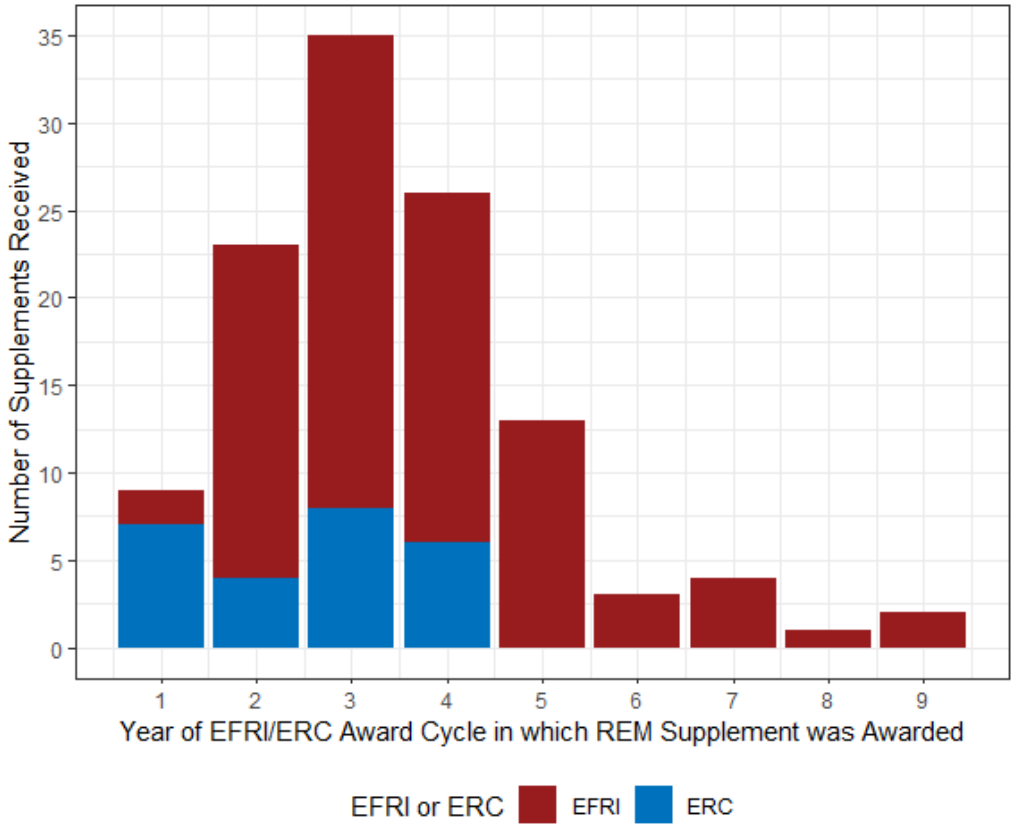


Figure 7. Distribution of REM Supplements along Year of EFRI/ERC Project in which REM Supplement Was Awarded

C. Summary

Collecting and analyzing the REM supplement data allowed us to better understand the extent to which the REM supplement is relied on by EFRI and ERC projects. Some of the findings are:

- Between 2011 and 2021, EFRI awarded 91 REM supplements to 42 EFRI projects;
- Between 2018 and 2021, ERC awarded 25 REM supplements to 10 ERC projects;
- REM supplements touch 10 to 15 percent of EFRI awards and a slightly larger percentage of ERC projects (20 percent); and

- For the EFRI program, half of the EFRI awards that receive one REM supplement reapply and are awarded at least one more year of supplements.

4. Research Participants Findings

In this chapter, we combine a number of the methods to answer the first major research question about the impact of the REM program on the RPs during and subsequent to their participation in the program. Results of our analysis include data from survey responses, as well as information collected and analyzed from REM proposals. While the survey data do provide insight on the RP population, an incomplete sampling frame and lower response rate mean this survey may not be representative of the larger RP population. For example, more recent RPs had a higher response rate to the survey and may skew measures that require additional time to complete, such as education level or additional research experience. Likewise, data provided in the REM proposals are incomplete and can only provide part of the picture.

A. Respondent Breakdown

In this section, we provide a description of REM participants who responded to the survey. The following breakdown may not reflect the population of REM participants, as the survey may not be representative of the larger population of participants. The majority of research participants reported participating in the REM program once (81 percent).

1. Stage of Education

In the participant survey, RPs were asked what their student or employment status was during their REM experience. Participants were able to select more than one status in the case that they participated in more than one REM program, or held multiple educational and employment levels simultaneously (See Figure 8). Many respondents reported being an undergraduate student at the time of their REM (45 percent). Additional education and employment levels of RPs reported in the survey include high school students (21 percent), high school teachers (15 percent), and community college students (14 percent). These responses are shown in Figure 8. These educational/employment levels align with the intended RP affiliations as listed in REM proposals and the REM Dear Colleague Letter.[8]

[8] A REM DCL is available here: https://www.nsf.gov/pubs/2020/nsf20117/nsf20117.jsp

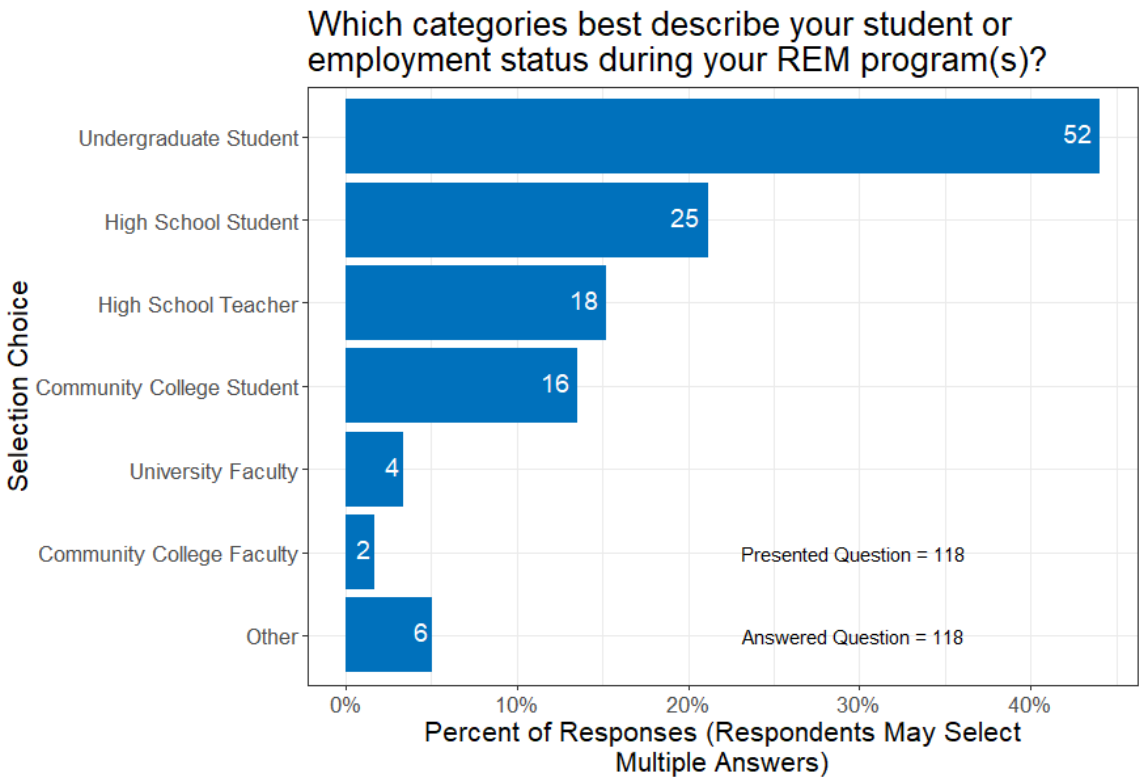


Figure 8. Student or Employment Status at Time of Taking Survey

Participants of the survey were asked for their highest level of education completed. Most of the respondents had completed high school and were working on or had achieved a bachelor's degree. These responses are shown in Figure 9. Those who listed high school as their highest level of education also tended to have participated in the program most recently (in 2020 or 2021), indicating that they have not yet had time to complete higher levels of education.

Though largely positive, one respondent noted feeling alienated due to educational status, saying,

> *"I felt talked down to a lot since I went to a community college and the students that go to a four year seem very elitist. Despite the preaching about diversity, equity and inclusion from the program it's a very elitist environment."*

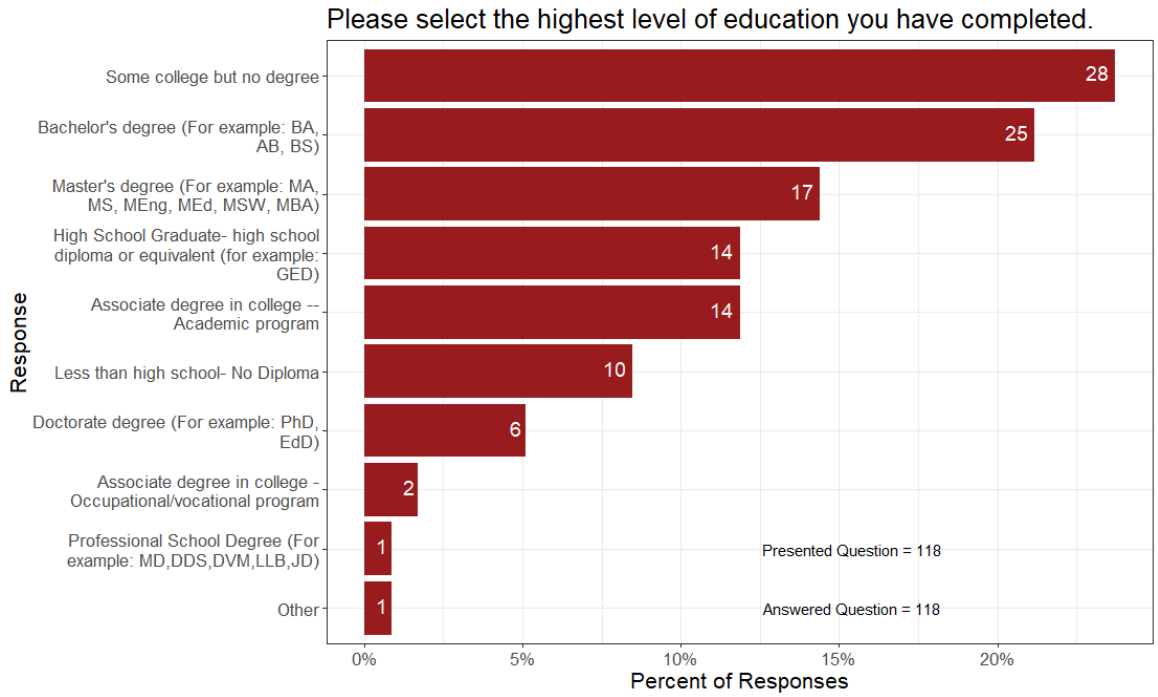


Figure 9. Respondent Breakdown by Highest Level of Education Attained

2. Demographics of REM Participants

Broadening participation is a goal of the REM program, and REM participants surveyed do represent a diverse group of STEM students and teachers. The largest group (45 percent) reported their race as White, followed by 38 percent of RPs identifying as Black/African American as indicated in Figure 10. This was a select all that apply question, and individuals could select more than one race. NSF data on bachelor of science engineering majors indicate overall degree earners as 63 percent White, and only about 4 percent Black/African American in 2019 (NSF 2022).

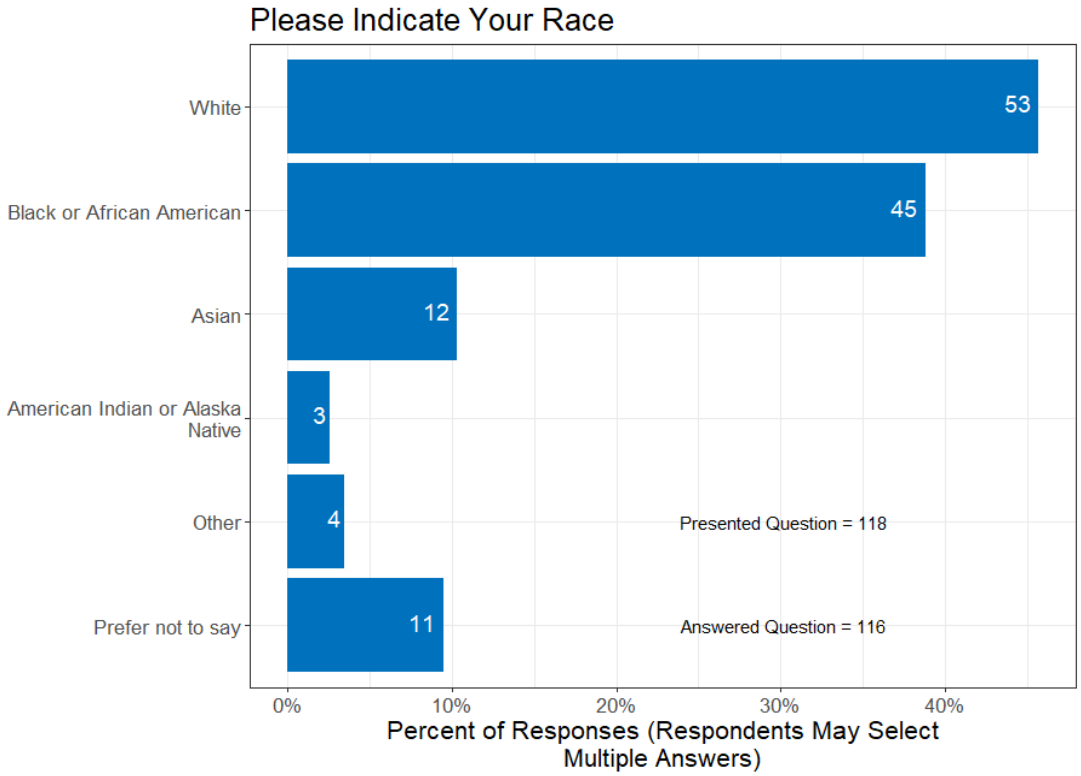


Figure 10. Respondent Breakdown by Race

B. Research Experience of REM Participants

1. First Research Experience

About 69 percent of RPs reported that REM was their first research experience. Sixty-seven percent of RPs stated that they had not participated in another research experience after the REM program. These data are shown in Figure 11.

When asked for general feedback, three respondents mentioned they would recommend REM to others, and three respondents expressed a desire to participate in REM again. One respondent expressed both, saying,

> *"If I could participate in the program again I would. Also, I would recommend this program to students interested in STEM because it is a perfect immersive opportunity to gain an overall view of research in STEM."*

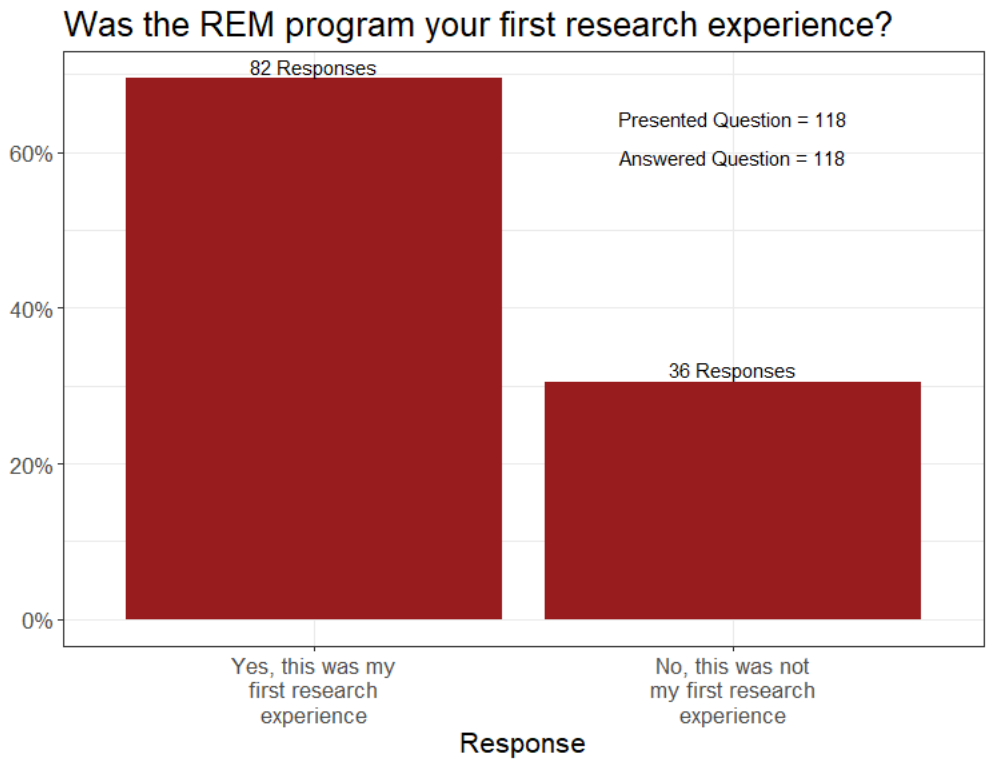


Figure 11. Respondent Breakdown of First Research Experience

2. Program Satisfaction

Overall, respondents were satisfied with the REM program, with 94 percent rating the research experience overall good or excellent. Most survey respondents reported either good or excellent working relationships with other research group members (95 percent) and time spent doing meaningful research (89 percent).

Figure 12. Research Experience Satisfaction

3. Cohort Experience

Figure 13 shows that survey respondents reported strongly disagree, disagree, neutral, agree, or strongly agree to several measures of cohort experience. Participants largely reported agree or strongly agree to statements including that they interacted with other REM participants (80 percent), formed working relationships with other REM participants

(78 percent) and encouraged others to stay in STEM (74 percent). Measures examining post-REM interactions were lower, with 48 percent indicating that they maintained working relationships with other RPs after the experience ended.

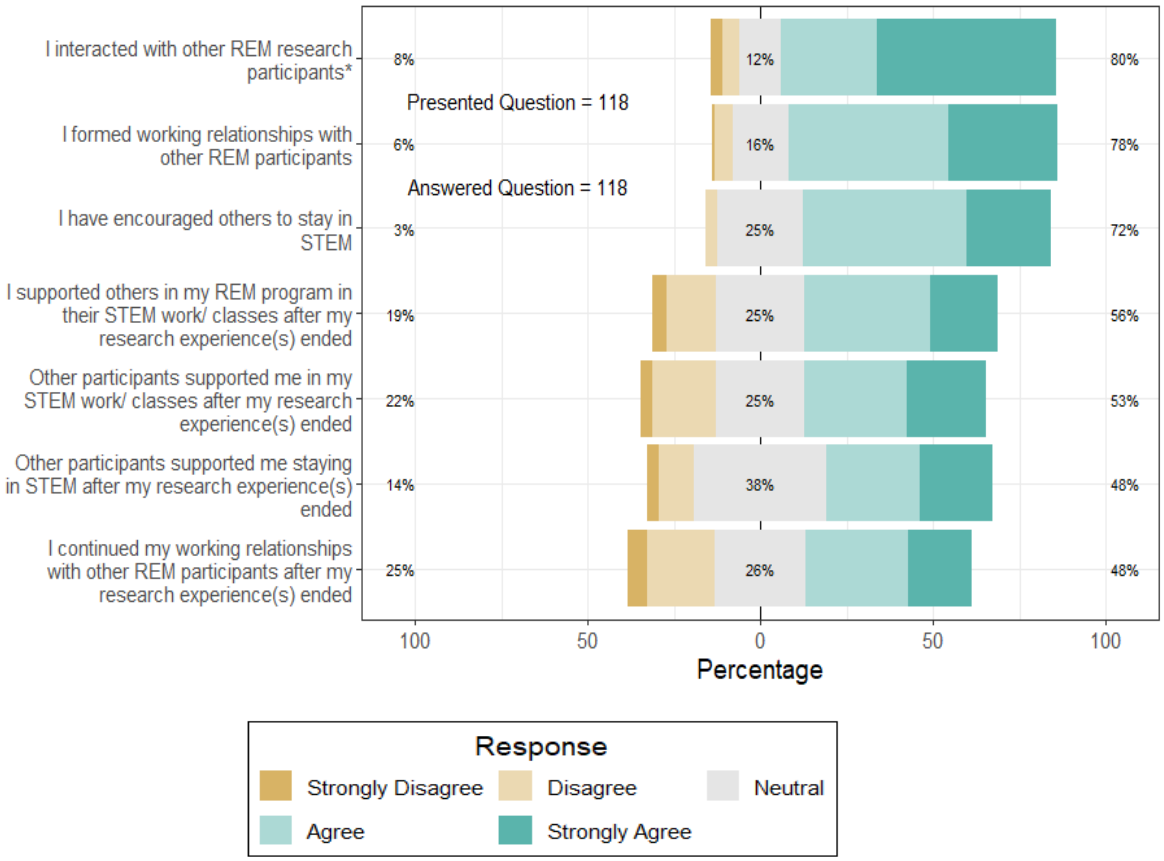


Figure 13. Cohort Interactions

Three respondents indicated that they were still in touch with members of their cohort. One RP shared,

> *"I had a very engaging summer and met some of my best friends who I still keep in contact with."*

Four RPs suggested the need for more meetings with other RPs or mentors, with one saying, "I would love to have more meetings or mixers with more graduate students or the mentors so we have a chance to network." One RP was disappointed that the ERN conference was cancelled for their year, sharing that,

> *"I enjoyed the overall experience. I wish there was more that the participants of the REM program could do in the future in terms of meetings. Unfortunately ERN Conference was cancelled and that was the event where I was hoping to meet all my fellow colleagues. I want an event*

like this in the future, as well as some sort of way to connect with everyone better."

While it is not an explicit goal of the REM program, one opportunity for growth could be to create better infrastructure for RPs to continue to interact after their time with REM has ended.

4. Impact of COVID

Throughout this evaluation, the program has been impacted by COVID. Some REM programs in 2020 noted COVID-related impacts to recruiting and implementation primarily due to campus closures. Pandemic-related closures impacted tours of engineering industry facilities that were a key aspect of some programs. Some PIs redesigned the REM program into a fully online format, with the lab components remaining intact. Teachers not only provided instructional and lab support, but in some instances created instructional videos to train and collaborate with other teachers, thereby serving as a driving force to keep the program functioning.

C. Benefits of REM Participation

In this section, we explore RP's engagement in scientific processes and the growth of their research skills through the REM program. While the previous section explored the relationships that many RPs form as a result of the REM program, this section seeks to understand the impact of these relationships and the overall REM experience on the RPs. In this section, we seek to understand the ability of RPs to (1) think and work like a scientist, (2) develop confidence in their own research, (3) grow their scientific skills, and (4) engage in scientific processes more broadly as a result of the REM program.

Much of the data gathered in this analysis stems from the RP survey. Results were overwhelmingly positive, and RPs reported gains across all of the skill areas. The specific areas in which this impact is felt by RPs is discussed in the following sections.

1. RPs Gained Skills in Thinking and Working Like a Scientist

Thinking and working like a scientist measures encompass skills such as problem solving, understanding research processes and theory, data analysis, and forming research questions. Participants reported how much or little they gained during the REM program. Figure 14 shows that survey respondents reported good or great gain in many scientific processes as a result of REM. Participants largely reported good or great gain in problem solving (85 percent), understanding theory and concepts guiding their project (83 percent), and understanding the connections among scientific disciplines (82 percent). While still a majority, fewer RPs reported good or great gain in analyzing data for patterns (69 percent).

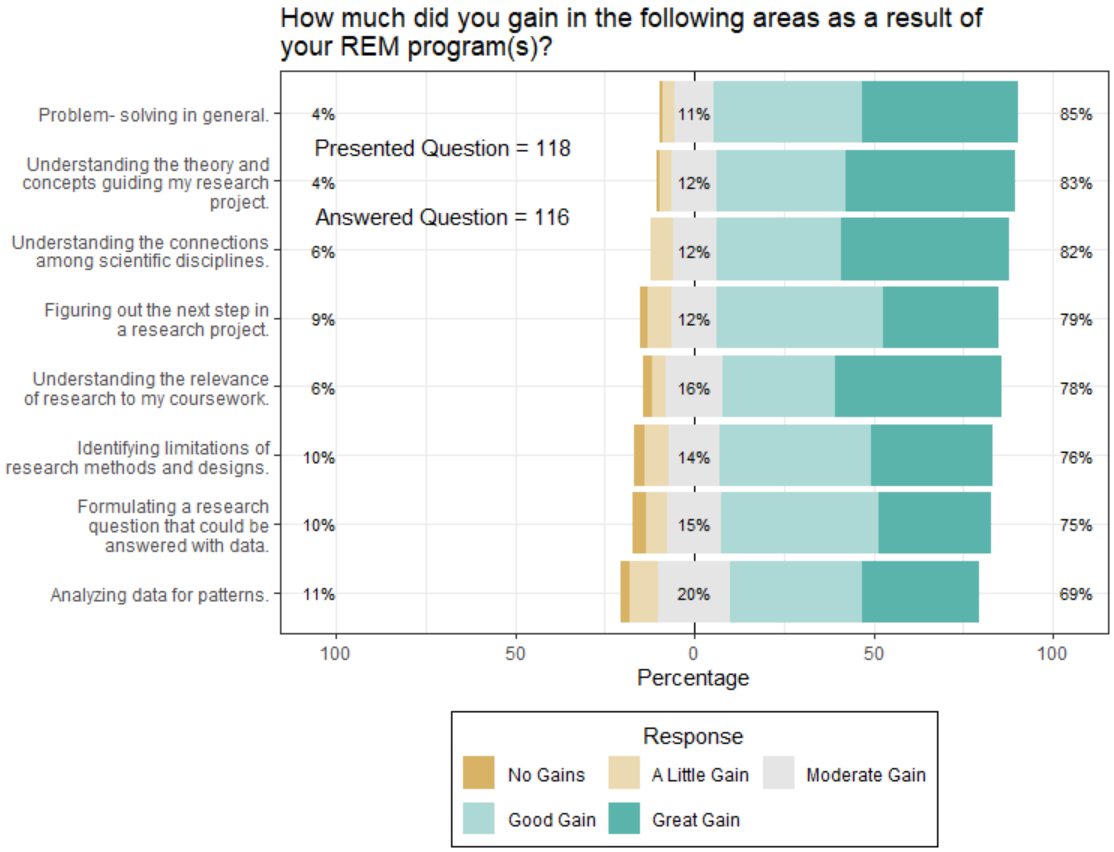


Figure 14. Gains in Thinking and Working Like a Scientist

2. RPs Reported Personal Gains Related to Research Work

Confidence in research and collaboration is an important desired outcome of the REM program. Figure 15 shows that overall, RPs had positive experiences in research and collaboration components of the REM program. Respondents reported good or great gain in their comfort in working collaboratively with others (85 percent), understanding what everyday research work is like (82 percent), and their ability to work independently (81 percent). Such responses show further evidence that strong relationships are formed during the REM program between RPs and mentors, as well as among RPs and other RPs.

Of those who indicated interest or involvement in STEM, 21 mentioned the importance of having the opportunity to conduct real-world research in their decision to remain in or pursue STEM. One individual said,

> *"It reinforced that I enjoyed and was capable of being part of the day to day work of doing research. It was easy to think that I liked the idea of being a research scientist, but the REM program was a good way to experience some of what it would actually be like to do that kind of work, and gave me the chance to talk to a lot of graduate students and professors who were already doing research, and learn from their experiences."*

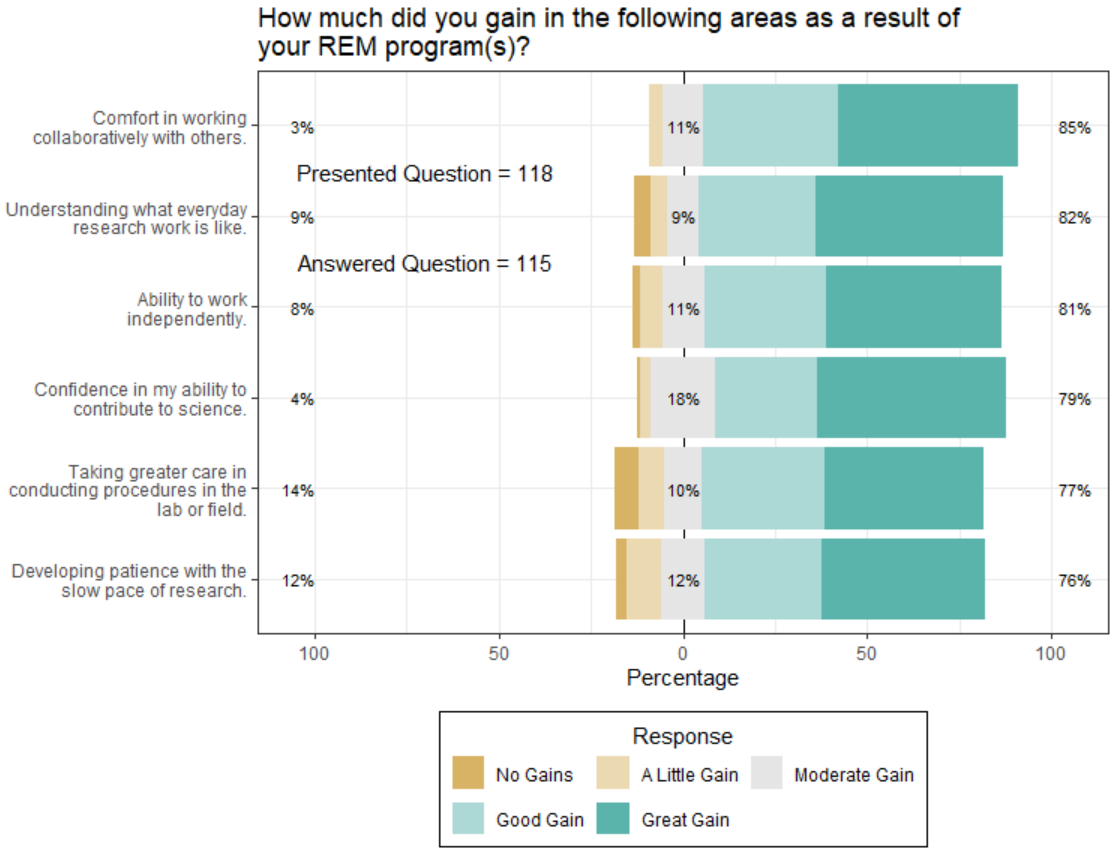


Figure 15. RP Personal Gains Related to Research Work

3. RPs Gained Scientific Skills

Gaining scientific research skills is an important desired outcome of the REM program. Overall, respondents of the survey reported improvements in scientific skills as a result of the REM program, as shown in Figure 16. Respondents also reported good or great gains in presenting scientific posters (82 percent), making oral presentations (80 percent), and managing their time (77 percent). Fewer respondents indicated good or great gains in calibrating instruments (58 percent) or using statistics to analyze data (57 percent). This is an unsurprising finding, as perhaps not all RPs who responded to the survey were involved in a project or project phase that included instrumentation or data analysis.

Of those who reported interest or involvement in a STEM field currently or in the future, several indicated specific skills they appreciated gaining in the REM program. Ten respondents described learning new technical skills, with one saying,

> *"As a current engineering student, the work I completed in the REM program has allowed for the application of skills and knowledge acquired in my undergraduate study. This experience has strengthened my ability and developed my passion to pursue a career in STEM, more specifically, energy."*

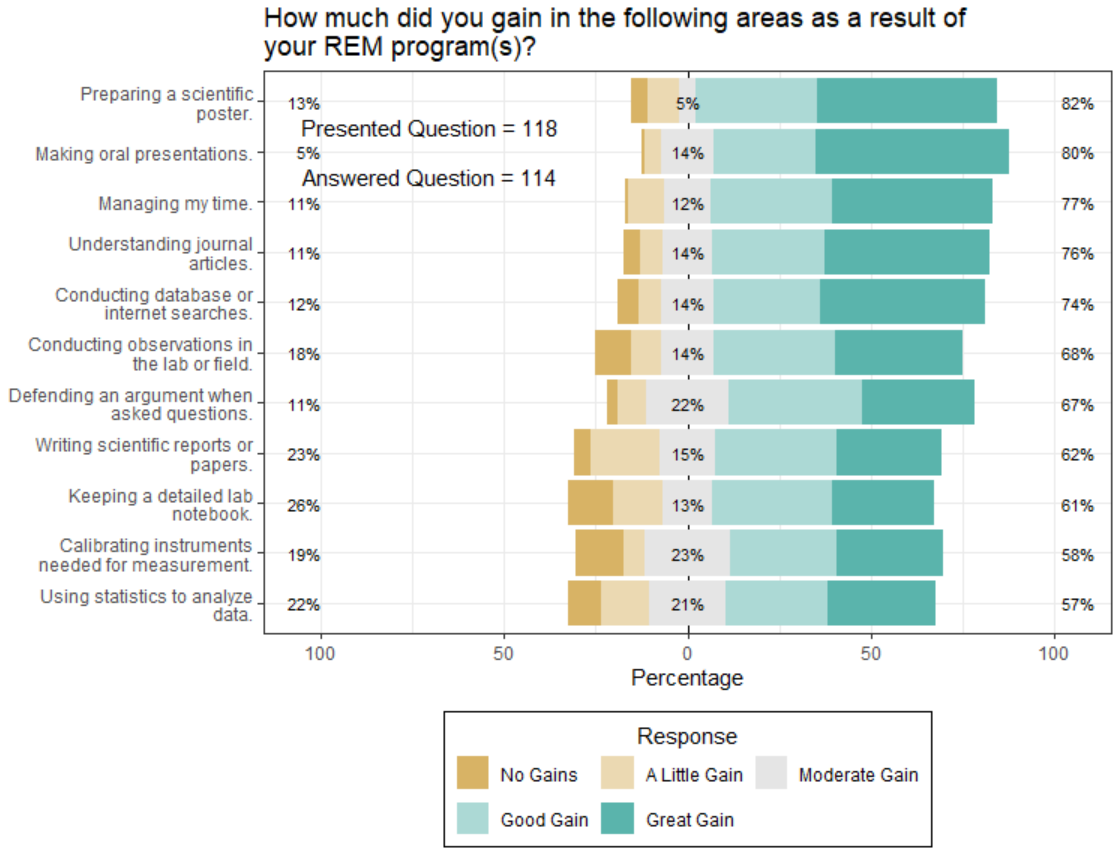


Figure 16. Gains in Scientific Skills

4. RPs Strengthened Attitudes and Behaviors as a Researcher

Gaining confidence and comfort in feeling like a researcher is another important desired outcome. The block of questions respondents of the survey rated on this topic are shown in Figure 17. Respondents reported engaging in real-world research (91 percent), feeling like a scientist/engineer (86 percent) and that they were able to think creatively about the project (84 percent). Engaging with scientists/engineers outside of the program was the lowest measure, with 67 percent of respondents doing so a fair amount or a great deal.

Of those who indicated they would like to stay or continue in STEM, 11 described gaining confidence in their ability to participate in STEM. One participant described this gain in confidence, saying,

> *"My research experience at (redacted) was amazing to say the least. It helped me learn about myself and my desires and also helped me grow. I knew I wanted to work in STEM, but my research experience really solidified that goal. Research is something I want to be a part of in the future, and specifically the REM program showed me that no matter my background, I can still contribute to knowledge."*

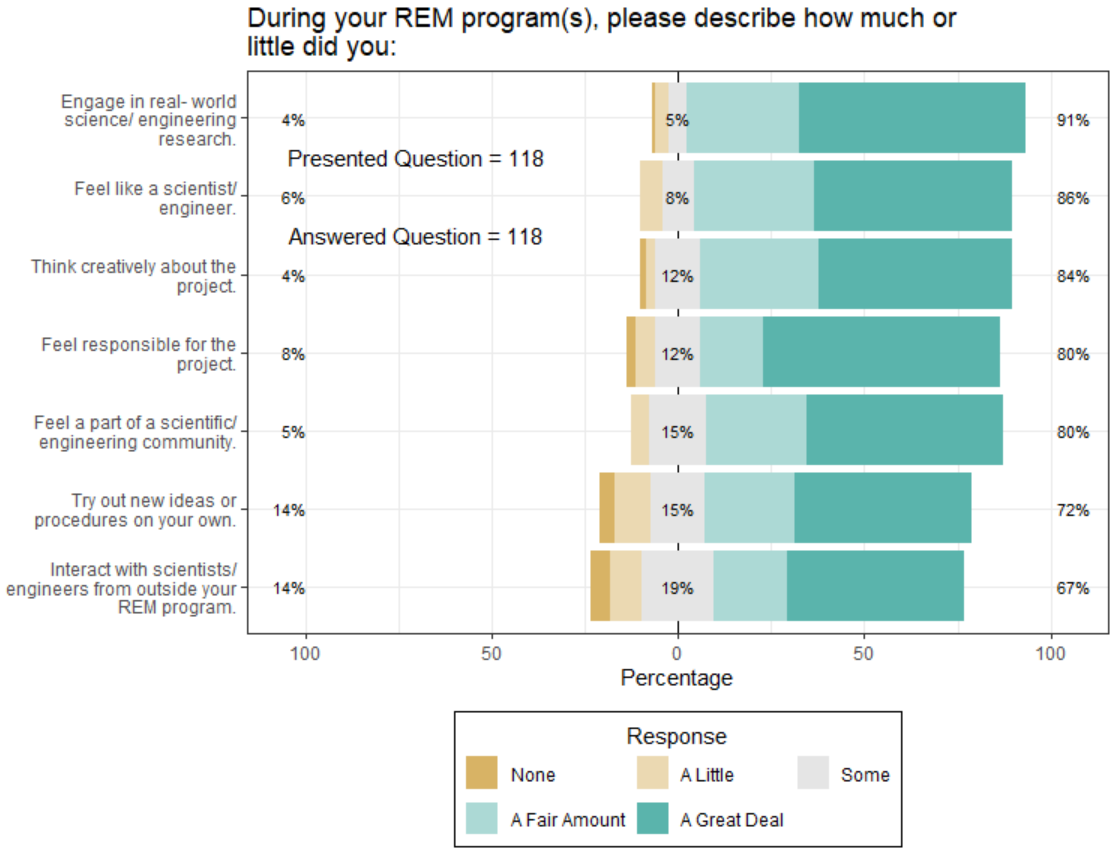


Figure 17. Attitudes and Behaviors as a Researcher

D. RP Findings

Survey results indicated the following:

- **REM served a diverse group of RPs**. Of those surveyed, RPs represented a diverse group of individuals compared to the national population of engineering graduates. Blacks, Hispanics, and women were more frequently represented in the RP pool as compared to the overall engineering population. REM RPs are most frequently undergraduate students, followed by high school students, high school teachers, and community college students. These groups align with what is sought in the DCL.
- **REM was most RP's first research experience.** This was the first research experience of most RPs.
- **Overall, RPs were satisfied with their experience.** They reported their time in REM as "good" or "excellent" on many measures of program experience, with nearly all surveyed rating the research experience overall as good or excellent. This positive review of their time in the program points to the current program providing a meaningful experience for surveyed participants who responded.

- **REM RPs gained key skills and attitudes.** These skills include thinking and working like a scientist, individual confidence in research and collaboration, and scientific skills.
- **RPs interacted with their peers.** Respondents reported engaging with the other participants in the program and forming strong working relationships during REM. RPs found value in the REM summer experience, and sought more opportunities to interact after their time with REM ended.
- **Most RPs reported a desire to remain in STEM.** This interest aligns with a key goal of the REM program. Their desire to remain in STEM was partly attributed to having the opportunity to conduct research, seeing potential graduate and career paths, and gains in confidence in their ability to participate.

5. Mentorship Findings

One unique feature of the REM program is that it explicitly called for the RPs to have structured mentorship as part of their REM experience. STPI staff therefore attempted to characterize the nature of the mentors and the approaches that REM awardees used to mentor RPs. This chapter describes our mentoring-related findings for the evaluation, including both descriptions of mentoring processes and RPs' views of the value of that mentorship as part of their research experience.

A. Mentor Types

Overall, we learned that nearly all respondents indicated they received mentorship during their REM experience. Mentor composition in the REM programs varied widely. Analysis from the RP survey indicated that mentors in the REM program were mostly graduate students (64 percent), university faculty (56 percent), and post docs (37 percent). About 20 percent of RPs reported returning to the REM program as peer mentors for younger undergraduates. This finding correlates with analysis from REM proposals, where many REM programs continued to employ returning undergraduate students as peer mentors to younger RPs. Figure 18, with corresponding questions from the RP survey, reflects the positions of REM program mentors.

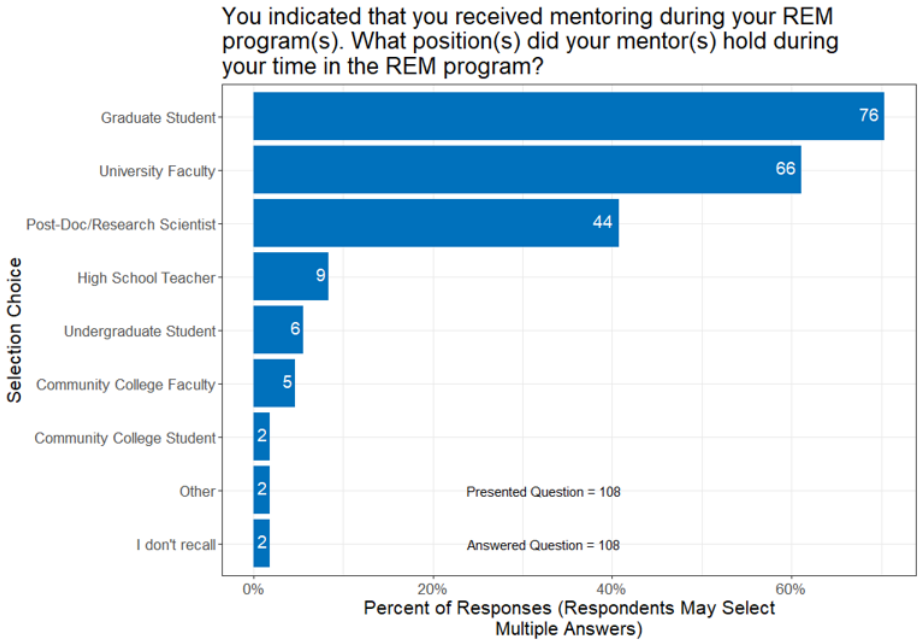


Figure 18. Positions Held by REM Mentors

B. Approaches to Mentoring

In reviewing the REM supplement applications, we found there was no single approach to mentorship across the supplements. The applications sometimes described the existence of a mentorship plan, but did not share the plan itself. High-level descriptions of the mentorship plans featured explicit goals of helping RPs explore careers, apply to graduate schools, and increase skills as a scientist. Most REM applications incorporated fundamental concepts such as safety training, scientific method and experiment design, and scientific integrity and ethics.

In some cases, applications described relying on an established mentoring approach from an existing program, such as Georgia Tech's Center for Engineering Education and Diversity (CEED) collaborative program. CEEDs include tiered mentoring structures where previous participants become mentors (team leaders), and emphasis is focused on the career and well-being of the students.

Analysis of REM proposals also indicated the timespan mentors spent mentoring the RP varied. Some mentoring programs lasted only during the summer of the activity, while others lasted for the summer and throughout the following academic year and even into the following summer.

Another feature we looked at was the extent to which proposals discussed the environment for the RP. A few programs housed students in campus dormitories as a tool to build community for RPs, and included social activities that would overlap with co-hosted events with math and STEM Academies to ensure that students remained engaged. In most cases, REM proposals did not discuss housing options for RPs.

The REM proposal analysis indicated a variety of mentoring styles as well. We identified four distinct types of mentorship described in the proposals: (1) PI-based mentoring, (2) network-based mentoring, (3) assigned mentoring, and (4) tailored mentoring teams (Figure 19). The following subsections describe each approach in greater detail. The classifications are not necessarily mutually exclusive, nor are we able to determine the most popular approaches, but from the information we gathered, we identified these general categories.

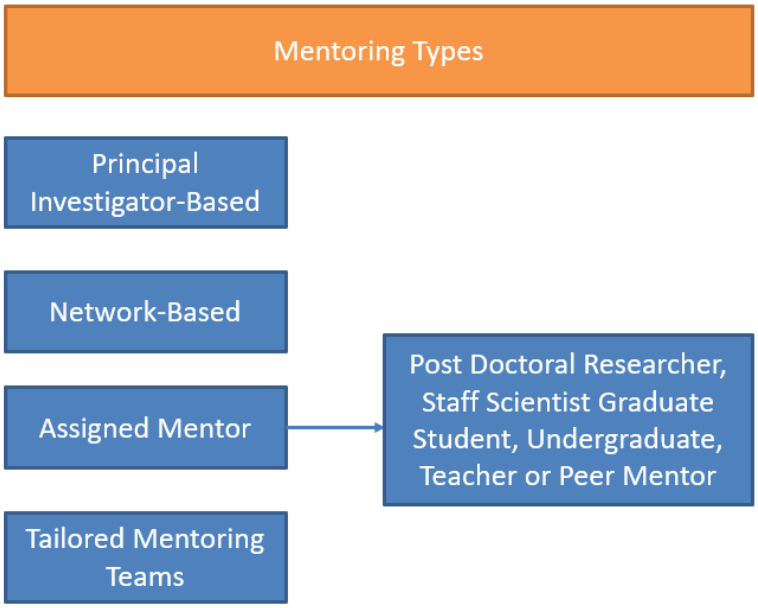


Figure 19. Mentoring Flow and Mentoring Plan Structures of REM Proposals

1. Principal Investigator-Based Mentoring

This type of mentoring involved one-on-one mentoring with just the PI and RP. Analysis of research proposals revealed that PI-based mentoring included daily to weekly 1-hour or more meetings to discuss educational goals, weekly lab meetings with the research group to discuss progress on research topics, as well as performance reviews, presentation preparation, and career planning meetings. Many of the REM proposals highlighted the PIs' extensive history of mentoring as justification for the one-on-one model. Almost all of the mentoring approaches included some form of PI-RP component, which is supported by the survey results. Eighty percent of RP survey respondents reported meeting one-on-one and forming professional relationships with their mentors.

2. Network-Based Mentoring

Some programs included a mentoring team or network that involved various combinations of PIs and other professors, high school teachers, postdocs, graduate students, undergraduates and peer mentors. This approach also included people outside of the institution where the RP was participating in their REM experience. Often referred to in REM proposals as a "constellation of mentors," the mentor teams also included lab technicians and seasoned peers that had already been involved with the particular project. The goal of this approach was to create a mentor-mentee community that brought together skill sets and resources (including content expertise, access to labs, academic support, and career preparation assistance) to provide comprehensive support to each RP.

3. Assigned Mentor

Analysis supports that the assigned mentor model was the most prevalent. Numerous REM proposals indicated their strategy for mentoring would be to assign a PI, research scientist, graduate student, or peer mentor to the RP. That is, this was planned in advance, and the PI or staff coordinating the REM supplement had *a priori* defined a mentor for each RP. This was commonly described in some programs as Vertical Mentoring, where faculty and staff mentor upper classmen, upper classmen mentor freshman and sophomore students, and the entirety of the mentoring effort was supervised by the PI (commonly referred to as "core mentor"). In some programs, additional one-on-one mentoring was provided by high school teachers and graduate students in the form of weekly 3-hour Graduate Record Examination (GRE) prep courses, guidance on translating scientific knowledge obtained in the lab into practices in the classroom, academic writing skills workshops, and communications and presentation skills workshops. Almost all REM programs that utilized the assigned mentor model also included the RP contributing to weekly lab meetings with the research group as well as some structured meeting schedule with the primary PI. Some programs allowed peer mentors to work closely with incoming RPs to help them become more comfortable in the research setting, while others elected to use peer mentors as guides to help new participants acclimate to the campus.

4. Tailored Mentoring Teams

REM programs utilized tailored mentoring teams that were specific to each RP and limited to mentors who were in the lab where the EFRI or ERC award was housed. While this approach was more focused, it allowed programs to assign students to research groups based on interests of the participants and alignment with subtasks of the EFRI project. According to the proposal analysis, primary PIs provided oversight of the research topics and basic knowledge required for the research and then delegated either a doctoral student or post doc as a research coach to the RP. Research coaches provided training to the assigned participants until they were able to work independently.

Tailored mentoring teams were also common to REM programs aiming to target specific underrepresented groups, including Tribal communities and disabled students. In these programs, mentors were trained explicitly to work in these communities and with these students, and the mentoring approach was longitudinal in scope, lasting well after the summer REM program ended. According to the proposal analysis, some programs welcomed well-trained high school teachers onto their mentoring teams to assist with attracting and retaining earlier stage students as well as keeping those students motivated. Tailored mentoring teams also included faculty from community colleges to assist with recruiting and engaging students from those schools.

C. RP Feedback on Mentorship

In addition to examining the REM supplement applications, we also relied on data from the RP survey to understand how RPs viewed mentoring. The RP survey analysis revealed most RPs received one-on-one mentoring. Respondents reported mentors provided career advice (59 percent) and guidance specific to their REM project (45 RPs). Figure 20 breaks down the questions for RPs on mentorship activities.

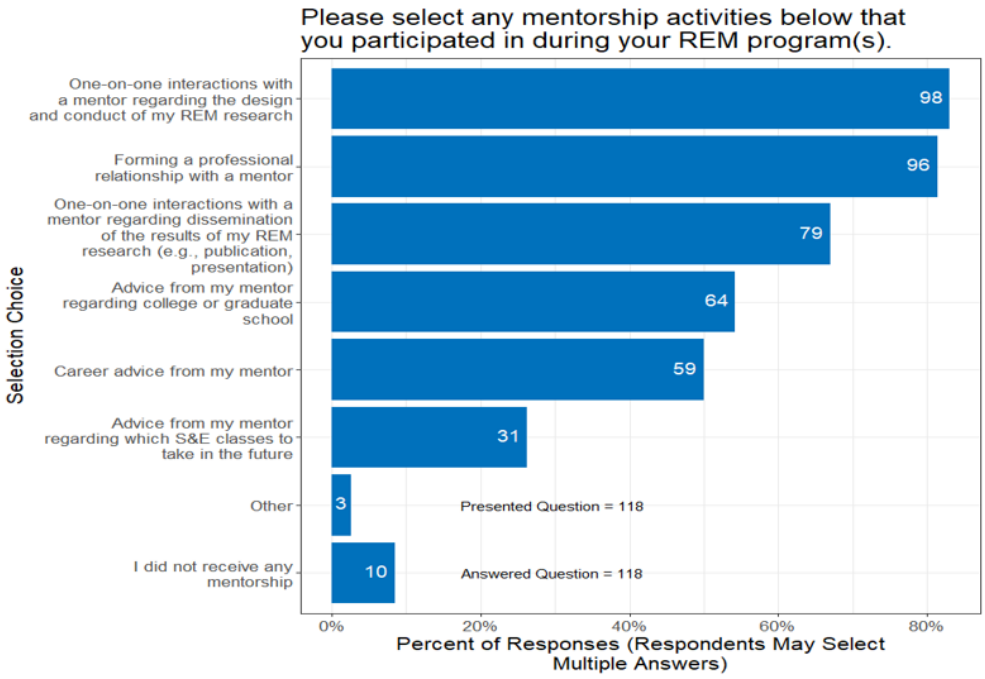


Figure 20. Types of Mentorship

Overall, mentorship was positively received, with one participant noting,

> *"Mentorship was a vital aspect of my REM experience. My faculty mentor was very insightful and helpful in matters regarding research, graduate school, and general post-graduate opportunities."*

Some RPs indicated in free responses that their mentor provided tips on writing and presentation skills. A few RPs noted that they are still in contact. Another participant added,

> *"The mentoring was full-time advising and monitoring during experiments, dissertations, writing, poster preparation, and practicing. My mentors were very serious about their project and very attentive to everything we were doing. They made sure to show us every detail in the experiments and discuss topics we did not understand, so they did teach us a lot!"*

1. RP Experience with Mentors

In the survey, RPs were asked to rate the mentorship experience that they received. Respondent answers were overwhelmingly positive, with 91 percent of respondents indicating their working relationships with their mentors as good or excellent. RPs also reported the amount of time spent with their mentor as good or excellent (85 percent), and most received advice regarding future career paths. This information is presented in Figure 21. These data indicate that RPs generally had a positive experience with their mentors in the REM program.

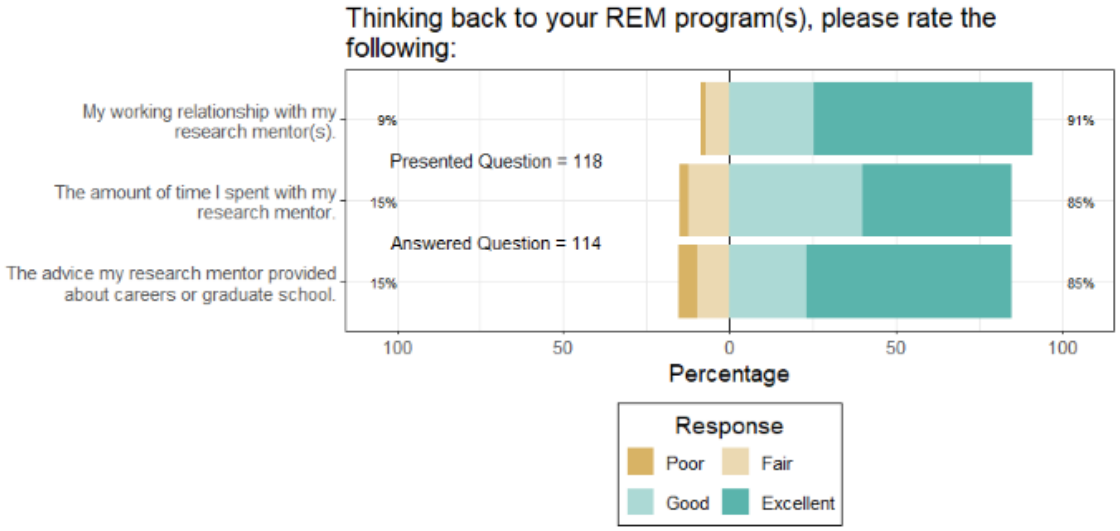


Figure 21. RP Experience with Mentorship

2. RPs as Mentors

One question in the survey asked REM participants if they also acted as mentors in the program. Overall, 20 percent of respondents indicated that they had acted as a mentor to other REM participants. Additionally, some of these participants reported engaging the program across multiple years. Many participants in this category listed their education/employment level during the program as being high school teachers or university/community college faculty. These responses show that, in certain cases, the distinctions between RPs and mentors are blurred.

3. Absence of Mentoring

Some RPs indicated that they did not receive any mentorship. While 10 respondents to the survey acknowledged they did not receive mentoring, 6 of those respondents identified themselves as either high school teachers or university faculty. Of the four students who noted they did not receive mentoring during the REM program, feedback varied on why this was the case. One student indicated not having a defined research

project, and, while in fact paired with a high school teacher, spent most of the time doing busy work. This student proposed being paired with a graduate student or professor in the future. Another student indicated that while there was no real organization or mentorship component to the REM program, it was still an enjoyable experience.

D. Mentor Training

While not required nor present across all proposals, mentor training was delivered and disseminated in various ways. These trainings were in the form of PI- and Co-PI-led workshops lasting several days or weeks, informal meetings between PIs and graduate student mentors to exchange technical ideas and formulate research questions, and online courses that included ethics, conflict of interest, credit and authorship, stewardship of intellectual property modules. Trainings in some programs were outsourced to partnering universities with established Centers of Excellence (such as the Center for Teaching and Learning), which would then develop a tailored training program for the REM mentors. Each lead PI appeared to incorporate the training associated with their needs. Because the training for mentors, types of mentors, and frequency of contact with mentors varied widely, we cannot assert that mentoring had an outsize impact on RPs experience.

One avenue for mentor training provided to EFRI-REM mentors is the Mentoring Catalyst initiative. This project, established by PIs at the North Carolina State University and the University of Wisconsin, has three main goals:[9]

1. Provide mentor training to REM mentors,
2. Build an online community of REM mentors, and
3. Strengthen relationships between faculty mentors and graduate mentors.

Since 2019, roughly 60 mentors have participated in the training from universities including Purdue, Harvard, Georgia Tech, University of Georgia, and University of Wisconsin. These trainings span up to 8 hours, but may be shortened and tailored to specific needs depending on the university and REM program. While the Mentoring Catalyst program does survey those who engage in the training, STPI was unable to obtain these data.

E. Mentorship Findings

Below is a summary of select findings on mentorship in the REM program.

- **RPs were mentored by many different kinds of mentors and sometimes acted as mentors.** Nearly all respondents indicated they received mentorship

[9] For more on the Mentoring Catalyst initiative, see: https://mentoringcatalyst.org/about-us/

through REM. Mentors ranged from PIs to post-docs to graduate students. In some cases, RPs acted as mentors.

- **RPs reported receiving good or excellent mentorship.** From the RP perspective, mentors provided advice on the direction of their research, and some reported receiving college and career advice. RPs reported forming professional relationships with mentors. Beyond reported RP-mentor interactions, mentorship quality was difficult to assess. Some REM projects had rigorous mentoring protocols and assignments. A few RPs surveyed reported receiving little or no mentorship.
- **There were many types of mentorship employed.** Since there is no requirement for specific types of mentoring in the REM program, each REM is able to decide what type of mentoring they will provide with their research experience. This leads to a diversity of mentorship structures, mentor-mentee interactions, and mentorship topics.
- **We could not assess the effectiveness of mentor training.** The study team was unable to acquire sufficient data for mentorship training provided through the Mentoring Catalyst initiative. Since there was no survey of mentors, we do not know what training they may or may not have been provided outside of the program.

6. Research and Partnerships

A. RP Impact on Research

In general, determining and assessing the extent to which an R&D investment or a particular person affected research outputs or outcomes is challenging, but it is even more challenging to assess their contribution towards research impacts. That said, we attempted to investigate research outputs and tie them back to the RPs, where data are available.

In total, we found that 85 unique RPs were listed as authors on 197 REM research products. Of these 197 publications, 42 or 21 percent listed the RPs as the first authors of the publications.

We broke down this data further by the type of publication produced, shown in Figure 22. In general, RPs were associated with conference papers and journal articles about equally, but were first authors much more frequently on conference papers.

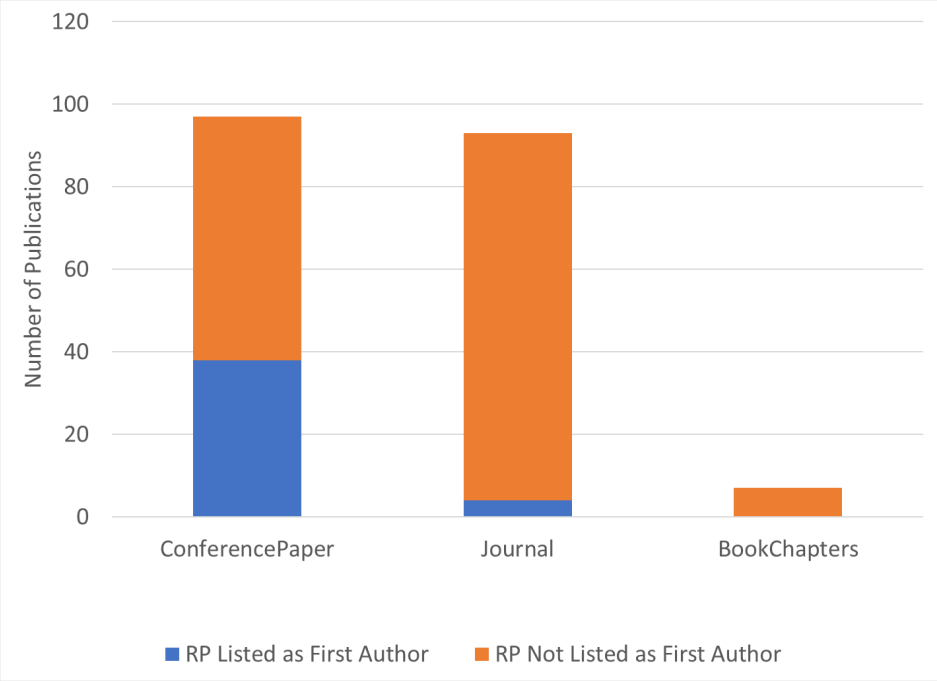


Figure 22. Breakdown of RP Research Outputs by Type

The inclusion of RPs in EFRI/ERC publications suggests that RPs are engaging with the research in ways that produce tangible outputs. While this does not necessarily correlate

to a positive impact on the program's research, it does show a deep level of engagement with the program.

B. Partnerships

The REM Dear Colleague Letters stated,

> Each REM supplemental funding request should be specific to the local setting, resources, and skills of the PI/Research Team. The REM Program especially encourages partnerships with one or more of the following types of institutions:
>
> - Inner-city schools or other high-needs K-12 schools;
> - Community colleges that serve underrepresented populations; and
> - Four-year colleges that serve underrepresented populations.

STPI examined the REM supplement applications and found the large majority of REM programs engaged with local colleges and universities, while some specifically partnered with Historically Black Colleges and Universities (HBCUs) and Minority Serving Institutions (MSIs). If there was no direct partnership with the university or colleges, some programs partnered with the Diversity, Equity, and Inclusion (DEI) office on the campus. We also found that several REM supplements partnered with local high school districts, with some programs aiming to engage students as early as 9th grade. A few programs built relationships with Veterans Affairs officers or minority STEM organizations to expand RP participation.

We also found that for those REM supplements funded for multiple years, REM supplements often partnered with same institutions. Once a partnership was established, it deepened with subsequent years. Often there was a high school teacher or staff member at the partnering institution that was both the main point of contact for the partnership as well as an RP themselves. Many of the high school teachers or community college RPs came from the partner institutions.

Partnerships also served as the basis for recruiting high-school students, community college students, and STEM teachers. That said, many programs used existing outreach resources from their EFRI/ERC programs to recruit, which included adding new material to brochures or recruiting RPs through outreach to other underrepresented programs. Some programs made recruitment trips to HBCUs/MSIs or to minority organization conferences to scout for RPs. In some instances, programs found success by partnering with entire high school districts instead of a single school in order to engage as many students as possible.

C. Research and Partnerships Findings

A few findings emerged regarding REM research and partnerships:

- RPs contributed to research outputs listed in EFRI and ERC annual reports. Among the outputs with their names, RPs were listed as first author on conference papers more than any other type of publication.
- Many REM supplements relied on institutional outreach efforts with the local community when developing partnerships.
- Most REM supplements maintained partnerships from one year to the next.
- Most partnerships were local, and the high school or community college RPs came from these partner institutions.
- It is unclear whether some partnerships were formed as a result of the REM program or were an extension of existing partnerships the PI or EFRI/ERC institution already had.

7. Recommendations and Considerations

The evaluation of the REM program identified a number of overarching findings and revealed some options for NSF to consider as they advance and expand the REM program. This chapter will align the REM program goals with a set of overarching findings and recommendations.

Goal 1: To provide research experiences and mentored opportunities for high school students, STEM teachers, undergraduate STEM students, faculty, and veterans who may not otherwise become engaged in a research project

Finding: From the survey, we found that the REM program served a diverse set of RPs from high school students to teachers to undergraduate students. We also found that 70 percent of RPs surveyed indicated the REM program was their first research experience. The evaluation of the program indicates that REM is reaching the population it is intending to serve and offering experiences that students and high school teachers participating may not otherwise have found.

Recommendations or Considerations: We offer no recommendation towards this goal. The REM program appears to be meeting its goals of providing research experiences and mentored opportunities to different types of REM participants. The program should continue doing outreach to the communities it has been serving.

Goal 2: To engage participants from underrepresented groups

Finding: We also found that the REM program served a diverse group of RPs. Survey respondents were 38 percent Black/African American, 24 percent Hispanic/Latino, and 56 percent reported their gender as female. Furthermore, 36 percent reported being first generation college students.

Recommendations or Considerations: We offer no recommendation towards this goal. The REM program is reaching a socioeconomically, racially, and ethnically diverse RP population. The program should continue encouraging the REM PIs to focus on engaging RPs from underrepresented groups.

Goal 3: To enhance careers of participants in STEM

Finding: The RPs surveyed reported very positive and satisfactory REM experiences. To that end, over 90 percent of RPs surveyed reported that their participation in the REM program contributed to their desire to continue their education in a STEM field. RPs reported gaining research skills through the REM experience. The survey results indicate

the REM program provided a very positive contribution towards the STEM career aspirations of RPs.

Recommendations or Considerations: We offer no recommendation towards this goal. The REM program appears to be meeting its goals of contributing to the STEM career interest and engagement for RPs. At this time, we suggest encouraging REM PIs to continue promoting STEM career engagement.

Goal 4: To enhance EFRI- or ERC-supported research

Finding: Although we were unable to assess the full extent to which EFRI-supported research was enhanced by RPs, we found that RPs were first author on about half of the research outputs—journal articles and conference proceedings equally.

Recommendations or Considerations: To better understand the progress towards this goal of RPs contributing to and enhancing EFRI- or ERC-supported research, we suggest systematically collecting information from annual and final reports regarding the research contributions of REM participants.

Goal 5: To build partnerships with local, underserved institutions

Finding: Through the analysis of REM applications, we found that REM proposals discussed developing partnerships through institutional outreach with the local community. For the most part, REM supplements that had more than one supplement partnered with the same institutions for subsequent years.

Recommendations or Considerations: The data on partnerships with the REM institution and partner institutions could be improved. Though not explicitly required or needed, one option for furthering understanding partnerships is to look across the institutions to examine what other partnership, capacity-building or diversity awards are being awarded. There may be some interesting synergies with programs such as NSF's Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science and Broadening Participation in Engineering.

Goal 6: The effects of mentoring on the research participants

Finding: We found that RPs were mentored and reported receiving good or excellent mentorship. RPs reported that mentors provided advice on the direction of their research, and received advice regarding college and career prospects. RPs also reported forming professional relationships with mentors. The majority of mentors were graduate students and faculty. The approaches to mentorship varied across supplements. In some cases, RPs were mentored directly by the PIs, and in other cases they had multiple mentors across the project. Furthermore, mentor training and requirements for mentor training varied across projects.

Recommendations or Considerations: While RP survey respondents were positive about their mentoring experience, the REM program may want to obtain more information on how mentors are trained and how mentoring is conducted. One approach is to consider defining minimum mentor training requirements that are the same across REM supplements and aligned with research on effective approaches for mentor training. Another consideration would be to establish a consistent reporting requirement for REM PIs to collect data on mentoring, including the level of mentor engagement and what mentoring was provided.

Goal 7: The effectiveness of diverse and flexible cohorts

Finding: We did not gather enough information to assess the extent to which REM supplements implemented a cohort approach. We did learn that RPs formed working relationships with the other RPs and learned from one another during their summer experiences.

Recommendations or Considerations: STPI collected information from the free response comments in the RP survey that offered suggestions for the program**.** Some RPs suggested the program could facilitate additional opportunities for RPs to engage more with NSF and other NSF programs. This may strengthen the RP connection to NSF and the larger scientific community. Another suggestion was to establish more cohort-building activities during the REM summer experience to help build a sense of community. Some REM supplements reported proposing these activities, while others did not. Lastly, some RPs surveyed suggested that they would appreciate if the program fostered RP connections post-REM through a listserv, LinkedIn groups, etc. This could help RPs continue professional relationships after their REM experience had concluded.

Other Findings

Additional Finding 1: In order to set up the evaluation, we invested a considerable amount of effort into collecting common data across the EFRI and ERC projects as well as the REM supplements. The information collected by the program was not always consistent nor was it sufficient to conduct an evaluation. Data collection practices regarding mentors, mentor training, roles of mentors, frequency of mentoring interactions, and other relevant information could offer much greater insight into the program's effectiveness.

Recommendations or Considerations: One approach to easing the data collection burden is for the REM program to develop a low-burden mechanism for assembling an ongoing roster, including contact information. This can be done independently or by building bridges with the Research Experiences for Undergraduate (REU) Program to improve data infrastructure to collect info on RPs over time. One of the challenges in collecting data from NSF grantees is that OMB clearance is likely required to gather the information. REU has sought to add questions to NSF's annual reporting format and could be a mechanism for REM to gather data as well. This recommendation also requires

establishing a common approach to collecting information from RPs—and perhaps PIs and mentors—after each summer. Implementing a longitudinal data collection system would allow the REM program to understand the quality of the REM experience from year to year.

Additional Finding 2: About 10 to 15 percent of EFRI projects and 20 percent of ERC projects seek REM supplemental funding. Of those EFRI projects that are awarded a REM supplement, about half seek a subsequent supplement.

Recommendations or Considerations: The REM program could consider identifying a target each year of how many EFRI and ERC projects are awarded REM supplements. We make no judgement on whether 10 or 20 percent is a "good" or "bad" number, but a target for inclusion may help communicate goals for program officers and for PIs. As for those REM PIs that do not reapply for a REM supplement, it may be worth understanding their decision process and determining why they are not seeking additional years of the REM program. If it is a programmatic concern that can be remedied by the REM program, those issues should be addressed.

Appendix A.
Research Participant Survey

Thank you for taking part in this study conducted by the IDA Science and Technology Policy Institute (STPI) on behalf of the National Science Foundation's Emerging Frontier in Research and Innovation (EFRI) program and the Engineering Research Centers (ERC) in the Directorate for Engineering. STPI is a Federally Funded Research and Development Center (FFRDC) that provides rigorous, independent research and analysis to the Federal government.

Purpose of the Survey
This survey solicits your perspective as a former research participant in the Research Experience and Mentoring (REM) program.

Confidentiality Statement and Instructions for the Survey
STPI is independent of the National Science Foundation (NSF) and has been contracted to collect these data. All responses will be kept confidential and protected to the extent possible by law. Only aggregate data will be provided to NSF and your survey responses will not be linked to you or your institution. Your decision to participate is voluntary and will have no effect on your current or future relationship with NSF.

The survey will ask for information about your experience as a REM research participant. The estimated survey completion time is 20 minutes. You will be able to move backward through the survey to review or edit responses. Your survey responses are automatically saved up to the last submitted page, so you will be able to pause and return mid-survey using the link provided. However, once you submit the survey, you will not be able to edit your responses.

If you would like to review information about the NSF REM Program, please visit https://www.nsf.gov/eng/efma/rem.jsp

Paperwork Reduction Act Burden Statement:

The public reporting burden to complete this information collection is estimated at 20 minutes per response, including the time for reviewing instructions. This collection of information is voluntary. An agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a currently valid OMB control number and expiration date. [OMB Control Number 3145-0261, expiration date: 11/30/2024].

Inquiries and Concerns

If you are not the best person to complete this survey about the REM program, or if you have any questions or concerns about completing this survey, please contact us at REMeval@ida.org.

If you would like to verify the authenticity of this study with the NSF, please contact Dr. Alias Smith (alismith@nsf.gov).

Your responses are invaluable to the study. Thank you for your participation.

REM Award Information

Our records indicate that you were part of a REM program in [YEAR], at [INSTITUTION], working on [GRANT] with [PI].

Do you remember participating in this program?

- ☐ Yes, I remember
- ☐ No, I do not remember

Does the above information accurately describe the number of times you participated in the REM program, as well as the year(s), institution(s), grant(s) and PI(s) of your REM program(s)?

- ☐ Yes, the above information is accurate
- ☐ No, the above information is NOT accurate

[If *No, the above information does not accurately describe my REM program(s)]*

Please list the year(s) you participated in the REM program, and the institution(s) at which you participated.

_____

_____

Was the REM program your first research experience?

- ☐ Yes, this was my first research experience
- ☐ No, this was not my first research experience

Have you participated in other research experiences since the REM program?

- ☐ Yes, I have participated in other research experiences
- ☐ No, I have not participated in other research experiences

Which categories best describe your student or employment status during your REM program(s)? Please select all that apply.

- ☐ High School Student
- ☐ Community College Student
- ☐ Undergraduate Student
- ☐ High School Teacher

- ☐ Community College Faculty
- ☐ University Faculty
- ☐ Other___

Future Directions and STEM Retention

Please select the highest level of school you have completed.

- ☐ Less than high school- No Diploma
- ☐ High School Graduate- high school diploma or equivalent (for example: GED)
- ☐ Some college but no degree
- ☐ Associate degree in college - Occupational/vocational program
- ☐ Associate degree in college -- Academic program
- ☐ Bachelor's degree (For example: BA, AB, BS)
- ☐ Master's degree (For example: MA, MS, MEng, MEd, MSW, MBA)
- ☐ Professional School Degree (For example: MD,DDS,DVM,LLB,JD)
- ☐ Doctorate degree (For example: PhD, EdD)
- ☐ Other____

{if any other than "High School Graduate, or Less than high school"} Is your current or desired job/educational program in a Science Technology Engineering or Math (STEM) field? A STEM field is defined by the NSF as having a Science & Engineering (S&E) or S&E-related bachelor's or higher degree or who work in an S&E or S&E-related occupation.

- ☐ Yes, my current or desired job/educational program is in a STEM field
- ☐ No, my current or desired job/educational program is NOT in a STEM field

{If currently in STEM} Has the REM program contributed to your desire to study or work in a STEM field?

- ☐ Yes, the REM program contributed to my desire to study or work in a STEM field
- ☐ No, the REM program did not contribute to my desire to study or work in a STEM field

{If yes, it did contribute} You indicated that the REM program contributed to your desire to study or work in a STEM field. Please describe how below.

_____

_____

During your REM program(s), please describe how much or little did you:

	None	A little	Some	A fair amount	A great deal	N/A
Engage in real-world science/engineering research.						

Feel like a scientist/engineer.						
Think creatively about the project.						
Try out new ideas or procedures on your own.						
Feel responsible for the project.						
Interact with scientists/engineers from outside your REM program.						
Feel a part of a scientific/engineering community.						

Cohort

The REM program involves multiple participants at the same research institution each year. Were you aware that there were other participants in your REM program(s)?

- ☐ Yes, I was aware that there were other participants
- ☐ No, I was not aware that there were other participants

You indicated that you were aware that there were other REM participants in your program(s). Please select whether you agree or disagree with the following:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I formed working relationships with other REM participants					
I continued my working relationships with other REM participants after my research experience(s) ended					
Other participants supported me in my STEM work/classes after my research experience(s) ended					
I supported others in my REM program in their STEM work/classes after my research experience(s) ended					
Other participants supported me staying in STEM after my research experience(s) ended					
I have encouraged others' to stay in STEM					
I did not interact with any other REM research participants					

After the summer research experience was completed, describe any additional aspects of the REM program that you engaged in.

Mentorship

Please select any activities below that you participated in during your REM program(s). Select all that apply.

- ☐ Forming a professional relationship with a mentor
- ☐ One-on-one interactions regarding the design and conduct of my REM research
- ☐ One-on-one interactions regarding dissemination of the results of my REM research (e.g., publication, presentation)
- ☐ Advice regarding which S&E classes to take in the future
- ☐ Advice regarding college or graduate school
- ☐ Career advice
- ☐ I did not receive any mentorship
- ☐ Other, please specify ____

{If any except "I did not receive any mentorship"} You indicated that you received mentoring during your REM program(s). What position were your mentor(s) in at the time of your REM program(s). Select all that apply.

- ☐ University Faculty
- ☐ Post-Doc/Research Scientist
- ☐ Graduate Student
- ☐ Undergraduate Student
- ☐ Community College Student
- ☐ High School Teacher
- ☐ Community College Faculty
- ☐ I don't recall
- ☐ Other____

{If any except "I did not receive any mentorship"} You indicated that you received mentoring during your REM program(s). Please briefly describe the mentoring you received.

Thinking back to your REM program(s), please rate the following:

	Poor	Fair	Good	Excellent	N/A

My working relationship with my research mentor(s).					
My working relationship with research group members.					
The amount of time I spent doing meaningful research.					
The amount of time I spent with my research mentor.					
The advice my research mentor provided about careers or graduate school.					
The research experience overall.					

Did you attend, virtually or in person, the Emerging Researchers National (ERN) conference?

- ☐ Yes, I attended ERN
- ☐ No, I did not attend ERN
- ☐ I do not remember if I attended ERN

[if attended ERN]. You indicated you attended the Emerging Researchers National conference. Please indicate whether you agree with the following items regarding the ERN conference post-REM.

	Agree	Disagree
I presented at the broader ERN meeting		
I presented at the REM poster presentation held at the ERN meeting		
I formed relationships with REM participants at ERN that continued post-conference		
I have utilized tools that I learned at the ERN conference		
Participation in the ERN meeting influenced staying in STEM		

[if "agree" to "Participation in the ERN meeting influenced staying in STEM"]. You indicated that participation in the ERN meeting influenced you staying in STEM. Please describe how your participation in the ERN meeting influenced you staying in STEM.

_____

_____

[if "agree" to "I have utilized tools that I learned at the ERN conference"]. You indicated that you have utilized tools that you learned at the ERN conference. Please describe what tools you have utilized, and how you have utilized them.

_____

_____

Scientific Skills

How much did you gain in the following areas as a result of your REM program(s)?

	No Gains	A Little Gain	Moderate Gain	Good Gain	Great Gain	N/A
Thinking Like a Scientist						
Analyzing data for patterns.						
Figuring out the next step in a research project.						
Problem-solving in general.						
Formulating a research question that could be answered with data.						
Identifying limitations of research methods and designs.						
Understanding the theory and concepts guiding my research project.						
Understanding the connections among scientific disciplines.						
Understanding the relevance of research to my coursework.						
Personal Gains Related to Research Work						
Confidence in my ability to contribute to science.						
Comfort in discussing scientific concepts with others.						
Comfort in working collaboratively with others.						
Ability to work independently.						
Developing patience with the slow pace of research.						
Understanding what everyday research work is like.						
Taking greater care in conducting procedures in the lab or field.						
Gains in Skills						
Writing scientific reports or papers.						
Making oral presentations.						
Defending an argument when asked questions.						
Preparing a scientific poster.						
Keeping a detailed lab notebook.						
Conducting observations in the lab or field.						

Using statistics to analyze data.						
Calibrating instruments needed for measurement.						
Working with computers.						
Understanding journal articles.						
Conducting database or internet searches.						
Managing my time.						

Final thoughts

What else should we know about your experience with the REM program?

_____

_____

Demographics

Please indicate your race, select all that apply.

- ☐ White
- ☐ Black or African American
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Native Hawaiian or Other Pacific Islander
- ☐ Other –
- ☐ Prefer not to say

Are you of Hispanic, Latino, or Spanish origin?

- ☐ Yes
- ☐ No
- ☐ Prefer not to say

What is your gender identity (Check all that apply)

- ☐ Male
- ☐ Female
- ☐ Genderqueer/gender non-conforming/non-binary
- ☐ Different identity (please state): _____
- ☐ Prefer not to say

Have you ever served on active duty in the U.S. Armed Forces, Reserves, or National Guard?

- ☐ Never served in the military
- ☐ Only on active duty for training in the Reserves or National Guard
- ☐ Now on active duty

☐ On active duty in the past, but not now

Were you the first in your family to attend college? *Definition: neither of your parents completed a four-year degree.*

☐ Yes, I was
☐ No, I wasn't

Was English the primary language spoken in your home growing up?

☐ Yes, it was
☐ No, it wasn't

Thank you so much for your participation.

Appendix B.
EFRI Program Solicitation Numbers

This appendix provides the program solicitation numbers used to gather EFRI project data between 2007 and 2021. These codes can be found by locating the NSF EFRI program solicitation for each year. These codes were then used to search the backend awards database on NSF internal systems.

- NSF 20-614
- NSF 19-599
- NSF 19-502
- NSF 17-578
- NSF 16-612
- NSF 16-502
- NSF 15-502
- NSF 13-583
- NSF 12-583
- NSF 11-571
- NSF 10-596
- NSF 09-606
- NSF 08-599
- NSF 07-579
- NSF 06-596

Appendix C.
REM Research Participant and Mentor Data

NSF and the REM program do not maintain a database of REM RPs that could be used as the basis for tracking and program evaluation, including as a sampling frame for a survey of RPs. STPI developed this database. The purpose of this appendix is to outline the data landscape of REM participants and mentors collected by STPI. A portion of this data was used to survey RPs to further understand their experience with the program.[10] The methods for collecting these data are outlined in the methodology chapter of this report.

We begin by discussing the methodology for collecting REM RP and mentor data. We then outline the universe of data STPI collected. Because these data are incomplete, we explore potential sources of bias that could be apparent in the sampling frame of REM RPs. Following this, we assess RP and mentor data in greater detail before closing with a summary of the data.

REM PI Data Responses

The PI responses to STPI's request for data confirmation can be divided into three categories: (1) PIs that have confirmed or updated the data provided by STPI; (2) PIs that have not confirmed the data provided by STPI but did provide some information on REM RPs and mentors in their annual reports; and (3) PIs that have not confirmed the data provided by STPI and did not include information on REM RPs and mentors in their annual reports. Table C-1 shows the data for each of these categories.

[10] Due to potential bias in the dataset as discussed later in this section and because older REM participants may not have up-to-date contact information as provided by PIs, STPI constrained the sampling frame for the survey to RPs who participated in the program after 2016.

Table C-1. Status of Data Collected Across EFRI/ERC Projects, and Individual REM Supplements

Status	Number of EFRI/ERC Projects (52 Total*)	Number of REM Supplements (116 Total)
Have Confirmed Data	39	93
No Info & No Response	10	13
Some Info from Annual Reports	5	10

*Note: Projects listed in the first column do not add up to the total as two projects have some data for particular supplements and no data for other supplements.

Thirty-nine PIs (75 percent) responded to confirm or update the data collected by STPI. Of the remaining 13 PIs that did not respond with information for at least one supplement, 5 have listed RP and mentor information in their annual reports for at least some supplement years, and 10 did not list RP and mentor information in their annual reports for at least some supplement years.[11]

Additionally, because RPs are selected on an annual basis, the best measure for assessing RP data completeness is the percentage of REM supplements whose RPs have been confirmed by their PIs. Of the 116 REM supplements that have appointed RPs, 93 (80 percent) confirmed or updated the data collected by STPI; 10 (8.6 percent) did not respond but did list RP and mentor information in their annual report; and 13 (11 percent) did not respond and did not list RP and mentor information in their annual reports.

Potential Implications for the Sampling Frame

The incomplete sample frame outlined above introduces the potential for bias in the dataset for the RP survey based solely on RP information collected. STPI identified four sources of potential bias: (1) PIs in later years are more likely to confirm information sent by STPI than those in earlier years; (2) PIs with multiple REM supplements are more likely to unconfirm than PIs with just one REM; (3) EFRI and ERC projects differ in their likelihood to respond to confirm the data; and (4) PIs with college-level RPs differ in the likelihood that they will respond as opposed to PIs with high school-level RPs. The analyses below explore the likelihood that our current sample of RPs is significantly higher in previous supplement years.

Bias in Response by Year

With respect to the first source of potential bias—PIs in later years being more likely to confirm information sent by STPI than those in earlier years—STPI analyzed the PI

[11] Because PIs have listed RP information for certain supplements and have not listed information for others, these two categories are not mutually exclusive.

response rate for each supplement across years. Figure C-1 shows that the number of confirmed RPs across years is generally consistent, with one additional unconfirmed supplement found in 2017.

To explore this concept further, we generated a probit regression to assess the degree to which both EFRI/ERC project type and year awarded could affect whether a supplement is confirmed. In running the analysis on the dataset, we determined that when considering the difference in parent project type, the year in which the supplement was awarded does affect whether the PI will respond with data.[12] Specifically, across years, there is an upward trend in the probability that supplement data will be confirmed.

This potential for bias is furthered by the fact that data for those who participated in earlier stages of the REM supplement may have outdated contact information, preventing STPI from contacting these individuals. Furthermore, participants who engaged in the program less recently may also be less likely to remember specifics concerning their research experience, making them less likely to respond to survey requests. Each of these factors, in addition to the PI response bias listed above, hold the potential to bias the sampling frame towards more recent participants.

[12] p =3e-04

Figure C-1. Percentage of Supplements Each Year for which STPI Has PI Confirmed Data

Bias in Response by Number of Supplements

The second potential source of bias—PIs with multiple REM supplements being more likely to confirm than PIs with just one REM—is explored in Figure C-2. The graph shows the percentage of EFRI/ERC projects that have confirmed data, distributed across the number of supplements each project has received.

Based on current data, the bias towards parent awards with multiple supplements was determined to not be statistically significant as to affect the sampling frame.[13]

[13] p =0.1703

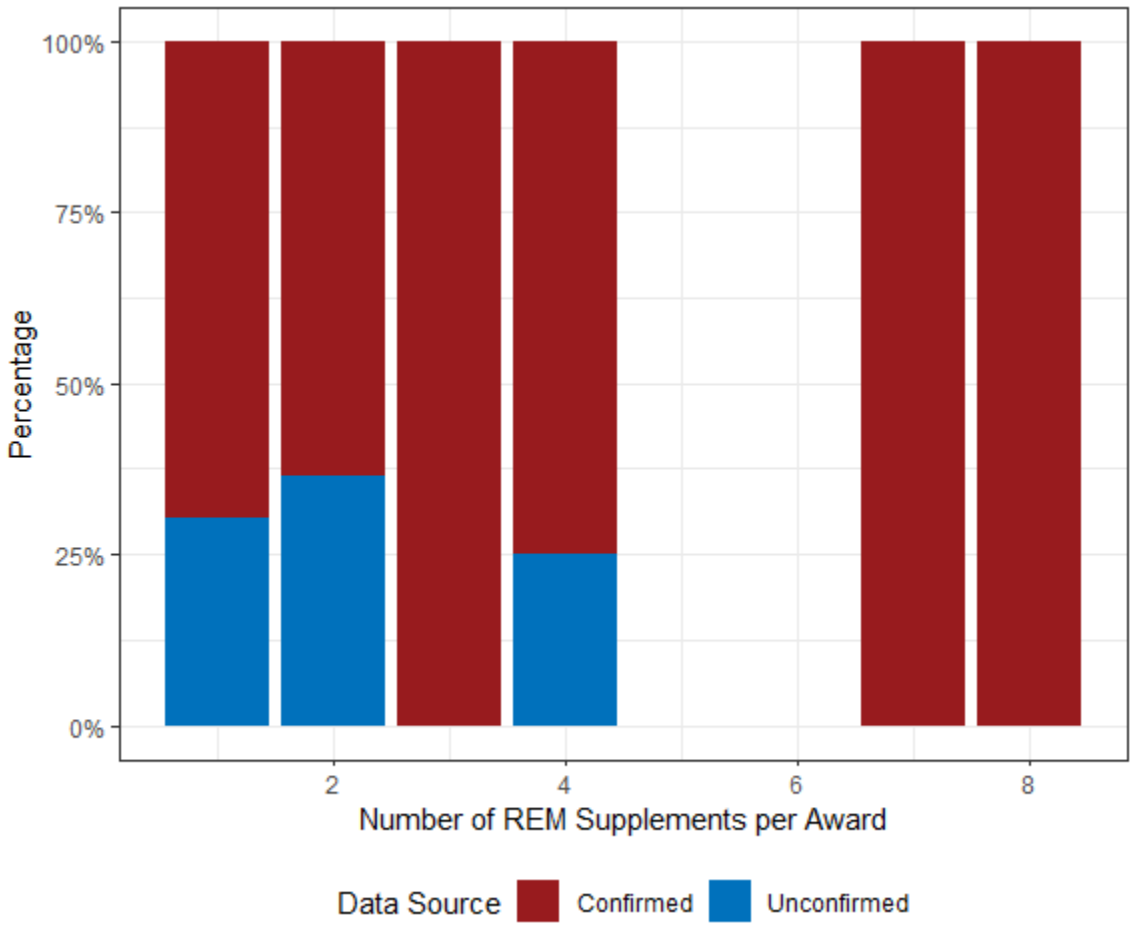


Figure C-2. Percentage of Confirmed and Unconfirmed EFRI/ERC Projects Distributed Across Number of REM Supplements Received

Bias in Response by Parent Project

A third potential source of bias is the possibility that either EFRI or ERC parent awards are more likely to confirm the data. Figure C-3 shows the percentage breakdown of confirmed and unconfirmed data for both EFRI and ERC projects. The graph shows that the response rate for EFRI awards is currently 83.3 percent and the response rate for ERC awards is 94.7 percent.

To assess the statistical significance of this variation, we ran a probit regression on the data. From the analysis, we were able to determine that the correlation between PI response and parent project type is statistically significant.[14]

[14] p =0.0109

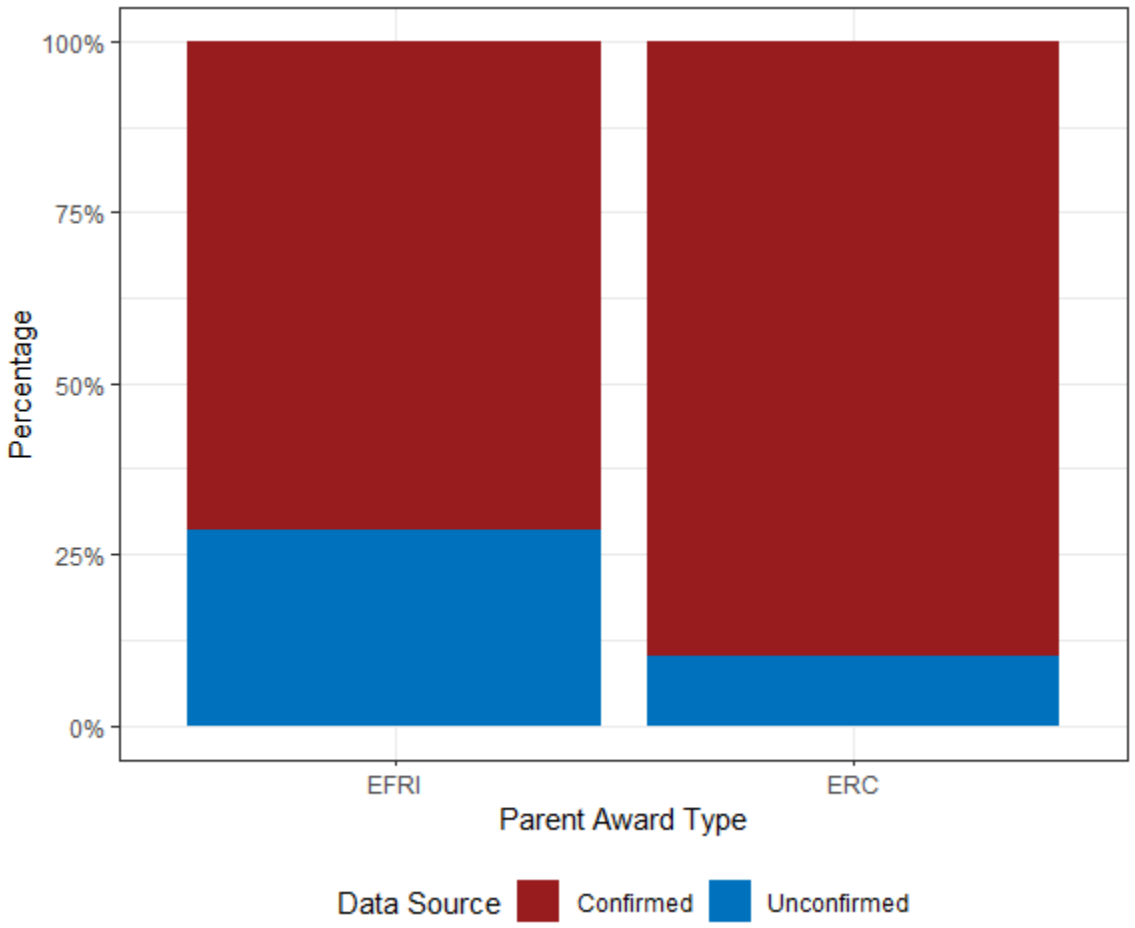
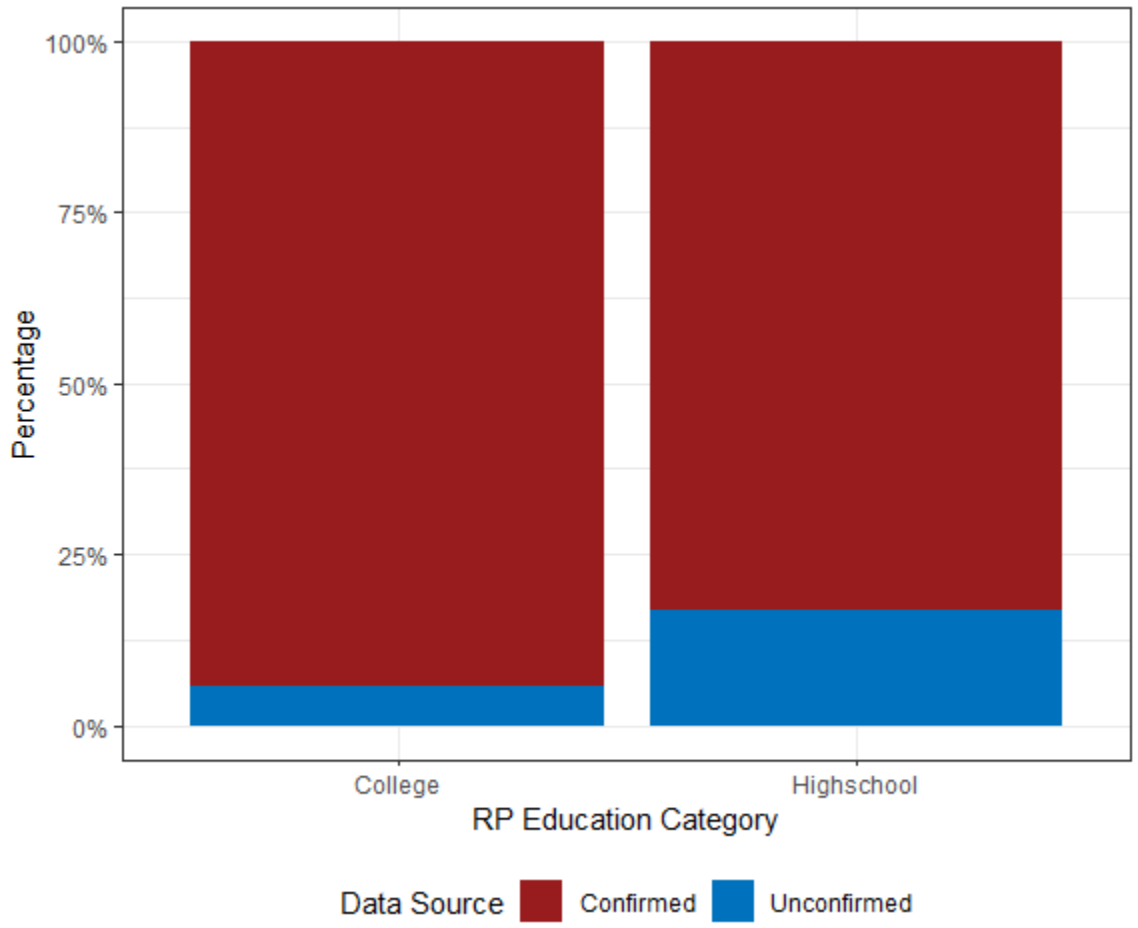


Figure C-3. Percentage of Confirmed/Unconfirmed EFRI and ERC Projects

Bias in Response by RP Education Level

The final potential source of bias is the possibility that REM PIs with college-level RPs are more (or less) likely to respond to confirm data than PIs with high school-level RP data. Figure C-4 shows that of all data collected thus far, a larger percentage of college-level RPs have been confirmed by PIs than high school RPs. The variation holds the potential to bias the sample frame to account for college-affiliated RPs, at the expense of those at the high school level.



Note: RPs included in the college and high school categories may be either students or teachers. With 129 RPs, the listed role was not sufficient to distinguish between high school and college. In these instances, the RP was omitted from the graphic.

Figure C-4. Percentage of Confirmed/Unconfirmed Research Participants by Education Level Affiliation*

RP Data

Table C-2 details the current universe of RP data collected by STPI. In total, STPI has collected data on 650 unique RPs. However, because certain RPs participated in the REM supplement multiple times, the total number of RPs collected is 731. Of this data, 589 unique RPs have been confirmed by REM PIs, and 673 total RPs have been confirmed by PIs.

Additionally, in looking only at RPs that have been confirmed by REM PIs, the average number of RPs per project is 7.24. Given that there are 23 supplements for which STPI does not have a confirmed list of RPs, we have estimated the total number of RPs that have not been confirmed by PIs to be approximately 166. Of the approximate number of unconfirmed RPs, STPI has data for 58 participants. This leaves approximately 108 RPs

for which STPI does not have any data. This information is also presented in Table C-2 below.

Table C-2. Breakdown of Current Universe of RP Data

	Total	Unique
RPs	731	650
PI Confirmed RPs	673	589
Estimated Unconfirmed RPs	166	Unknown
Unconfirmed RPs for which STPI has Data	58	34
Estimated Unconfirmed RPs for which STPI has no Data	108	Unknown

The data show that the current sampling frame is roughly 80 percent of the estimated total population of RPs between 2017 and 2021. Additionally, there is a significant portion of the population of RPs for which STPI has not collected any data.

Of the RPs for which STPI does have some data, the proportion of each student's educational affiliation is distributed across a number of different categories. Table C-3 shows the percentage of confirmed and unconfirmed RPs that are high school students, high school and community college teachers, and university students.

Table C-3. Proportion of Confirmed/Unconfirmed RPs by Educational Affiliation (Role)

Role	Confirmed/Unconfirmed	Percentage
University Student	Confirmed	48.6%
University Student	Unconfirmed	3.1%
High School Student	Confirmed	10.3%
High School Student	Unconfirmed	2.9%
Teacher HS/CC	Confirmed	10.4%
Teacher HS/CC	Unconfirmed	1.9%
Unknown	Confirmed	22.8%

*Note: EFRI PIs reported additional RPs not included in annual reports using free response. For this reason, certain roles cannot be clearly mapped to a single category and as such have been marked unknown.

The table also shows that, of the current universe of RPs, the largest percentage are undergraduate students and that the majority of RPs collected thus far have been confirmed by PIs.

RP to Mentor Ratio

Table C-4 compares the number of PI confirmed RPs and mentors across REM supplement years. The data show that, across REM supplement years, the ratio of RPs to

mentors varies greatly, between 0.82 and 2.71. These data suggest that the effects of mentorship on RPs may be difficult to compare across years as the number of mentors per RP varies across years, potentially affecting the relationship between RPs and mentors.

Table C-4. RP to Mentor Ratio Across Supplement Years

Year	Number of RPs	Number of Mentors	Ratio
2012	38	14	2.71
2013	47	27	1.74
2014	73	43	1.70
2015	52	41	1.27
2016	45	44	1.02
2017	43	24	1.79
2018	70	85	0.82
2019	96	95	1.01
2020	82	73	1.12
2021	104	122	0.85
Total	650	568	1.14

Abbreviations

CEED	Center for Engineering Education and Diversity
DCL	Dear Colleague Letters
DEI	Diversity, Equity, and Inclusion
EFMA	Emerging Frontiers and Multidisciplinary Activities
EFRI	Emerging Frontiers in Research and Innovation
ERC	Engineering Research Center
ERN	Emerging Researchers National
GRE	Graduate Record Examination
HBCU	Historically Black Colleges and Universities
IDA	Institute for Defense Analyses
MSI	Minority Serving Institutions
NSF	National Science Foundation
OMB	Office of Management and Budget
OSTP	Office of Science and Technology Policy
REM	Research Experience and Mentoring
RP	Research Participant
STEM	Science, Technology, Engineering, and Mathematics
STPI	Science and Technology Policy Institute

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14. ABSTRACT

In 2011, the National Science Foundation's Emerging Frontiers in Research and Innovation (EFRI) program began offering a supplemental funding opportunity for grantees called Research Experiences in Mentoring (REM) with the explicit goal of increasing and improving the engagement of students in the research experiences. In 2018, the Engineering Research Centers (ERC) followed suit and offered the supplement as well. The Science and Technology Policy Institute was asked to conduct an evaluation of the REM program on a diverse set of research participants (RPs) which included high school students, community college students, high school teachers as well as undergraduates. Through conducting a survey (with permission from the Office of Management and Budget), STPI found that the program was generally meeting its goals and engaging RPs from diverse background that would not normally have been offered research experiences. The long-term effects of the REM program on research participants and their mentors are not as well understood because we were unable obtain longitudinal data on the RPs. From our understanding of the program, the REM program is working well but could improve on their data gathering about RPs, mentors and other characteristics of the program. Such data would facilitate a more robust long-term evaluation.

15. SUBJECT TERMS

Broadening Participation; Evaluation; mentorship; science, technology, engineering, and mathematics (STEM)

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