

GEO REU HANDBOOK

**A Guide for Running Inclusive and
Engaging Geoscience Research
Internship Programs**

First Edition

Edited by
Valerie Sloan
Rebecca Haacker

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and Engaging Geoscience
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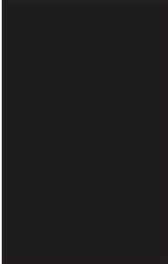
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*In memory of Dr. Janet Liou-Mark, whose loving dedication to her students
and colleagues will never be forgotten.*



FOREWORD

Running a Research Experiences for Undergraduates (REU) is a rewarding yet challenging endeavor. REUs are a well-established way to engage undergraduate students in research, build self-confidence and create a sense of belonging for students who might not see themselves entering STEM careers.

We hope that this handbook will provide easily accessible information on the steps involved in creating and running an REU program. It provides a guided walk through designing an REU, recruiting and selecting students, preparing mentors, team-building, diversity, equity and inclusion, and logistics. Other topics such as program evaluation, safety, anti-harassment training, and publishing are covered as well. Examples, templates, and resources are provided throughout.

The content of this handbook comes from years of shared experience, materials, advice, and input from the community of REU sites funded by the National Science Foundation Geosciences (GEO) Directorate. The community of REU site managers engages and collaborates through workshops, an email listserv, conference sessions, and the sharing of materials on a website. In this collaborative and supportive community, site managers feel comfortable asking questions, offering their experience, and sharing materials. Welcome to the REU Community!

This community of practice is truly a remarkable one, and we hope that this handbook adequately shares the collective wisdom of the many people who have generously shared their thoughts and materials over the last decade. We thank all contributors and invite you to contribute to future annual editions of this handbook.

*Valerie Sloan
Rebecca Haacker*



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CONTRIBUTORS

List of Authors

Asher, Pranoti; American Geophysical Union
Atchison, Christopher L.; University of Cincinnati
Barnes, Timothy; University Corporation for Atmospheric Research
Batchelor, Rebecca; University of Colorado Boulder
Blake, Reginald; New York City College of Technology
Bruno, Barbara C.; University of Hawai'i Mānoa
Burt, Melissa; Colorado State University
Dalbotten, Diana; University of Minnesota Twin Cities
Gold, Anne U.; CIRES, University of Colorado at Boulder
Haacker, Rebecca; National Center for Atmospheric Research
Hubenthal, Michael; Incorporated Research Institutions for Seismology
LaDue, Daphne; University of Oklahoma
Liou-Mark, Janet; New York City College of Technology
Marín-Spiotta, Erika; University of Wisconsin Madison
Medina Luna, Lorena; National Center for Atmospheric Research
Mogk, David; Montana State University
Morris, Vernon; Arizona State University
Nocerino, Jennifer; Geological Society of America
Noriega, Gabriela; Southern California Earthquake Center
Serrato Marks, Gabriela; Massachusetts Institute of Technology
Sloan, Valerie; National Center for Atmospheric Research
Thatcher, Sean; Rutgers University
White, Lisa D.; University of California Museum of Paleontology

Image Contributors

We thank the GEO REU community for having contributed photos to this handbook. Contributors include:

Bermuda Institute of Ocean Sciences (staff)
Bishop, Janice; SETI Institute REU
Campbell, Lisa; Texas A & M University
Conlee, Don; Texas A & M University
Dalbotten, Diana; University of Minnesota Twin Cities
Diaz, Andre; Arecibo Observatory, Puerto Rico
Esteban, Sergio; SETI Institute REU
Fitzsimmons, Jessica; Texas A & M University
Garza, Corey; California State University, Monterey Bay
Hubenthal, Michael; Incorporated Research Institutions for Seismology
Konter-Smith, Bridget; University of Hawai'i Mānoa
Maranda, Lucie; University of Rhode Island
Medina Luna, Lorena; National Center for Atmospheric Research
Myrbo, Amy; University of Minnesota
Noriega, Gabriela; Southern California Earthquake Center
Pope, Audrey; Bermuda Institute of Ocean Sciences
Sloan, Valerie; National Center for Atmospheric Research
Tiscareno, Matthew; SETI Institute
The SOARS program, University Corporation for Atmospheric Research
UCAR Center for Science Education

Layout & Design

Zietlow, Daniel; National Center for Atmospheric Research

Copy Editing

Vicki Holzhauer; Longmont, Colorado

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WHAT IS AN REU?

Rebecca Haacker

Diana Dalbotten

Research Experiences for Undergraduates (REUs) are internship programs run with the intent of engaging undergraduate students in science through involvement in mentored research, professional development, and a sense of cohort with peers. The Directorate for Geosciences in the National Science Foundation funds several [REU programs](#) in the ocean sciences, atmospheric and geospace sciences, Earth sciences and polar programs.

Whether you are writing a [grant proposal to NSF](#) or refreshing plans for next year's REU program, this chapter is intended to help with your planning.

➔ What is an REU?

The Research Experiences for Undergraduates (REU) Program is a signature National Science Foundation program for students to have the chance to experience and engage in doing their own research. Dalbotten et al. state that:

“Anecdotal evidence indicates that the REU program has been notably successful in providing hands-on experience and cooperative learning—both in the field and also in the laboratory. It has attracted numerous young people to the geosciences, including many from underrepresented groups, and has also proven to be an important cornerstone for many others who have gone into other professional fields.”

Students do a research project with a mentor or team from start to finish, connect with peers, and gain professional skills like communicating effectively. Most students who participate in an REU say that they find it to have been extremely worthwhile.

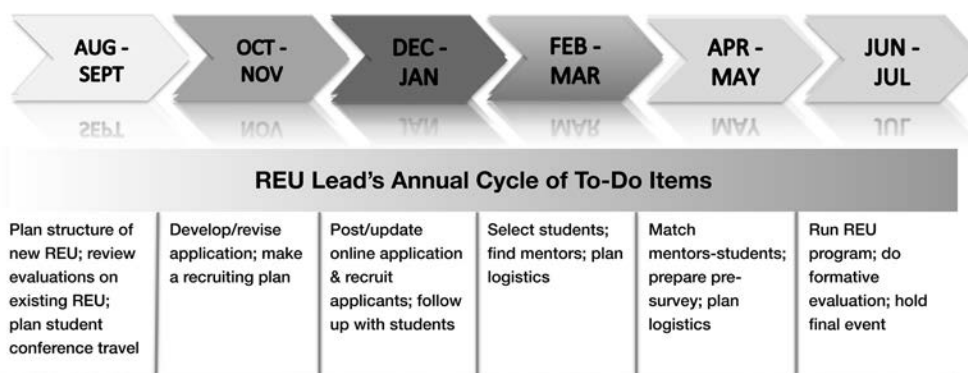
Typical elements of an REU

An REU usually involves:

- » A 7 - 10 week, paid, hands-on, summer work experience in a research environment
- » Cohort-building amongst undergraduates interested in the same field
- » Working under the mentorship of a scientist or team
- » Learning skills such as field or lab techniques, or computer modeling
- » Analyzing data and interpreting results
- » Learning scientific communication through presenting a poster or talk locally, virtually, or possibly traveling to a conference
- » Exposing students to a whole new world of science

REU Timeline

Most REU programs follow a similar timeline, shown in the figure below:



➔ Planning a Research Experiences for Undergraduates

Planning for an REU should ideally begin before the proposal is written. Maybe you are writing a new grant or are taking over an existing one. Here are some crucial tasks for successful REUs that may be easily overlooked if not discussed upfront:

1. Design an exciting, workable research experience program that will be engaging to students.
2. Make sure you have adequate logistical resources and support so that your program will work. Think about issues like communicating with mentors, travel arrangements, housing, sharing about the program through social media and articles, and more.
3. Create a good research environment that is safe and friendly. Make sure you are making your program accessible. Issues to consider would include diversity and inclusion, accessibility, and preventing harassment of any kind, including sexual harassment.
4. Build in mentoring that supports students not only scientifically but holistically.
5. Think how you will build camaraderie in the program with things like icebreakers, orientations, setting and communicating expectations, and working in collaborative teams.



History of the REU Program

“At some universities, research experiences have always been a part of the undergraduate experience, both informally and in formal programs. Historically, students have participated in these programs at their home institutions where a single student is placed into the laboratory of a faculty member. They relied on a strong university research program, faculty with time to oversee the student’s research, and a student with the willingness to seek out, or request access to, the opportunity. In 1958, NSF began to foster these experiences through the Undergraduate Research Program (URP).

“This program allowed universities to competitively apply for funding to host teams of students in a summer research program. Research that followed confirmed the value of these experiences for promoting students to participate in STEM and to move on to graduate programs. In 1978 the Council for Undergraduate Research (CUR) was formed to promote research opportunities as an integral part of the undergraduate experience [CUR, 2009]. The URP was suspended in 1978 for review, and then replaced by the REU program in 1987 [Schowen, 2002].

“Today, the REU program and other research programs sponsored through organizations such as National Institutes for Health (NIH), National Oceanic and Atmospheric Administration (NOAA), National Aeronautics and Space Administration (NASA), and US Geological Survey (USGS) have created myriad summer research programs for hundreds of undergraduate students every year. Although the mentoring skills and enthusiasm of the research advisor are still a key element of the quality of the experience, a variety of supports have been added to programs, including writing support, library tutorials, ethics programs, Graduate Record Examination (GRE) prep courses, and others.

“Participation in research as an undergraduate is now viewed as an integral part of the undergraduate experience by university faculty, administrators, and future employers, especially in STEM fields, and has become an important consideration for entry to a graduate program in STEM. In addition, young faculty who were themselves participants in undergraduate research programs are now eager to share this opportunity with future generations.”

*From: Dalbotten, D., R. Haacker-Santos, S. Zurn-Birkhimer (2014):
New Voices: The Role of Undergraduate Geoscience Research in
Supporting Alternative perspectives on the Anthropocene. Future Earth
– Advancing Civic Understanding of the Anthropocene, Geophysical
Monograph 203, 2014*

6. Build in extra activities that help students excel: career development, writing workshops and poster workshops, field trips, research ethics discussions, community interactions, and opportunities for dissemination and community service.

Suggested checklist for planning your grant or existing REU

1. Consider the overall goals you have for running an REU program.

Some potential goals might be:

- » Diversifying your field
- » Supporting recruitment into your graduate programs
- » Creating strong partnerships with other institutions
- » Giving your faculty opportunities to mentor student research
- » Supporting an ongoing research program with additional funds or personnel (including the undergraduate workers)



2. Consider the overall theme of the program. What types of research projects do you want to do in the REU program?

- » Does the research theme provide good, doable research projects? Will they be team projects or individual projects?
- » Does the research provide a good mix of indoor and outdoor time? Field work and computer work? Will it be engaging to undergraduates?
- » Will undergraduate students have the capability of conducting the research or will they need additional training, and how time-intensive will that training be?

3. Consider institutional resources that will support the program

- » Contact other programs or your housing office to inquire about housing
- » Do you have access to support staff, libraries, laboratory spaces?
- » Insurance (clarify liability insurance)
- » Local environment (is it safe and does it offer activities for students in their off-hours?)



4. Institutional Partners

- » All partners should be involved in designing the REU from the proposal stage on
- » Have you talked to program partners about the REU and how they want to participate?
- » How do you work with community partners?

5. Model or structure of the program

- » What type of structure will you have, team work vs one-on-one mentoring?
- » How many students can you reasonably host and support?
- » Is it a traditional summer program? An international experience? A single-campus model or a dispersed model?

6. Budgets

- » What funds do you need to run this program effectively and safely?
- » What additional in-kind support will your institution provide to run the program?



➔ The GEO REU PI Network

As a manager or PI of a GEO REU you are invited to join a welcoming and supportive community of practice. The GEO REU PI Network is a community of people committed to providing high-quality geoscience research experiences for undergraduate students. The GEO REU Resource Center, housed at the National Center for Atmospheric Research, runs a listserv, holds quarterly telecons, shares resources on its website, and hosts education sessions at the annual fall meeting of the AGU in San Francisco, among other things.

[Join the GEO REU Listserv](#) to stay in touch about upcoming events (telecons, conferences), share resources, and have a go-to community where you can ask questions.

[Find resources, tips, and materials at the GEO REO Resource Center.](#)



Further Reading

Dalbotten, D., R. Haacker-Santos, S. Zurn-Birkhimer. 2014. *New Voices: The Role of Undergraduate Geoscience Research in Supporting Alternative Perspectives on the Anthropocene*. *Future Earth – Advancing Civic Understanding of the Anthropocene*, Geophysical Monograph 203.

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CREATING AN INCLUSIVE REU APPLICATION

Christopher Atchison

Valerie Sloan

Rebecca Haacker

Gabriela Serrato Marks

Sean Thatcher

The REU application process is key to attracting motivated students with strong potential, while giving signals about your program's values. Students may decide to apply based on the type of work available and by believing that they will fit in or feel comfortable, given the descriptions and photos. Having a simple and straightforward application can keep students from turning away. Every REU requires a separate application, and so it helps to lighten the application requirements where possible. Here are some steps and tips on creating a successful application process.

➔ Making Your REU Application and Website Inviting and Inclusive

When a student is looking for a research opportunity or is ready to apply, they will likely check out your website first. An appealing, accessible, and inclusive website is often the first view a student gets of your program's community and approach to diversity. To appeal to a wide range of students, it is helpful to develop materials with these features in mind:

- » A program description that demonstrates that diversity and inclusion as a priority. For example, see the University Corporation for Atmospheric Research [SOARS program's statements](#).
- » An engaging website that shows a range of projects available:
 - Field-based, lab-based, computational, modeling, data analytical
 - Individual or collaborative
 - Interdisciplinary, cross-culturally relevant
 - Potential for student involvement in project design
- » Image matters! Evaluate the images, videos, and language you use to promote your REU. For example, a banner photo showing all white male students and faculty on top of a mountain may not feel like the right program for someone who may not identify with that group, or like those types of activities. Some questions to ask yourself include:
 - Are you promoting diverse student experiences that are also accessible for students with disabilities?
 - Are you showcasing diverse advisors and mentors?
 - Are you discussing program policies that will keep students with diverse race, gender, ethnicity, religion, and disability identities safe and supported?
 - Are you demonstrating access and inclusion through audio and descriptive captioning of videos?
- » Integrity is important: Keep in mind that showing images that do not accurately represent your program for the sake of showing diverse students is misleading to potential students. Be honest with the portrayal of your program. If you have not had diverse cohorts and do not have images of diversity to show on your website, be sure to highlight in the description how your program will work with students from groups historically underrepresented in the Earth system sciences. Assure students that no matter their background, they will be supported, included, and successful.

University of Massachusetts Boston

Coastal Research in Environmental Science and Technology

Program Information

Research Topics

How to Apply

Contact

Summer Research Internships in Coastal Systems

Announcements

» To ensure the health and safety of our faculty, students, staff, and surrounding community, UMass Boston will continue to operate in hybrid fashion, with some courses lodged on campus and others—the majority—continuing in remote modality during the fall 2020 semester. Many answers about the campus's response to the coronavirus can be found in our special section.

The **Coastal Research in Environmental Science and Technology (CREST)** program at the University of Massachusetts Boston (UMass Boston) is a 10-week immersive research experience serving 8 undergraduate scholars per year. CREST exposes these students to cutting edge, authentic, coastal environmental research at UMass Boston in an integrative transdisciplinary program. CREST focuses on coastal research that incorporates the natural and social sciences and leverages the existing research and educational programs within the School for the Environment at UMass Boston.

"I credit the CREST REU experience for initiating and growing my serious interest in STEM. The program remains one of my favorite research experiences, and I would love to see myself end up back in Boston some day!"

Christiana, Kenyon College, CREST-REU scholar

Research Topics

Program Information

The CREST-REU Program at the University of Massachusetts Boston has been funded by grants from the National Science Foundation's Division of Ocean Science's. Our most recent funding award is NSF Award # OCE-1658901; PIs: Christian and Poynton and previous awards include NSF Award # 1359242 and NSF Award # 1062374.

Fig 1. This website is inclusive in terms of the photos that show people doing both indoor and outdoor work, women and people of color that would be accessible to all and be of interest to those who seek one or the other. Second, the students shown include a woman and a person of color, which suggests an inclusive program culture.

- » An example of an appealing, inclusive website is that for the [Summer Research Internships in Coastal Systems](#) at the University of Massachusetts Boston (Fig. 1) which stays away from stereotypical images of the geology field camp with a group of White, able-bodied men at the top of a mountain peak, which doesn't feel inclusive to some.
- » An REU website that is accessible for people with disabilities will:
 - Use larger text and high contrast. Avoid colors that negatively impact those with color vision deficiency, such as red and green.
 - Is your website [screen reader](#) compatible?
 - Is it a mobile friendly website?
 - Ensure that all interactive content is keyboard accessible, meaning that you can navigate through the fields without using a mouse.
 - Conform with the [Web Content Accessibility Guidelines \(WCAG\)](#).
 - Provide [alternative text](#) for images, especially graphics that contain important content, like deadlines. Alternative text is different from a caption - see the example below.



Caption: Belize REU students, program faculty, and local children gather to fly a drone.

An example of alternative text: College students, program faculty, and children standing in front of a yellow building, some are looking up to the sky. A student standing towards the middle wearing a blue shirt, a backpack, dark pants, a hat and sunglasses looks up while holding a remote control for flying a drone. (University of Central Florida REU: Preparing the Next Generation of Scholars through Community GIS and Citizen Science. Image credit T. Hawthorne).

- » Follow basic guidelines in making your REU materials accessible to those with visual and hearing disabilities. Ensure compliance with the United States Access Board's [Section 508](#) and eAccessibility requirements that all institutions must adhere to with digital media. You can test your website's accessibility using the [WAVE Web Content Evaluation Tool](#). If you find significant issues with your institution's website, bring them up with your web developer.
- » Get to know the accessibility capabilities of your other tools, in addition to your primary website. For example, even Google Documents has the ability to add alternative text.

➔ Include Essential Information

- » Post REU application information online by early December, if possible.
- » Make sure to include: application deadlines, program duration and dates, locations, logistics, rate of pay or stipend amount, and costs covered (e.g., travel and lodging).
- » Choose an application deadline that corresponds with other programs (e.g., early February). Choose a weekday in case of issues that arise. February 1st or 15th are often used.
- » Clearly state the eligibility requirements: e.g., must be a U.S. citizen or permanent resident; must be currently enrolled in college and have one semester remaining after the summer for NSF REU programs.
- » Give students until March 15th to decide whether to accept your offer. REU sites can make offers to students prior to March 15th but need to be clear that a decision is not required until the 15th of March, per general guidance from GEO Program Officers.
- » Demonstrate a commitment to diversity, equity, and inclusion, and make clear your efforts to create accessible experiences for students with disabilities. For support, contact the International Association for Geoscience Diversity at <http://www.theiagd.org> or at info_at_theiagd.org.
- » Provide a contact phone number and email address for questions about the application. This will help to make your program feel more welcoming and accessible.



To get an idea of how other programs in the Geosciences Directorate advertise and operate their application processes, visit other REU websites via the [NSF REU site](#).

Check with Your Institution

- » Before you design your application process, check with your HR offices about payment procedures. Most REUs pay students with a stipend and don't formally hire them.
- » Ask about using demographic information in the selection process and whether it is allowed. The history of how universities and other organizations may use demographic data in affirmative action is complex and ongoing as described [in this historical timeline](#).

➔ Setting Up Your Application System

A webpage for the REU is usually the basic platform for the application. Include links to an application form and clear instructions for how to submit transcripts or other documents.



- » Select the platform or tool for handling applications forms, transcripts, letters of recommendation, if required. These might be a departmental website, SurveyMonkey, Google Forms, or Qualtrics. Ensure that the system allows students to upload documents and materials. Test your web application process with someone from outside of your institution.
- » Provide a downloadable PDF of the application form, as faculty sometimes print out forms for students without internet access. Include a mailing address or fax number where they can submit it.
- » If possible, set up a process that confirms the receipt of the application.
- » Provide information on where to:
 - Complete an online application form
 - Upload or email electronic transcripts
 - Submit letters of recommendation
- » Accessibility: Be sure that the application form is accessible to individuals with disabilities (e.g., screen reader compatible, high contrast, adjustable text size).
- » Provide a contact phone/email address for questions about the application.

Designing the Application

The application process should be straightforward and clear about what is required and how to submit materials. Applications can be onerous to complete, especially if a student is applying to more than one REU program. Aim to keep requirements as simple as possible. Avoid asking applicants to list tedious information that does not add value to the evaluation of the applicant. Streamlined application requirements might include the following:

- » Personal information (e.g., name, email, phone, address), keeping in mind protecting Personal Identifying Information (PII)
- » Education information (year in college, institution name, major, courses)
- » Research interests (can be a checklist of topics or open answer – this helps with matching students to projects)
- » Skills background (e.g., computer, lab, field, or other skills)
- » Honors, awards, or scholarships
- » Previous work experience, including volunteerism
- » Service or education work (e.g., tutoring, teaching, outreach)
- » Transcripts: Request unofficial electronic transcripts, as they are easier and cheaper for students to send.
- » Essay questions can be the key to finding students who fit your program, and can be the most important part of the application. See below for more information.
- » Include information about potential interview questions that could be used in lieu of recommendation letters or essay questions. Be sure that real-time captioning is available during an interview for students who are deaf or hard of hearing.

Include Demographic Questions at the End of Your Application Form



In order to determine the impact of your recruiting practices, it is important to know the demographics of your applicant pool. Consider comparing your REU application pool with the selected pool in terms of race/ethnicity, gender, disability, veteran status, and first-generation status, regardless of whether this information is used in the selection process. Check with your organization if you are allowed to use demographic information in the selection process or only collect it in aggregated form for reporting purposes. For example, here is one [document of demographic questions](#) that are used in educational programs.

Promoting the REU Program and Application

Make sure that your recruitment strategies are getting your program in front of the right audience. For example, you can advertise the REU on email lists and opportunity boards that have an explicit focus on diversity and inclusion.

If you choose to advertise on social media, you can continue to show that accessibility is a priority by including image alternative text and captions on videos, at a minimum. All key information should be in text form, not just in a graphic. Be aware of your social media audience: will you be reaching out to undergraduates around the US who have no previous exposure to research, or will you be informing PIs at research institutions?

Vocabulary

Word choice can go a long way toward making your materials more inclusive. Here are a few suggestions for words and phrases to use and avoid.

Disability: Use “disabled” or “students with disabilities.” Avoid “handicapped” or “differently abled.”

Race and ethnicity: Avoid “women and minorities” or “minority,” except for “underrepresented minorities.”



One example is the [SOARS internship program which writes](#): “SOARS seeks to involve students from groups that are historically underrepresented in the sciences, including Black or African-American, American Indian or Alaska Native, Hispanic or Latino, female, first-generation college students, veterans, and students with disabilities. SOARS welcomes lesbian, gay, bisexual, and transgender students; students who have experienced, and worked to overcome, educational or economic disadvantages, and/or who have personal or family circumstances that may complicate their continued progress in research careers.”

Gender: Include non-binary genders in demographic questions. In the application, ask for the student’s pronoun with a blank text field to allow the most flexibility. Avoid binary language (men/women, he/she) and use “students” and the pronoun “they” instead.

→ Implicit Biases in Application Materials

Application Metrics are Often Laden with Biases

Be aware that those with financial resources and strong social capital and support systems may have more experience on their resumes. For example, a student who can afford to go to school without holding a job will have more time to focus on grades and possibly earn a higher GPA. They may also have time to join clubs, participate in extracurricular activities, or gain experience through work that is relevant to their field. See the [chapter on Selecting a Diverse and Balanced Cohort](#) for a more in-depth discussion. Note that the small advantages or disadvantages that a student faces along the way are compounded over time.



Biases in Letters of Recommendation

Research shows that letters are rife with bias, with a tendency to portray women, people of color, and other members of groups historically underrepresented in the geosciences less favorably. This is also true for people from non-research-focused institutions. Furthermore, letter writing places an undue burden on faculty, especially at small colleges where they may be the only faculty member writing letters for multiple students.

“Female applicants are less likely to be described as “brilliant,” “trailblazer,” or “one of the best students I’ve ever had,” according to a study of recommendation letters for highly selective geoscience postdoctoral fellowships” (Kuo, 2016).

See [“Letters of Recommendation: Just Say No”](#) (Inside Higher Ed, 2019). Some REU managers are asking for references rather than letters of recommendation, and then calling the references before hiring the student.

➔ Effective Essay Questions

Standard Questions Give Limited Results

Often essay questions in REU applications ask about students' interests and goals, which may lead one to giving higher rankings to those who have had the time and funds to explore opportunities, and overlook those who have potential but haven't had the chance to develop leadership qualities. These questions might read as follows:

1. Write about what your career goals are and how participating in this REU program will help you meet these goals.
2. Describe the areas of research in the geosciences that interest you most, your personal goals for the internship, and indicate your preference for working in office, lab, or field settings.

One REU site manager wrote, *"We stopped using a question like this, because we found that we got extremely uniform answers from that question, and it didn't help to distinguish the candidates. Nearly every student would write an essay on the theme of 'I want to get a PhD, and this program will help me get into grad school.'"*



Carefully Chosen Essay Questions Provide Insight

Essay questions can be the key to finding students who will make a great participant in your program, especially if you go beyond asking about aspirations and goals. Here are two examples:

1. Describe how you have overcome or dealt with a challenge or adversity in your life. This can be either a specific situation or a broader issue.
2. This program is dedicated to enhancing the diversity of future scientific communities and sharing our science with a broader audience. Describe how you, based on your personal background and life experiences (including social, cultural, familial, educational, or other opportunities or challenges) will contribute to this mission during and after participating in this REU.



Some REU managers suggest adding one of these questions to your essay prompts, citing very informative answers that help with the selection process:

1. Is there anything else that you would like our selection committee to know about you?
2. What unique qualities and characteristics will you bring to our REU program?

Provide Guidance on Essay Length

Include guidance on the answer length for each essay prompt, e.g., “Please write at least 200 words, and no more than 400 words.” Sometimes students who have a lot of potential but have not had a lot of academic preparation might write too little unless a length is specified. Others may write too much.

The Win-Win of Inclusive Promotional and Application Materials

An inclusive REU application provides your site with the opportunity to draw in students from groups historically underrepresented in the geosciences, including those with disabilities, to make your program more successful (Powell, 2018).

- » Show that you care about diversity, inclusion, and the students themselves through the language, statements, and photos used in your website.
- » The essay questions used in your application will also be an indicator of what qualities you value and encourage in your program. This may be important to students who know firsthand the struggles of dealing with racism, sexism, ableism, or other implicit biases in their lives.

Resources

Barron, Brenda. [How To Make Your Website Accessible to People with Disabilities](#).

National Disability Association (Ireland). [Make your websites more accessible](#).

WC3. [Web Content Accessibility Guidelines \(WCAG\) 2.0](#).

W3C Web Accessibility Initiative. [Easy Checks – A First Review of Web Accessibility](#).

Further Reading

De Paor, D.G., Karabinos, P., Dickens, G.T., & Atchison, C.L. 2017. Color vision deficiency and geoscience illustrations. *GSA Today*, 27. DOI: 10.1130/GSATG322GW.1.

Kuo, M. 2016. [Recommendation letters reflect gender bias](#). *Science*. Oct. 3.

Powell, K. 2018. [These labs are remarkably diverse — here's why they're winning at science](#). *Nature*, 558, 19-22. DOI: 10.1038/d41586-018-05316-5.



RECRUITING STUDENTS FOR YOUR REU

Diana Dalbotten

Valerie Sloan

One of the REU program's goals is to provide opportunities for students with potential who might not otherwise get them, as well as to engage a broad range of students into science career and educational pathways. If your NSF REU award has a stated goal of recruiting and including students from a particular background or region, it will be important to build connections with faculty at Minority Serving Institutions, community colleges, and other universities who serve those students. See the [chapter on Creating Inclusive REU Applications](#) for more on creating inclusive web and application materials. This chapter will provide an overview of ways to recruit broadly for your REU program.

➔ Introduction

After developing an inviting and inclusive website and application, the next step is to recruit student applicants. Build personal connections with faculty as much as possible by connecting at conferences, at meetings, or simply by calling them on the phone. As they get to know and trust you, they will be more likely to recommend students to you, and this becomes something that they will do every year. These relationships become a key element in one's long-term recruitment process, and an initial investment pays off in the following years.

➔ Having a Recruitment Strategy

In writing a proposal for an REU site or supplement, it's important to have an active recruitment strategy, including a clear implementation plan. Passive recruitment approaches tend to be ineffective. Create a strategic plan for recruiting and diversity before you write your proposal and include these points:

- » Know your intended audience—whom do you intend to recruit?
- » What are your targets for underrepresented students? Are you aiming to increase overall representation, or do you focus on specific groups because you have a reason to (i.e., if you are making an REU specifically to address accessibility, or if you are working on research in Hispanic communities).
- » Clarify in advance what your goals are for the pool of students you hope to have in your program, and why these are the students you want in the program. There should be some logical connection to your goals.
- » Identify which institutions you will partner with for recruitment. It's important to include students from smaller colleges, community colleges, and from Minority Serving Institutions in your recruitment plan.
- » Map out a plan to reach your intended audience and encourage their applications.

➔ Creating Inclusive and Engaging Recruitment Materials

Have a description of your REU program to share with faculty and students in emails, flyers, or on websites. In your description:

- » List your institution and location, the discipline of research, and the dates of the program.
- » Give a brief description of the program and what the student will get out of the experience (e.g., students will participate in doing oceanographic research, and learn how to

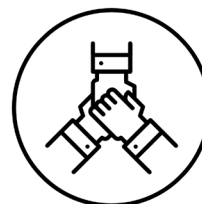
- communicate their research results to a scientific audience).
- » Include the application deadline. Many REUs use a deadline of Feb. 1 or 15, for example
 - » List the characteristics of the students being sought, including:
 - Academic background (e.g., majors or science background). Many MSIs have different or limited numbers of majors. For example, many have no earth science courses, or they may have Sustainability Science rather than geology. Consider broadening your pool to include core subject majors like math, physics, chemistry, biology, computing, engineering.
 - Academic level (e.g., 2nd year undergraduate)
 - Type of institution student is at (e.g., community college or 4-year college)
 - Eligibility with respect to citizenship or permanent residency
 - » Specify the support that students will receive, including the pay or stipend, travel, housing, and mentoring.
 - » Be inviting and inclusive in the language used in your description. Look at other REU websites to see how inclusive they seem to you.
 - » Think about what message your recruiting materials might be sending about the kind of participant you want in the program. Is that causing students from your target recruiting audience to decide they are not that person?
 - » In emails or flyers, include a link to your webpage, a photo, and logo for your institution and for NSF. The images in your recruiting materials should give a realistic picture of how much time indoors/outdoors/physically challenging the program really is. If you can make adaptations for students who don't enjoy working outdoors or can't meet the physical challenges, do you say so?
 - » If your program includes flexibility for nontraditional students (i.e, parents encouraged, or remote participation a possibility), be sure to make it clear in your recruiting materials.
 - » Get feedback on your recruiting materials, especially from faculty at MSIs and CCs or underrepresented students. Is your message making it out the door?



➔ Partnerships for Recruiting

Many students in internships learn about the opportunity from a professor or peer. In addition, they may find the opportunity through a web search. Students from underrepresented groups are more likely to learn about REUs from a professor. To successfully recruit students into your program, it is important to make connections with faculty, and if possible, students.

- » Contact faculty and chairs at other universities and community colleges by calling, meeting up, or via individual emails. Ask faculty to recommend students in addition to sharing your flyer. Visit their institutions when possible.
- » Include departments such as environmental studies, math, chemistry, physics, computer science and engineering, as these students have skills that are essential in the geosciences.
- » Give a short 5-10 minute presentation about your opportunity in a few STEM classes. See example presentations for ideas on how to discuss REU programs.
- » Ask faculty to tell you about students with great potential, and introduce you to them.
- » Share your opportunity via email with faculty and students.
- » Collaborate with other programs to recruit students. Hold workshops at MSIs, or at conferences and tell students about the advantages of applying for research programs.
- » Contact former REU interns via social media and ask them to tell friends about the opportunity. Students can be excellent recruiters.
- » Keep in touch with former graduate students from your lab, as they will often be good at recruiting students for you.
- » Each year, follow up on letters of recommendation from faculty for the students you take into your REU. Write to those faculty and thank them for recommending the student. Share with them how the student did in the program and invite them to recommend more students in the future.
- » Consider having your cohort train at an MSI for part of your internship.



As you develop these relationships, faculty will be more comfortable recommending students to your program, and you will be able to support students in a more customized way, knowing more about them.



➔ Post Your REU Opportunity on Key Websites

You can [post opportunities to minority-serving science societies](#) including AISES, NABG, and SACNAS, as well as other science organizations.

- » [AISES](#) (American Indian Science & Engineering Society): Send in a description (200 words). This goes out to 11,000 members including faculty and students at Tribal Colleges.
- » [NABG](#) (National Association of Black Geoscientists): Go to their Facebook page, like it, and post your opportunity there
- » [SACNAS](#) (Society for the Advancement of Chicano and Native Americans in Science):
 - First create an account (or login) on their website.
 - Next go to "submit opportunities online." It does not cost to post student opportunities. They will then approve the request to post.
- » [GA](#) (Geoscience Alliance) This is a national alliance of individuals committed to broadening participation of Native Americans in the geosciences
- » [IBP](#) (Institute for Broadening Participation) [Pathways to Science](#) database: This reaches many students from underrepresented populations.
- » Post on **Facebook pages** and **job websites** of science organizations such as [AMS](#), [GSA](#), [ASLO](#), and [AGU](#).
- » **Earth Science Women's Network** (ESWN). You can post opportunities on their website discussion board (<https://eswnonline.org/>) and/or their [Facebook page](#).
- » The [Equity and Inclusion in the Geosciences Facebook Page](#) accepts job, fellowship, or REU opportunity postings.



Check whether your REU is listed on the NSF [REU website](#). Does it link to your REU website properly? Check it each year, and each time you make a change to your REU web address or PI. To request a correction, contact your NSF Program Officer.

➔ Recruitment at Conferences

Join and participate in minority science societies like SACNAS, NABG, and AISES and develop connections with faculty and students from underrepresented populations. Note that practices for remote conferences will look different; however, look for and host events like those mentioned below.

- » Attend networking events, like the talking circles at AISES that allow you to meet mentors and instructors. Consider them listening opportunities where, rather than just telling people about your program, you go in with the intention of learning as much as possible about other institutions and programs.
- » Offer career development and professional development workshops for students at these conferences and share research opportunities with the students.
- » Learn about the majors and research programs in place at MSIs and the potential opportunities and barriers towards participation they have for students at their institution. Attend cultural sessions and events. Sessions on traditional knowledge, traditional food sources, etc., will help you build cultural knowledge.
- » Check into field trip opportunities offered by the conferences



- » At conferences, visit all the posters in your target disciplines and talk to the students.
 - If they are not there, leave a flyer for your REU tacked on their poster bulletin board with a note saying their research is interesting and to connect by email.
 - Make a note of their department, advisor, and institution. Later on, contact that professor to ask them to nominate a student to your REU.
- » Share a booth with colleagues from related programs and disciplines to form a block and enhance your presence at the conference. Create a recruiting network of like disciplines and cooperate in drawing students to the booths and encouraging them to apply. Sharing a booth will allow you time away from the booth that can allow you to attend sessions.

➔ Develop Connections with Community College Faculty Members

There is a national effort to bring community college students into the science workforce. There is greater diversity in community colleges than in many universities. Many of these students have not had the opportunity to attend four-year colleges for financial or other reasons, but have strong potential.



- » Community Colleges: These are listed by state at the [American Association of Community Colleges](#) website.
- » Minority Serving Institutions: Check whether any of these are located near your institution. They are listed by state as follows:
 - [HBCUs](#) or Historically Black Colleges & Universities (see [map of HBCUs](#))
 - [HSIs](#) or Hispanic-Serving Institutions
 - [Tribal Colleges](#) (see [map of Tribal Colleges](#))

Final Tips



Developing relationships with faculty who are at [Minority Serving Institutions](#) (MSIs) and can nominate a student to (and share news about) your program can lead to all kinds of partnerships. These can include joint research projects or linked student programs, sending majority REU students from majority institutions to Minority Serving Institutions for a period of training, and joint proposal writing.

Keep in mind that faculty at MSIs are approached weekly by people wanting to include them in grants at the last minute. Working collaboratively means designing programs together and can be meaningful and invigorating.



SELECTING A DIVERSE AND BALANCED COHORT

Valerie Sloan

Barbara C. Bruno

Rebecca Haacker

The REU selection process is an unrecognized bottleneck in the diversity pipeline. Faculty and program managers often lament that there are not enough strong, diverse candidates in the application pool. However, this may reflect biases in the selection process, rather than in the applicants' capabilities or potential. This chapter shares tips and strategies for selecting a diverse cohort of students and provides background information for new PIs.

➔ Student Recruitment Guidelines

The NSF REU program aims to broaden participation among students from underrepresented groups. The Solicitation (20-587) states that:

- » NSF is interested in increasing the numbers of women, underrepresented minorities, and persons with disabilities in research. REU projects are strongly encouraged to involve students who are members of these groups. Underrepresented minorities include African Americans, Hispanics, American Indians, Alaska Natives, Native Hawaiians, and other Pacific Islanders.
- » At least half of the student participants must be recruited from academic institutions where research opportunities in STEM are limited (including two-year colleges).
- » REU projects are encouraged to consider students who are veterans of the U.S. Armed Services and first-generation college students.
- » Undergraduate participants supported with NSF funds must be U.S. citizens, U.S. nationals, or permanent residents of the United States.

Other underrepresented groups in the geosciences: Students from groups not listed in the program solicitation (e.g., those in the LGBTQ+ community, Asian Americans, and low-income students) are also underrepresented in the geosciences. Although there are multiple ways to define underrepresented groups, the key goal is to create diverse, inclusive geoscience research communities.

Students with previous REU experience:

In order to provide experiences to as many students as possible, REU coordinators should confirm with the program director managing that site if they would like to recruit a student who has already participated in an NSF-funded REU Site.



➔ Factors to Consider in Selecting Your Cohort

Target demographics: Remember your proposal's demographic goals. If possible, avoid the "lonely only" - i.e., single student from a particular background.

Institutional diversity: At least half of the students are to be recruited from community colleges or other institutions with limited research opportunities.

Maximum benefit: Strive to select students who might not pursue science without this REU experience; for instance, those who have not had similar prior experiences.

Gender balance: Strive for a gender balance, with a maximum of 60% from any gender.

STEM courses: Check that the student has sufficient STEM coursework and has done adequately in those courses to be able to succeed, bearing in mind that small colleges might not have the specialized courses that larger institutions are able to offer.

Technical skills: Compile a list of necessary skills for each project, and consider whether any of these skills could be taught during the REU. For team projects, students can have different skills, complementing and teaching each other.

Privilege versus financial constraints: e.g., Did the student participate in short international volunteer experiences, or have they worked at service jobs throughout college? Holding a job while in school can demonstrate diligence, perseverance, loyalty, grit, and good time-management skills.

Leadership skills: These may include qualities such as integrity, accountability, communication, passion, empathy, creativity, decision-making, vision, and the ability to inspire others. Applicants' experience, essay questions, and interviews can reveal these traits.

Experience facing adversity and hurdles: Students who have dealt with issues such as poverty, physical disabilities, learning disabilities, or trauma may be more resilient and more compassionate team players.

Champions of diversity: Does the applicant have a track record in broadening participation, such as tutoring underserved students or working in a minority-serving organization? Does their experience suggest that they will be an engaged, supportive member of the cohort?



Institutional Rules on Using Demographic Data in the Selection Process

Rules regarding the use of demographic data when selecting an REU cohort are evolving, both over time and across institutions. Many institutions allow demographic data to be used so that cohorts can be more balanced, e.g., in terms of gender and ethnicity. Some organizations do not permit demographic data to be used in the selection process. Check the rules at your institution.

Check with your program officer whether they would like you to collect demographic information on your students. These data demonstrate whether the REU program is succeeding at recruiting students from underrepresented groups.



➔ Factors to Use With Caution

The favorite, GPA: Going with this easy metric may exclude students who have tremendous potential and who may fall within your target demographics. Research shows students with high GPA do not perform better as researchers. GPA may reflect the amount of time available to study, and therefore privilege.

“In my Ph.D. class the student who was the “smartest” (best test and exam scores) was the only one who did not have a successful research career. He was very smart but not very original in the way that leads to success as a scientist.”

– Doug Duncan, *Astrophysical & Planetary Science Department, University of Colorado at Boulder*

Extracurricular activities: Participation in sports, organized activities or volunteer trips abroad can show that the student is engaged and has leadership experience. Note that these activities are more accessible to students of privilege. Those in lower income brackets or with greater family responsibility may not have the financial resources or time to participate.

Letters of Recommendation: Letters of recommendation can provide insight into a candidate’s strengths and weaknesses and connect their skills and experiences to job requirements. However, research shows they are

rife with bias, with a tendency to favor men over women, Whites over minorities, and applicants from research-intensive institutions over non-research institutions. For example, letters often describe women as helpful, hard-working, pleasant team players, while men are described with standout terms like brilliant, focused, and having strong potential.

Some GEO REUs are no longer requiring letters of recommendation due to biases inherent in letter-writing, the disproportionate burden placed on faculty at smaller institutions, and the difficulty that students sometimes have in obtaining letters.



A five-year study of 1,000 letters of recommendation for postdoctoral fellowships in the geosciences showed that female applicants were only half as likely to receive “excellent” letters compared to male applicants, for example, describing applicants as having a “thorough understanding of the subject” versus being a “brilliant scientist and role model” or a “trailblazer.” The authors attribute this to implicit (unconscious) gender bias (*Dutt et al., 2016*).

➔ How does the process of selecting a cohort work?



While methods of selecting a cohort vary widely across REU sites, all have the goal of identifying candidates who will benefit from the experience, succeed, contribute to the cohort, and potentially fulfill demographic targets in the REU proposal.

Most REU applications will ask applicants about their interests in scientific topics and techniques, and use these in matching students with projects. Other REU sites post project descriptions online and ask students to rank those projects.

The selection process usually includes the following steps:

1. Identify the needed project skills
2. Work with a small selection committee to do an initial screening of applicants
3. Reduce (or increase) the number of applications
4. Create a list of top candidates
5. Conduct short telephone or video interviews
6. Inform students of the decision

A More Detailed View of the Selection Process

1. Identify the needed project skills:

Talk with mentors about the skills involved in the project and which of those can be taught or modeled.

2. Work with a small selection committee:

Choose two or three colleagues for the selection committee who can share the workload and bring diverse perspectives to the table. Before reviewing applications, the committee members must be:

1. Educated about NSF goals, program goals, implicit bias, and factors to consider in selecting a diverse and balanced cohort.
2. Aware of the skills that are needed for each research project, and whether they are needed by each student or the team as a whole, and whether they can be taught during the REU program.
3. Aware of the selection process and the number of applications the mentors will be able to interview.



Meet with the mentors and compile a list of skills that they really need students to have for their project. Press them on this list --is it REALLY necessary for students to come with each skill in place? For example, if coding skills are necessary, can you run a coding workshop for students during the first week of the program, rather than requiring they already have this skill? This supports diversity because then you don't favor students from Research 1 universities that have greater access to a wide variety of skill acquisition."

- Itchung Cheung, Hatfield Marine Science Center, Oregon State University

Should we provide implicit bias training for reviewers?

Yes. Implicit bias training helps us to see our own tendencies in selecting candidates and improves how people review applications. Such training can be facilitated by diversity professionals in your institution or by external consultants.

What is the role of the mentors in cohort selection?

Mentors are often involved in selecting from a subset of the applicant pool, but in some cases, the selection committee matches students with projects. Some mentors may believe that they

should be allowed to select from a large pool of applicants. However, mentors who are not familiar with the program goals or with the biases in certain measures tend to select students with the highest GPA, the most research experience, the strongest letters of recommendation, and those who are the most familiar to them, culturally. This may lead to a cohort that is not balanced or does not align with the REU goals.

3. Reduce (or increase) the number of applications:

Have too few applications from your target demographic group?

- » Ask the GEO REU community via the email listserv to share applications with you.
- » Encourage students with incomplete applications to finish them.
- » Allow late letters of recommendation (or omit the requirement from your process).
- » Set a priority (versus firm) deadline, which allows for a second round of recruiting.

Have a huge number of applications? Do an initial screening using a threshold criterion. For example:

- » **Omit obvious cases:** Students applying to the wrong internship or with incomplete applications.
- » **Academic level:** Be careful using this criterion, as it may eliminate candidates from your target pool.
- » **GPA:** Some programs use a GPA cut-off such as 3.0. Be careful not to eliminate candidates from your target pool (e.g., community college students, first-generation students, or veterans).



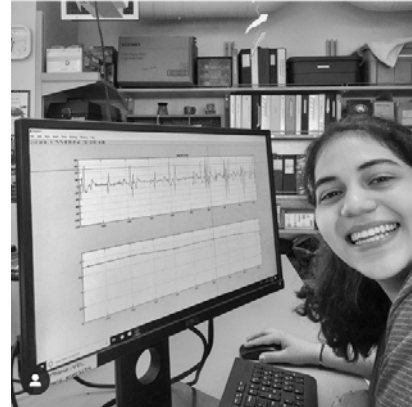
Next: Pare down to the top ~25 – 40 candidates with the help of your selection committee.

Tip: Ensure that each application is reviewed by at least two people for considering the more difficult cases.

4. Create a list of top candidates:

List, for example, the top three students who can be interviewed by the PI and mentor, or select the top ten students overall with backups for interview purposes.

Providing unique accommodations or support: If any student needs special accommodations, they should talk to their NSF program director about support. For additional information on supporting students with physical, learning, or other disabilities, contact the International Association for Geoscience Diversity (IAGD) for recommendations, while realizing that each individual situation can be different. If the student is a primary caretaker, discuss the situation with your NSF Program Officer.



5. Conduct short telephone or video interviews:

It is recommended that the PI interview the top candidates, ideally with the mentor for each project. Ask and answer questions, and then choose which students to accept. Even short 10–15 minute interviews can provide a sense of the students' interests and concerns. Students will cooperate in setting up a time for a call because they are very interested in the job! It is well worth the time.

6. Inform students of the decision

When should we send out acceptance letters? As early as possible, but no later than March 1st. All GEO REU sites must give students until at least March 15th (the Common Acceptance Deadline) to accept their offers. Sending out acceptances by March 1st will give students at least two weeks to decide. An acceptance form that stipulates some conditions is provided in this chapter's Appendix.

Should we send out rejection letters? Yes. Decline notices for student applications are expected, and are an important part of the process. Do this right away so that they can accept other opportunities. See the sample letters and acceptance form in the Appendix.

Sharing their application with other programs:

For the top candidates who are not given a spot, put a positive spin on their rejection letter by informing them that although they were not selected, the reviewers saw value in their application and would like to forward it to other REU programs for consideration. Contact the GEO REU email list community to share applications.

See the sample letters and acceptance form in the chapter Appendix.

Summary: Dos and Don'ts of the Selection Process

1. Don't hand a pile of applications to your research mentors to choose from. It is your job as PI (or site manager) to manage the selection process.
2. Don't handle the selection process singlehandedly. Form a committee of a few people, and assign at least two reviewers per application.
3. Do ensure your selection process is aligned with your program goals, as stated in your proposal.
4. Do provide training for mentors and others involved in the selection process, including information about program goals, implicit bias, and factors to consider to select a diverse cohort.
5. Do work with mentors to identify skills really needed by students *a priori* versus skills that could be readily acquired during the program (e.g., by providing trainings).
6. Do consider different skill requirements for individual or team-based projects.
7. Do choose students who will benefit the most from the experience, rather than those that have the most experience.
8. Do choose students who show an interest in giving back and being supportive to create a more cohesive cohort.

Take home: Selecting students for an REU program may *seem* like a straightforward process. However, if REU site managers let things unfold without being intentional, the cohort may be neither diverse nor supportive.



Resources

Ways to reduce biases in hiring

<https://biasinterrupters.org/wp-content/uploads/Identifying-Bias-in-Hiring-Worksheet.pdf>

How GPA and GRE scores don't predict student performance in graduate school

<https://www.sciencemag.org/careers/2017/01/student-performance-measures-don-t-perform>

Pathways of unconscious bias

<https://nccc.georgetown.edu/bias/module-1/2.php>

Further Reading

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 Appendix

Sample Letter of Acceptance

February 28, 2021

Dear {Name},

Congratulations! You have been selected as a participant for this summer's {name of} program at the {name of institution}. As an REU intern, you will:

- » Conduct original research under the guidance of a science mentor
- » Prepare a research paper and presentation based on your research
- » Participate professionally in all REU activities

This year's summer program for interns will take place from May 24 to August 5, 2021. The program will provide you with:

- » A stipend or wage of \$xx per hour (or per week/month, etc.) for up to 40 hours a week during the summer internship at {name of institution}
- » Round-trip airfare to {location} from anywhere within the United States (including Puerto Rico)
- » Paid housing accommodations during your summer internship. (Paid housing is taxable income.)
- » A local bus pass

Continuation of employment will be subject to all of {name of institution}'s policies, including satisfactory performance, and subject as well to the availability of funding to support those program activities to which this offer applies.

In the near future, we will be in touch about travel arrangements, housing accommodations, research themes, and mentors.

Please let us know by March 15th, 2021 of your decision by e-mailing {email address} and submitting your signed acceptance contract (also by email), should you choose to accept the position. In the meantime, please feel free to contact us with any questions. We believe the {name of program} is an excellent opportunity for academically talented students like you. We look forward to working with you!

Cordially,

{Signature,
Printed name,
title}

Sample Acceptance of {name of REU} Internship Position

Submission deadline: March 15, 2021

With this, I accept the position as REU intern as offered to me in the included letter. I reviewed the position description and accept its terms. {Name of REU} will provide me with housing in {town/location} for the duration of the internship, and I will adhere to the rules associated with this housing. I understand that, upon receipt of this acceptance letter, {name of REU} will arrange and pay for (or reimburse me for) my travel to/from {location of REU}, from anywhere within the United States and Puerto Rico ("Travel Costs"). If, after sending this acceptance and once {the REU program} books {or pays for} my ticket, I decide not to participate in the program, I will reimburse {REU program} for any and all Travel Costs. [{The Name of REU program} evaluates the reason for cancellation and respects personal or family emergencies].

Sincerely,
{Signature,
Printed name,
title}

Sample Letter of Decline

February 28, 2021

Dear {Name},

I regret to inform you that you were not selected for the {name of program} Research Experiences for Undergraduates Program at the {name of institute}. The response to this summer's program was tremendous and we only had {number, e.g., 10} positions available. The selection committee deliberated extensively before coming to consensus. Many strong candidates had to be turned away simply because we can only support a limited number of students.

If you would like us to share your application with other programs that are still seeking applicants, please let me know.

Other internship opportunities to consider in future include those posted at these sites:

- » NSF Research Experiences for Undergraduates: https://www.nsf.gov/crssprgm/reu/reu_search.jsp
- » NOAA Student Opportunities: <https://www.noaa.gov/education/opportunities/student-opportunities>
- » GSA (Geological Society of American): [geosociety.org](https://www.geosociety.org) (see Education and Careers)
- » AMS (American Meteorological Society): [ametsoc.org](https://www.ametsoc.org) (see Education, jobs)

Please note that if your graduation is December of next year or later, you will be eligible again in the following summer. The application will be posted by December 1st and will be due February 10th.

Thank you for your interest in our program. I sincerely wish you the best in your educational pursuits.

Sincerely,
{Signature,
Printed name,
title}





LOGISTICS AND STUDENT HANDBOOKS

Diana Dalbotten

Gabriela Noriega

Rebecca Haacker

Running an REU is a year-round endeavor, starting with preparing marketing and application materials in the fall, selecting students and finding mentors in the winter, and preparing the logistics including travel, housing, software, and project planning, all before the program starts. In addition, it is worth cultivating new and old relationships with partners throughout the year, including working with them in recruiting students. See the [chapter on Recruiting Students for Your REU](#) for more on that. This chapter gives an overview of the logistical pieces that you should prepare for as you start planning your REU.

➔ Logistics Before the Program Starts

Paying Students

Paying your REU students requires working with your administration early and clarifying how they would like to handle payments. Get this underway even before you have selected students.

- » Generally administration will require you to either pay students with stipends or hire them as student employees.
- » Determine whether it is a “stipend” or “pay” before you do your budget. Stipends usually count as a participant support cost on your grant and are subject to different overhead rules.
- » Ideally process payroll information as soon as you have accepted your full group of students and they have accepted your offer. It takes time to get students in the system and payments processed.
- » Provide students with a check for the students on their first day of the program, as some will not have the resources to pay for travel, rent, food or other costs.
- » Your administration should confirm what paperwork you need to collect, such as a W9.
- » Clarify if students need to register as students at your institution.
- » If students are paid with stipends, you can control the frequency of payments. It works well if you give students one check when they arrive, one mid-summer, and one at the end of the summer when they complete their work, or more frequently than that.



Health Insurance

Insurance requirements may vary at each institution. Ensure you communicate with students the expected requirements so that they have time to gather documentation or acquire the appropriate insurance if they don't have it.

- » Clarify with your institution what kind of insurance students are required to carry.
- » Most programs can't provide health insurance but expect students to be insured. Some students can't afford it.
- » Clarify how Workers Comp works and other liability insurance issues you might need to know about on your campus.

- » Some institutions will require that you register program participants with the on campus health center/provider to ensure that your participants are eligible to receive acute medical care while they are on campus. This may result in health fees at the end of the program.
- » Some institutions may require that you gather information from students (e.g., vaccination records, proof of insurance). Students will need ample notification to be able to gather and provide documentation.
- » If a student does not have health insurance, but your institution requires it from all participants, students might consider purchasing temporary health insurance.

Agreements and Forms

Prior to the start of each program, you should review and update all of the necessary agreements if needed. Your institution or funding agency may have changed requirements or guidelines. Ensure you update your program's contracts and agreements to reflect any changes.

When students accept your offer, consider a contract that outlines your expectations for the program, the code of conduct and deliverables (paper, poster, talk), and issues such as working on teams, hours they are expected to work. Ask students to sign this and send it back to you.

Other forms to have students sign are listed in the [chapter on Safety](#), and include an image/media release form, a code of conduct agreement, a liability form, and a medical and emergency contact form.

Travel Arrangements



Today some programs will have travel and others will be fully remote. If there is travel to your program, prepare a process in advance to save yourself a lot of extra work.

- » Timing: Get the student travel information as soon as all students are accepted. This would include their departure airport, date of birth, gender and name as officially spelled out on their official ID.
- » Be sensitive to special needs when arranging travel.
- » Be aware students may be traveling with little or no money.
- » Driving or flying: students may have a preference to drive. Let them know if and how much mileage they can charge.
- » Spell out what expenses you will and will not cover. These might include baggage, missed flights, changes to flights.
- » Get students to approve the itinerary before you buy a flight, or have them plan travel and seek reimbursement from you with receipts.
- » Arrange transport or provide information on shuttles from the airport.
- » Note that travel insurance may not be covered by the funding agency.

Housing Arrangements

If your students travel to your institution, you will likely coordinate their housing arrangements. Be aware of cost differences between housing provided by your institution or a private managing company.



- » Housing often needs to be arranged in the early spring at most campuses, possibly before you accept students, as many dorms can fill up over the summer.
- » Students will want information about their dormitory--what it's like, what will be provided, will they have roommates, etc. Do your dorms have food or will students need to buy groceries and cook (will there be a microwave or stove)? This might mean you give them an extra stipend instead of paying for dorm food or a meal plan. They often want to know whether to bring bedding with them.
- » What accommodations will you need to make for parents, non-traditional students, gender non-binary students--think about these issues early.
- » Some students may decide to arrange their own lodging. They may be local or have local relatives with whom they decide to lodge. Decide what kind of funding to provide students who opt out of dorms.
- » Consider using a short survey to match roommates based on preferences of quiet hours/ study time, level of social interactions/visitors to the apartment, and other factors.

Program Calendar

A program calendar should be one of the first planning tools you create. It will help organize your program's activities and help identify any scheduling conflicts/gaps in advance.



- » A calendar with major events, start and end dates, meetings, etc., should be started before students arrive. Mentors and students will want to know asap what the overall schedule for the summer looks like.
- » A shared Google calendar or something similar is flexible and easy to share.
- » A program calendar is also a good tool to document all of the program activities and will be useful when you work on reports and presentations about your program. Ensure you update it frequently throughout the program.

➔ Preparation for Being on Campus

Safety Issues

- » Provide written information about local/campus police and health care as well as local hospitals to the students.
- » Students should fill out a form that shows their insurance information, emergency contact, and any known medical issues.
- » See the [chapter on Safety](#) for more comprehensive information.

What to Bring

Students will be eager to plan their travel to your site. If you provide them with detailed information, their eagerness will not turn into stress.

- » In general, students need to know what to bring for your location. This includes clothing appropriate to the weather in the local area. Let them know dress code expectations; in particular, any business attire for professional presentations such as their poster session.
- » Students also need to know what specifically they will need for working with their science mentor. Special closed-toed shoes for the lab, hats, insect spray, sunscreen, etc. The science mentor could provide this info.

- » Make sure you don't require purchasing any new equipment or specialty clothing or offer to reimburse students from your grant.
- » Clarify if you expect students to bring a laptop and have a plan for students who don't have one.



Local Transportation

In the event that students will be on campus and have a car, they will need to be able to get from town or to town.

- » If students bring a car, will they need a parking permit? On some campuses parking is expensive.
- » Students need to be able to get around. Is there adequate public transit? If not, will they be isolated?
- » Does your campus or town have a bike loaner program?

Travel After the REU to Conferences

- » Work with students to submit abstracts on time and to apply for conference student travel awards.
- » Clarify early with students what travel costs you can cover.
- » Check if you can arrange travel such that students don't need to be reimbursed, as many students don't have enough credit to wait for reimbursement.

➔ Handbooks for the Students

Consider collecting basic information in a handbook for students to have before the summer starts. Among other things, include:

- » Start and end dates
- » Program staff contact info
- » Maps of campus, local area
- » Information about transit
- » Tourist info: restaurants, sites to see, things to do
- » Safety contacts: police, campus offices, health, online safety, etc.



Resources

USC Wrigley Institute for Environmental Studies Research Experiences for Undergraduates (REU): Coastal Ocean Processes. [2018 Program Handbook For Mentors and REUs.](#)

Louisiana Universities Marine Consortium (LUMCON) [REU Program Handbook.](#)

NCAR - Wyoming [Summer Program 2020 Student Handbook](#)





MENTORING IN AN REU

*Barbara C. Bruno
Rebecca Haacker
Valerie Sloan
Melissa Burt*

REU internship managers know that mentors are like gold, for without them, there would be no program. It is useful to plan a mentoring and project structure that will provide support for students from different places, for example, a research mentor, writing mentor, computing mentor, peer mentor, and/or grad student mentor. Peer mentoring can involve having students work together in pairs or teams. This chapter provides guidance for preparing your mentors and helping them see what kinds of hurdles students may have been or are now facing in their lives, and mentoring them on their project, helping them to network, and guiding them on research and career plans.

➔ What is a mentor?

In REU programs, research advisors have an essential role as mentors to undergraduate students in what is often their first research experience. One of the key factors that REU students cite as impacting the quality and success of their summer is their relationship with their science advisor or mentor. If a student's mentor both supports and challenges their student, a tremendous amount of growth in confidence, skills, and learning can take place.

Mentoring goes beyond research advising and includes personal as well as professional development. Holistic mentoring that addresses a range of needs shores up students' abilities, resources, and resilience, resulting in greater productivity, satisfaction, and career success. Mentoring can be particularly beneficial for underrepresented students, who may lack role models and/or have less access to professional networks.

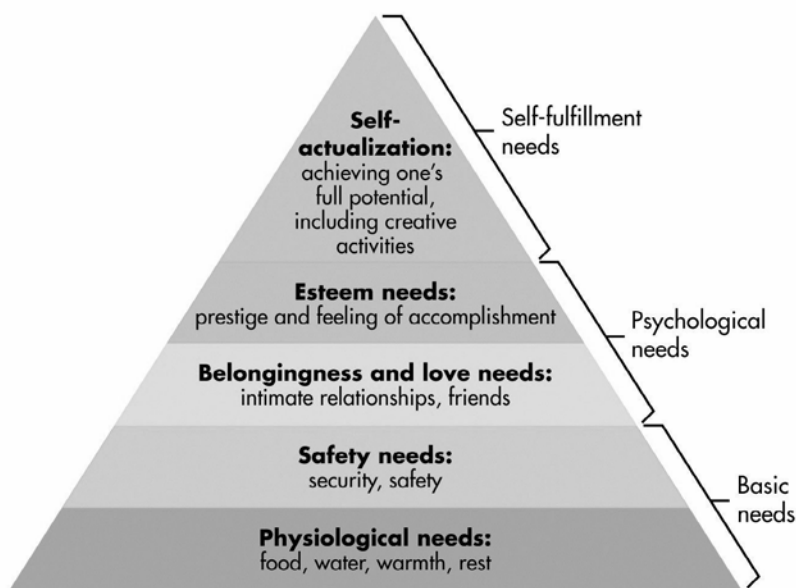


Fig. 1. Maslow's Hierarchy of Needs
(Source: Bulut et al. 2010)

Equally, the mentor benefits from being a mentor and having a mentee. Besides the obvious benefits such as attracting potential graduate students and getting additional research projects completed, mentors often report enjoying being able to teach and to provide career advice. Mentoring students from diverse backgrounds also exposes mentors to new perspectives, experiences, and ideas. It is important to articulate the benefits of mentoring to your REU mentors and to the hosting institution. According to Bulut et al. (2010), mentoring should address more than research itself but also the high levels of the Maslow's Hierarchy of Needs.

➔ Which mentoring model will you use?

Apprenticeship Model

Traditionally, REU programs have used the apprenticeship model, where one person is fully responsible for mentoring and advising a student. This is based on the assumption that the mentor has sufficient time, energy, knowledge, and skills to support the mentee.

A benefit of this approach is that the student may get excellent one-on-one mentoring from their advisor. This can help the student to engage in their research and see a way forward in science. A downside to this approach is that it can place a heavy burden on the mentor, and the student may not realize that others can support them in their work.

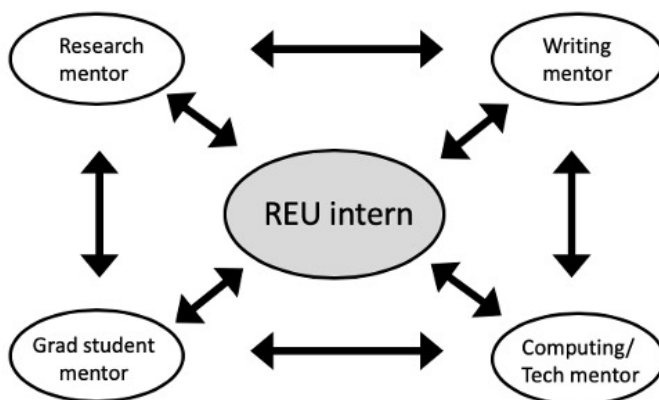


Multiple Mentor Model

More recently the multiple-mentor model has gained popularity. In this design, each student has several mentors, each of whom is responsible for a different area of the intern's professional development. These may include a research mentor or mentoring pair, a writing mentor, and a computer or technical mentor. In some cases, the mentoring team includes a graduate student or postdoc who is involved in the research.

A benefit is that this structure provides the student with a broad sense of support and multiple paths for getting technical assistance and professional guidance, as well as making meaningful personal

connections. It lightens the burden on the research mentor, and it provides a mechanism for teaching grad students and postdocs how to mentor a researcher. This setup requires a clear plan for communication so that the intern doesn't receive contradicting guidance on their project.



Research Pairs or Teams

Another approach involves having two or more REU students work on the same research project under the supervision of one or two research advisors. A team can be composed of a mosaic of students with different skill sets, which allows them to teach and learn from each other. In some REU programs, the teams themselves have different and interrelated roles as part of a larger project. The teams iterate with other teams to accomplish an overall goal.

Peer collaboration can be highly effective in improving learning outcomes and persistence, decreasing failure rates, and closing the achievement gap amongst undergraduates. Students learn the skills of collaboration, communication, and project management, all of which are helpful in jobs or graduate school. Frequent and clear communication facilitated by team mentors or program directors can help with challenges sometimes associated with group projects such as ensuring that all parties pull their weight and dealing with personality differences.

Small teams solving big problems



We have one overall project looking at earthquake hazards, with four distinctly different teams that each have a specific responsibility. One team creates a library of earthquake data, a second team identifies the probabilities of those earthquakes, a third team produces visual plots of the earthquake hazards, and the fourth team interprets that data to identify the risk involved. Each team is made up of four or five students with varied skills so that there are many strengths and opportunities for learning. Communication within and between groups is extremely important, and requires facilitation and guidance until the students take on those responsibilities themselves. We have one research mentor and one graduate student guiding each team, and an overall project director who facilitates the project coordination. This structure gives students the chance to learn soft skills needed in the workplace such as working collaboratively, communicating clearly, problem-solving, and being respectful and kind to other team members.

- Gabriela Noriega, Use-IT REU Director, Southern California Earthquake Center

Mentor Mapping Activity

Regardless of which mentoring model you design, it is essential to support students in developing a strong support network, including a peer network. Point out to research mentors that they do not have to be everything to their mentees. A good way to start is by having students map out their support network.

Activity Instructions:

Guide students through a “mentor mapping” exercise to identify mentors and learn how to build their network.

1. Introduce mentoring, and question the myth of the single mentor.
2. Provide the handout of the Support Network Map. Briefly describe the roles that different people play in our professional and personal lives. If you aren't sure about the role of a type of mentor, read the more detailed version provided by the Earth Science Women's Network.
3. Ask the students to write names in the empty spots. Give them at least 10 minutes to do this.
4. Facilitate a discussion and find out what people notice about their results. Are there gaps? Does one person serve in what might be too many roles? Ask how they might seek out mentors to fill in those gaps?

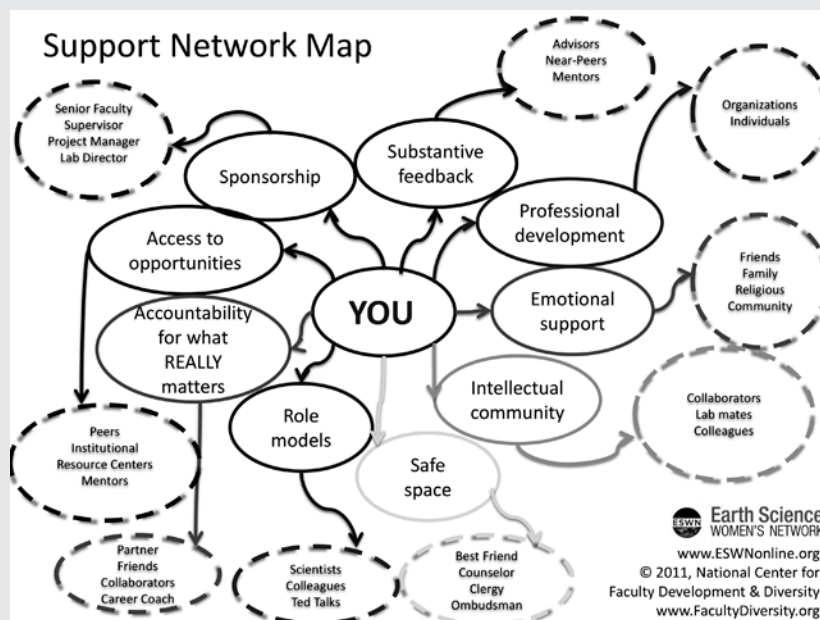


Fig. 2. A support network or mentor map from the Earth Science Women's Network at: <https://eswnonline.org/mentor-mapping/>.

For slides that contain the instructional steps and the mentor maps, go to: <https://eswnonline.org/mentor-mapping/>.

➔ Finding and Preparing Research Mentors

Seeking Mentors

A few months before the start of the program, REU PIs need to recruit mentors. Send out notices seeking mentors, and talk to colleagues. Please see an example of a "Call for Mentors" in this chapter's Appendix.

If it is possible, vet your mentor applicants to ensure respectful and safe treatment of the students. Ask informally about their past mentoring experiences. One can also say in the "Call for Mentors" that you send out that prospective mentors' names will be vetted by HR for any concerns. Supply HR with a list of potential mentors, and if there are any names that HR has concerns about, they would remove them from the list. This approach wouldn't work for mentors that come from outside of your organization.

In talking with prospective mentors, cover these topics:

- » Describe the goals of your program (see your proposal)
- » Outline the timeline and deliverables expected
- » Describe the type of mentoring and effort expected, and time involved
- » Explain that career or professional development activities are an essential part of the program
- » Describe any training on inclusive practices and implicit bias planned for the mentors
- » Articulate your own role in supporting the student and mentor, including regular check-ins

How can I prepare mentors in advance of the program?

Implicit Bias Education

Provide a seminar on implicit bias, employing the help of a campus office of diversity, equity, and inclusion or a contracted workshop facilitator if needed. It's a valuable investment for the summer and for those involved in selecting students - this year or next. This will help mentors to be more supportive and understanding of circumstances that they may not understand or appreciate and of the inherent biases and barriers built in to students' backgrounds and assessment.

Anti-harassment Education & Expectations

Schedule a speaker or session on anti-harassment and anti-discrimination with the help of your HR department or using resources provided in this handbook. Set expectations clearly in your

program. See the [chapter on Sexual Harassment Prevention](#) for more guidance on this and a template for a workshop.

Mentor Orientation

Hold a meeting for mentors before the program to welcome them and make things run more smoothly.

- » Thank them! Remind them of the benefits of mentoring
- » Review the REU program goals and mentoring goals
- » Provide program information including student deliverables, calendar of events, due dates, and logistics, as detailed below
- » If it's a returning group of mentors, invite discussion about last year

Share tips with your mentors

- » Review resources on inclusive practices and implicit biases
- » Treat your mentee with respect and sensitivity
- » Avoid making assumptions about your mentee
- » Invest time to get to know your mentee as a person (not just as a student) and to show that you care. This will build trust.
- » Set clear expectations from the outset – e.g., about communication and professional behavior – and model these expectations through your own behavior
- » Read these essential handouts: "[Tips for Online Mentors and Program Directors](#)," and "[Tips for Science Mentors](#)"

Review the traits of a good mentor

- » Provide effective feedback
- » Use active questioning to lead a mentee toward a solution
- » Foster independence/self-direction
- » Foster confidence
- » Build a scientific community within the research group
- » Build a social community within the research group
- » Convey respect
- » Communicate effectively
- » Appreciate individual differences
- » Expand professional network
- » Celebrate success

Source: Adapted from *Lee et al. 2007*.

Prepare mentors to watch for students under stress

Several [factors can cause stress](#) for research interns, such as:

- » Separation from family and the regular support system, or living with family
- » New freedom to make decisions
- » Competition with peers
- » Peer pressure (to party, etc.)
- » Choosing a career, uncertainty of the future
- » Ongoing current events such as police violence against Black and Brown people



Students may show signs of distress in different ways:

- » Challenges concentrating
- » Irritability
- » Frequently missed deadlines
- » Poor hygiene
- » Noticeable depression or restlessness
- » Excessive indecisiveness or mood swings
- » Direct comments about distress or personal problems
- » Expressions of concern by peers
- » Implied or direct threats of harm to self/others
- » Repeatedly arriving late to work
- » Obvious change in mental state and/or apparent intoxication
- » Behavior that doesn't match the context/setting



Supporting students in a virtual environment is more complicated because it is harder to know what challenges they are facing. This [Stanford University](#) [handout](#) provides good information on the challenges that students are facing today, how to show that we care, and how to respond. More [detailed information](#) [is available here](#).

Checklist of Necessary Information for Mentors

- » A list of the student's deliverables and deadlines (e.g., a proposal, talk, poster, report, blog, paper)
- » A calendar/list of important dates such as workshops, poster sessions, poster/talk deadlines, and abstract submission deadlines ([see calendar example here](#)):
- » Student start/end dates
- » Orientation and cohort-building activities
- » Workshops or seminar titles (e.g., on résumé-writing or graduate school)
- » Mid-program meetings with mentor, student, and REU lead
- » Presentation dates for a final poster session or colloquium

Details of Logistics and Expectations

- » Work with the mentor(s) to identify what the student needs in their workplace (desk, computer, phone, software), whether on campus or working remotely
- » Identify the hardware and software that are needed in advance
- » Be clear of what is expected of the student in terms of work hours (e.g., 40 hours per week), and ask mentors to consider what kind of flexibility they are comfortable with on timing and location of work
- » Ask mentors to discuss how and when to communicate with their interns. Using a form such as the [Mentoring Communication Plan](#) can make conversations much easier as this helps to establish expectations for both parties.

Provide guidance on mentoring

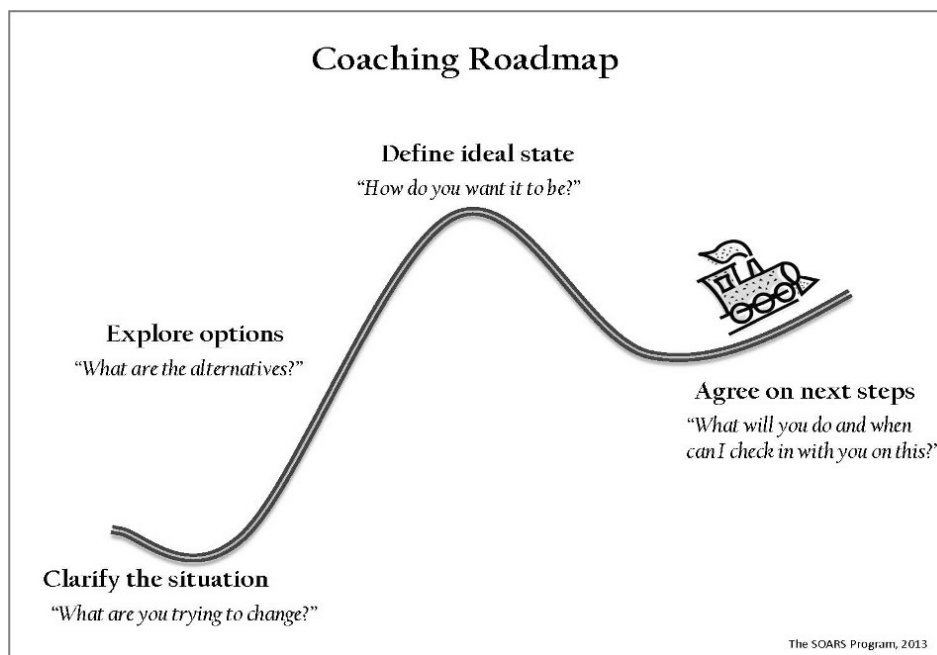
- » Plan to regularly engage with and support your mentors throughout the program
- » Hold a weekly check-in via Zoom or in person or a lunch-chat with mentors to keep everyone on the same page and to provide peer support
- » Send a brief weekly/biweekly email updating mentors on programmatic events and include a few photos if possible
- » Meet with each mentor and their student 3-4 weeks into the program and ask the student to present an update at a white board without PPT slides. This can be very helpful for seeing if things are on track and to assess student understanding of the project. Work with the mentor to do this, or do it on your own.
- » Check in with each mentor individually a few times during the REU program
- » Consider giving a mid-program/end-of-program survey to gather feedback on mentors, compile the feedback, and share with mentors

How can I help a mentor deal with a difficult situation?

Program directors need to have an established plan for mentors regarding when and whom to contact when difficult situations are too complex to handle on their own. Define upfront when you will need to be informed. For all other situations, encourage and support mentors to coach students through challenges. The Coaching Roadmap (SOARS, 2013) provides a simple model for a conversation mentors can have with their students.

After the REU program, meet with your mentors to debrief.

- » Meet with each mentor (or mentoring team) individually. Ask them to share their experiences with their mentee (both successes and challenges). A written mentor reflection could facilitate this process.
- » Bring the mentors together for a post-program celebration if possible. Share evaluation results, if appropriate, and brainstorm on ways to improve the program in future years.
- » Review the good qualities of a mentor and have them reflect upon their own mentoring. If possible, share mentoring successes in a debriefing meeting.



 **Resources**

Center for the Improvement of Mentored Experiences in Research (CIMER). Publications and online resources on research mentoring relationships. <https://cimerproject.org/>

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 Appendix**A Call for Mentors Sample Letter**

Here is an example template of a letter that could be sent out as a call to potential research mentors for your REU program. This is an edited version of a letter that was kindly shared by the Smithsonian Institute National Museum of Natural History (NMNH) REU site.

February 23, 2021

Dear Colleagues,

We are now seeking projects and mentors for our NSF REU Site *[name of program]*.

In our program, we match you up with an excellent intern *[OR a pair of excellent interns OR work with you on developing a team project]* to work on a research project. We handle ALL the paperwork, we pay the intern's housing and stipend, and we pay associated lab and meeting costs!

This email asks you to identify yourself as a potential mentor. Please email us today! We will be making our placements in the coming weeks.

NSF Research Experiences for Undergraduates *[name of REU]* is a 10-week paid science research internship for undergraduates. **It will run from *[start date]* to *[end date, year]*.** Information about the program can be found here: *[website]*.

The intern[s] will work on research full time Monday-Thursday. They will engage in REU programming (professional development, science communication training, diversity and anti-harassment training, networking, field trips) all day on Fridays.

Members of our research staff should submit projects that can be accomplished by an undergraduate in this 10-week time frame. The project proposal should identify a hypothesis-driven research question *[or how you will engage the student in shaping the research question]* and outline how the student will engage in the research.

Submissions from postdocs are welcome with a co-mentor who is a permanent staff member. **NOTE:** Included in the vetting process for mentors is a review of potential mentors by *[our HR Liaison]*. Should any names be put forth that he/she has concerns about, he/she would remove them from the list.

Sincerely,

[Your name, contact information]





TEAM BUILDING AND COHORT DEVELOPMENT

Gabriela Noriega

Timothy Barnes

Diana Dalbotten

Daphne LaDue

An important component to managing a research program is managing/coordinating relationships. Part of your program management plan should include strategies that will help students build strong relationships with their research mentors and their peers. Plan to incorporate team building activities early on and throughout your program. Getting students to feel comfortable in their new relationships with peers can make the summer go much more smoothly and be more enjoyable for all involved.

➔ Why do team building?

Team building activities help to build a strong cohort that will help build a stronger and resilient program. A tight cohort will be supportive among its members. Team building can also lead to more engaged students and therefore result in more effective outcomes and more meaningful research experience.

When students connect with each other at the start of the summer, they feel more comfortable, can learn better, and be more productive. A strong cohort can also provide support to help students deal with challenges in their research or other aspects of the REU. Having a tight cohort can mean a much easier load for the program manager or PI, because the students feel more included, happier, and as a result are more productive.

The following are some activities that help students to connect with each other more quickly and help them to prepare for the internship.



➔ Pre-program Cohort Building

Pre-program activities help students “break the ice” and can help decrease the stress that comes with starting a new program and meeting new people.

Personal Introductions

When first introducing the cohort to each other, consider using the What/Who format (*Knowles*, 1975). What is the typical stuff of introductions: I am a <year> <major> student at <college/university>. I am from <city/state/territory>. What is something unique about yourself that you would like others to know about you. This could include hobbies or any other defining characteristic.

REU director Daphne LaDue has been using this since first hearing about it at a class on Adult Learners. She reports, “It’s amazing the connections that happen early on. This activity spurs connections on social media and early formation of plans to do various shared activities over the summer.”

Question of the Week

This activity helps to build connections between students regardless of whether your program will be running on site or remotely. REU managers rated this activity highly.

1. Get students on to an app like Slack or GroupMe at least one month beforehand
2. Ask a question every Sunday to the group
3. Start with impersonal questions initially, as they are just getting to know each other
4. Examples include:
 - What is your favorite kind of food?
 - Post a photo from outdoors near where you live.
 - What is your favorite time of day?
 - What is your school doing in terms of teaching online vs in person?

One REU manager, Frank Marsik, wrote: “I really believe that using SLACK to build community during the weeks leading up to our program start helped. When we gathered on Tuesday, it certainly seemed like old friends getting together, rather than meeting people for the first time.”

Small Zoom Meetings

Meeting one-on-one or in small groups ahead of the program can be highly effective for building trust and connection early on. Some configurations could look like this:

- » Meet each student alone for 30 - 45 minutes to hear their concerns and get to know them and their circumstances.
- » Meet with three or four students for an hour to introduce yourselves to each other and learn about their passions. Send out a Doodle Poll with times, and then email the students who can attend certain times. This can be done on short notice, e.g., one day.



- » If time allows, have a full group meeting before the program starts. Use this opportunity to practice on Zoom together, review etiquette for online meetings (mute the mic, no eating, avoid sitting in front of a window), and get a feel for what the first day will be like.

Compile Biographies

Develop a document to help get to know each other before the REU begins, and to distribute to guest speakers and mentors. This is a good asynchronous first “team building” activity.

1. Give students a template of how to write a mini-autobiography, as well as a few examples.
2. Ask them to submit it before the first introductory meeting, which is facilitated online in advance, even for on-site programs.
3. Ask for a photo of them.
4. Bring everyone’s bios together and distribute the package.

Topics might include:

- » Name, location, home institution, field of study, and interest
- » What is your passion in relation to this field (e.g., marine mammal behavior, diving)
- » How you spend your spare time (e.g., any volunteering activities, work, interests)

Ice-breaker/Team-building Activities

There are many easy and fun ice-breaker activities that take no preparation but do a great job of helping students to connect and feel more comfortable in the group. See some examples below:

- » [The Sort and Mingle Game](#)
- » [Finding-Favorites Team-builder Activity](#)



Two Truths and a Wish

Have each participant think of two truths and a wish about themselves. Have them take turns presenting these and having the others guess which one is a lie. The person who guesses it correctly gets to go next or gets to pick the next person.

- » I can prepare sushi
- » I am the first person in my family to go to college
- » I am a DJ

This game allows people to get to know each other while having fun. Have the students prepare statements in advance if you can. “This is a particularly good one for getting folks talking.” - Joanna York, REU manager.

➔ Program Cohort Building

Team building activities throughout the program can be strategically implemented for different reasons. Some are appropriate to continue to foster strong cohort relationships. However, you should consider implementing skill-building activities that will both grow relationships and teach students new skills (e.g., project planning or map making activities).

Pushpin Map - Where in the World activity

This activity uses Zoom's annotate functions but could be hosted in Poll Everywhere or other interactive platforms. Ask students to place a "pushpin" on a map slide in screen share mode. On Zoom this can be done with a "stamp" (part of their annotate toolbox). Ask students to respond to a couple of questions:

- » Where were they born?
- » Where are they from?
- » Where would you like to go?

This activity will allow students to practice using Zoom, and they will need some clear directions.

Note: Zoom on some tablets does not offer the stamp-annotate function, but you could augment with other annotate tools.

Small Group Discussions

Create opportunities for students to meet in small groups for discussions. Discussion topics can range from informal or pop culture topics, to current events, or even to solve small challenges that you set for each group. The following is a short list of discussion topics, but the possibilities are endless.

- » What Netflix shows have you binge-watched during COVID-19?
- » Guesses on when the first named hurricane in the North Atlantic Ocean will be this year. Note their responses so we can see who is closest later.
- » Discuss where their first trip will be when they can travel again.



Goal-setting Activity

This tool of the Wheel of Life® is commonly used by professional life coaches to help an individual consider each area of their life in turn and assess what's off balance. Before the summer starts, ask each student to take a "helicopter view" of their life, so that they can work on bringing things into balance. Students work on this individually, and then pair up to discuss their Wheel of Life with another student.

- » [Wheel of Life Activity Explanation](#)
- » [Wheel of Life Worksheet](#)

Preparing for Mentoring Activity

This sheet briefly describes the mentoring relationship, and outlines some basic qualities of effective mentors and interns. It includes activities for small group discussions that bring out hopes, concerns, and plans for effectively communicating with their mentors.

- » [Preparing for your Mentoring Relationship](#)

Research Sharing



Undergraduate students are typically still learning a lot about the sciences in our programs and exploring directions for their futures. While many students will naturally share bits about their research during off-hours, not all students benefit equally from this. And for programs that are entirely online, like many in the summer of 2020, this may not happen much at all. Encourage a

weekly research sharing activity where students show a figure from a paper they are reading, a fragment of code, or a plot they created.

“This activity was actually suggested by my 2020 cohort,” reports REU director Daphne LaDue. “The virtual nature of our program that year made it far more difficult for students to learn about each others’ research except during practice presentations when everyone was nervous. They felt this would have benefitted them in many ways beyond just learning about science. They suggested it would be personally motivating (e.g., to accomplish more) and result in making connections that would help with both understanding topics and with coding.”

Esri GIS Story Mapping and Fun Share

This activity emphasizes place and culture, while using Esri GIS Story Mapping to provide training in creating story maps. Using Esri Story Maps, ask students to “map their place” and share back with their group regularly (during weekly group meetings). Encourage participants to show a photo, a video, or their story map in progress.

You can provide participants with GoPro cameras or GPS units to make this activity more interactive. However, you don’t need to do this if the costs are not within your budget. If you decide to provide equipment, make sure you order these in advance. Participants might share things they like to do (making a carved mask, a beaded graduation hat!), things about their culture, weekend excursions, pictures of their families, their pets (and videos from their pets wearing go-pros!).

Building Deeper Connections

Don't shy away from this very effective activity! It facilitates deeper connections between pairs of students. Students sometimes report this as being the most profound part of their experience.

» [Meaningful Conversations Activity](#)

Encouraging Social Events

When cohorts are in person, encourage them to consider doing one thing each week as a whole group. Build expectations that while they may not all become the best of friends, they are an important support for each other. Give them ideas.

- » For in-person programs, one pair of students could host a potluck dinner each week such as spaghetti.
- » For online programs, they could play online games like Skibble.io (like Pictionary), host a cook-together evening, or play games like JackBox on Steam.
- » Have “lunch time” on Zoom when everyone can hang out and eat together if they like. Choose a time that works for all of the time zones!

➔ Handbooks for the Students

Post-program activities help keep students engaged once the program ends. While post-program engagement is valuable to both the students and the program’s ongoing impact, it is often challenging for program managers to put into practice because of other demands. A good post-program plan will help make this component manageable.

Alumni Notifications

Create an alumni email list that you send notifications about ongoing opportunities, news about others in their cohorts (such as graduation), or to check in just for fun. Create a schedule that allows you to plan the topics you want to share with students.

Year-round Career Talks

Schedule regular (e.g., quarterly) informal meetings where you invite professionals from diverse professional backgrounds to share about their career experiences. Guest speakers can be academic, industry professionals, or even former interns! Themes can revolve around career pathways, including the grad school application cycle. This activity provides career information and networking opportunities for students that they often lack in regular university courses.

REU Family Time



Host a monthly or quarterly Zoom meeting and invite all alumni to attend. Providing support over the long term is highly valued by these young scientists particularly during a pandemic. This community-building also helps with building a professional network amongst the alumni, which leads to sharing of scholarship and job opportunities, providing feedback to each other on application materials, and giving inspiration and encouragement.



Further Reading

Knowles, M., 1975: *Self-Directed Learning: A Guide for Learners and Teachers*. Globe Fearon, 135 pp.



DEVELOPING AN ANTI-RACIST REU PROGRAM

Rebecca Haacker

Vernon Morris

Valerie Sloan

Lisa White

There are well-documented waves of racial violence in American history that have compounded police violence and seem to have a 20-30 year cycle. The increase in video recording, social sharing, and broadcasting of imagery of police violence in recent years has raised awareness of this racial violence. Police brutality against Black and Brown men and women is leading to calls for active anti-racist action versus passive support of diversity and equity. Bias and inequity are embedded in our history and our laws, and also in STEM and academic activities. In the context of an REU, this includes the selection processes of students, how leaders respond to racist remarks, the isolation of students of color in REU programs, and the low numbers of Black and Brown participants in many programs. This chapter provides insight into these issues and some recommendations of how to intentionally create an anti-racist REU program.

➔ Background: Racial Harassment and Discrimination

Racism in the U.S. has a dark past, starting with the colonial genocide of over 100 million Indigenous people and centuries of slavery and related killing. This systemic violence against people of color, such as police brutality, continues unabated today. Discriminatory policies are embedded in our laws and continue to maintain inequities in wealth, education, healthcare, and more.

In response to the State-sanctioned murders and violence against Black and Brown people, scientists in the geoscience community developed "[A Call to Action for an Anti-Racist Science Community from Geoscientists of Color: Listen, Act, Lead.](#)" Below is a quotation from this call.

"The inhumanity of racism in this country has yet again been made unavoidably clear through the racist cruelty of our law enforcement officers, the atrocities of COVID-19 health disparities, and the malfeasance of leadership across all levels, from local officials to the executive branch. For many Black scientists, these experiences form a rite of passage and a common bond. We share these traumas with our Latinx and Indigenous brothers and sisters and have for as long as this country has existed, and before. We cannot watch mutely, nor look away."

In 2020, racism in the U.S. has been brought to the forefront of the public's attention by police brutality against Black people, and the civil rights movement and protest, along with health disparities in the COVID-19 pandemic. The STEM community is recognizing that staying silent about racism in the sciences and in the community would be the same as implied consent. Institutions are taking action, such as dropping GRE requirements for graduate program admissions and establishing diversity, equity and inclusion committees, and action plans. The REU community must take an active stance ensuring its programs are inclusive, equitable, and proactively anti-racist.



Excerpt from

[A Call to Action for an Anti-Racist Science Community from Geoscientists of Color: Listen, Act, Lead](#)

“We [...] need to root out the racism in our own institutions. This is particularly necessary within the scientific community, where the impact of racism has limited the representation of Black, Brown, and Indigenous people across all sectors of the scientific enterprise.

We recognize that the racism that plagues the criminal justice system and society at large also afflicts the scientific community. Over-policing, stereotyping, inhumane treatment, disregard of humanity, and silencing is epidemic in all scientific fields. Black people struggle to break through the barriers placed in their paths to get to and through college. Black faculty are subject to biased reviews of job applications, grant proposals, and promotion packages, as well as the refusal to mentor them in an appropriate capacity. Black Lives Matter at home, at school, in the community, and at the workplace.

It is not enough for scientists to simply say that we believe in equality, equity, full inclusion, participation, and voices of all people in the scientific community. We must take action in a meaningful way to ensure these goals are met, and demand our collaborators and stakeholders do so as well.”

From: [A Call to Action for an Anti-Racist Science Community from Geoscientists of Color: Listen, Act, Lead](#)



➔ Training and Setting Expectations

As program director or manager, it is your responsibility to create a safe, kind, and respectful environment for students, mentors, and staff. As you plan your REU, contact your institution’s diversity offices for training and support and put a plan in place that is appropriate for your program.

As REU managers, we can’t simply hope for the best and assume that everything will work out. Proactive intervention is the best approach to preventing harassment. PI’s must take a leading role in the process.

Educate Yourself and Your Team

- » Become knowledgeable about federal and state laws regulating racial discrimination.
- » Read and study about the history of racism in this country; see a list of books and resources below.
- » Ensure you and your team have received diversity, equity, and inclusion training, as well as bystander intervention training.

Language to Use

There is ongoing discussion of what language to use describing students from groups that are typically noted as underrepresented. As one Black colleague said, "We are not a minority because we don't want to be there or because we are not interested. It is an action that has been taken against us systematically and regularly to exclude us from participating."

Other terms being used "include students from groups that have been":

- » Historically underrepresented
- » Racially minoritized
- » Racially marginalized

Terminology is complicated. For example, groups that have been historically excluded through slavery, internment, or more recently, redlining (refusing a loan to someone because they live in an area deemed to be poor and thus, a high financial risk), continue to be excluded due, in part, to systemic biases in selection criteria that in fact reflect an applicant's privilege.

Have Clear Rules in Place

- » Ensure that you have harassment and discrimination policies for your program clearly spelled out in your code of conduct. Be very clear that racist behavior will not be tolerated.



Training for Students

- » Prepare training for your students and get support from your institution or facilitators to have open conversations about race and privilege at the beginning of your REU.
- » Make training part of cohort building and welcome it as an opportunity to have meaningful conversations.
- » Focus on bystander intervention approaches that aim to develop participants' skills so they can disrupt inappropriate behavior.
- » Be ready to address national events with your students should they happen. Unfortunately, the nation continues to witness shootings and other violent acts of racism. Students report that having a space to safely talk about these events allows them to feel supported and enables them to be productive in their research. Be aware that this kind of conversation can be triggering and have support available in these instances. It is helpful to be able to offer support services such as counselling with a professional.

Reporting and Dealing with Complaints

- » Provide students with a route for getting support or filing a complaint in the event of a problem. Establish clear lines of communication for reporting. Appoint an ombudsperson(s) for students to contact if there is a problem. This person must be on-site & available during the entire REU session, including fieldwork. Address common fears that students face concerning reporting, including not being believed, retaliation, or of being sent home.
- » Follow up quickly on any complaint. Consequences for misconduct must be immediate and applied without exception. Practicing such a zero-tolerance policy goes a long way toward building student trust, and encouraging others to report incidents.
- » Recognize that field work puts students at particular risk and establish practices to minimize the dangers. Some challenges posed by field work are discussed in John & Khan 2018. These challenges may not be felt by everyone. For example, some racial and ethnic minorities may feel more unsafe in some rural locations that are overwhelmingly white and may have had a history of racial violence. Knowing the racialized histories of the locations that you will visit during the camp is essential. Discussing these histories openly and honestly (providing inclusive narrative geographies) conveys the type of empathy and cultural literacy that can build trust.

➔ Code of Conduct

Ensure that people have received the applicable [code of conduct](#) prior to starting the program.

- » Review the code of conduct during orientation/welcome/opening. Emphasize that people are not here to get a date but to learn, and ensure that people know where they can go to get help.
- » Ensure that staff has basic Diversity, Equity, and Inclusion (DEI) training to ensure they can facilitate a welcoming and inclusive summer. Issues that might come up include using non-binary pronouns, harassment reporting procedures, not accidentally saying racially charged things, and being ready to step in if any of the above happens between participants.
- » Get training so that you are better prepared to recognize and intervene in gender and racial dynamics. Ask your institution's Diversity Officer or Title IX Coordinator for support if in any doubt.
- » Provide multiple points of support for participants, so that they always have a place to go with concerns.

➔ Bystander Intervention Training

Provide training to staff and students on “how to do your part to protect your neighbors and co-workers when bias and harassment happen in front of you.”

The 5 Ds

1. Distract - Take an indirect approach to de-escalate the situation.
2. Delegate - Get someone to help.
3. Document - Video record or audio record, if possible.
4. Delay - Check in with the person who was harassed afterwards.
5. Direct - Be direct. First assess your safety. Be firm and clear in speaking up about the harassment.

➔ Role Models

The teaching/organizing staff that participants see over the summer should be diverse and culturally literate. If you are recruiting speakers from outside your organization to balance out



your staff/facilitators, then you may need to approach White women and people of color early in the process as they are often over-committed. Broaden the diversity of your professional network so that the pool of talent and cultural expertise available to you is enriched. Have a list of women and POC to approach in case your first invitees cannot attend. Try to achieve 50/50 gender balance and at least 30% POC in your staff and speakers.

➔ The Importance of People “Who Look Like Me”

Students sometimes comment that they were the only person of color in a group and that this feeling of isolation is oppressive. At times, students will express relief at seeing ‘other people who look like me’ in a program. Having peers who can share the experience of being different within a group can alleviate a great deal of stress for interns. Furthermore, if the student experiences racial slurs, exclusion, or other racist behaviors, they may be able to get support from their peers of color and/or speak up for each other. Having faculty and staff who are diverse and supportive and effective allies can be extremely comforting as well.

 **Resources**

[A guide to organizing Inclusive Scientific Meeting](#)

<https://500womenscientists.org/inclusive-scientific-meetings>

[Belonging resources from Mindset Scholars Network](#)

<https://mindsetscholarsnetwork.org/learning-mindsets/belonging/#>

Racism in Academia, a collection of Resources

<https://www.ucar.edu/sites/default/files/documents/related-links/2018-05/Racism%20in%20academia%20and%20the%20workplace.pdf>

[Why Color Blindness will Not End Racism.](#) - A video

https://www.youtube.com/watch?v=H4LpT9TF_ew

[How I stopped worrying and learned to love discussing race](#) - TED Talk video and transcript

http://www.illdoctrine.com/2011/11/my_tedx_talk_how_i_stopped_wor.htm

Elements of Effective Practice National Mentoring Partnership

<https://www.mentoring.org/?s=Elements+of+Effective+Practice+>

Panel Discussions

White, V. and L.D. White. 2020. "Moving Beyond Good Intentions: Creating a Diverse and Inclusive Community Through Commitment and Action." Panel hosted by the Society of Scholarly Publishing (SSP), Oct. 22nd. [Link to recording.](#)

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SEXUAL HARASSMENT PREVENTION

Barbara C. Bruno

Rebecca Haacker

Michael Hubenthal

Erika Marín-Spiotta

In recent years, reports of systemic sexual harassment in the STEM workplace have garnered national attention. Scientific societies, federal agencies, and academic institutions have responded by mandating anti-harassment training and establishing or updating codes of conduct accordingly. The [National Science Foundation \(NSF\) has stated that](#) it “will not tolerate sexual harassment, other forms of harassment, or sexual assault, within the agency, at awardee organizations, field sites or anywhere science or education is conducted.”

This chapter provides REU managers with the background and resources necessary to develop a safe and inclusive environment that is free of harassment. REU managers can't simply hope for the best and assume that everything will work out. Sexual harassment must be pro-actively prevented, not simply resolved. REU managers must take a leading role in the process.

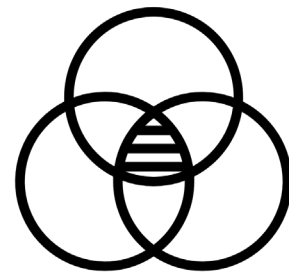
➔ Background and Rationale

Both individual testimony and research studies have shown how sexual harassment in academia negatively impacts the recruitment, retention, and advancement of women pursuing scientific, engineering, and technical careers. Sexual harassment is so prevalent that it jeopardizes progress in closing the gender gap” in STEM (NASEM, 2018).

Nationwide, almost half of undergraduates – and over 60% of undergraduate women – report personally experiencing sexual harassment (Cantor et al, 2015). While most of the existing research has focused on women, people of any gender – such as those who identify as trans or non-binary – can be severely impacted by sexual harassment.

Although this chapter focuses on sexual harassment, many of the concerns and recommendations presented also apply to other types of harassment, such as racial harassment.

It’s critically important to acknowledge intersectionality, defined as overlapping dynamics of oppression and discrimination at the intersection of one’s different identities (Crenshaw, 2017). Women of color, for example, may experience the “double jeopardy” of racial and sexual harassment. In a recent study of the planetary science and astronomy community (Clancy et al., 2017), 12% of white women reported skipping professional events due to feeling unsafe. For women of color, the figure was 18%, which is 50% higher.



Protecting REU interns is more than just a moral responsibility or a matter of being accountable to your institution. It is the law. All REU sites, whether at public or private institutions, receive federal funds, and therefore must comply with Title IX of the Education Amendments of 1972, which states that “No person in the United States shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any education program or activity receiving Federal financial assistance.”

Fig. 1 (opposite). The iceberg of sexual harassment. Like an iceberg with most of its mass below the surface, public consciousness of sexual harassment focuses on the tip of the iceberg, here labeled as sexual coercion, which is the most reported yet least common type of sexual harassment. While gender harassment receives less attention, it is the most common and least recognized and reported form of sexual harassment (NASEM, 2018).

SEXUAL COERCION

promising professional rewards in return for sexual favors

threatening professional consequences unless sexual demands are met

UNWANTED SEXUAL ATTENTION

sexual assault

rape

unwanted groping or stroking

~~~~~ PUBLIC CONSCIOUSNESS ~~~~~

**GENDER HARASSMENT**

relentless pressure for sex

unwanted sexual discussions

nude images posted at work

relentless pressure for dates

sexually humiliating acts

offensive sexual teasing

sexual insults  
e.g. "for a good time call...",  
calling someone a whore

sexist insults  
e.g. women don't belong  
in science

offensive remarks  
about bodies

obscene gestures

sabotage of women's  
equipment

vulgar name calling  
e.g. "slut," "bitch," "c\*\*t"

gender slurs  
e.g. "pu\*\*y"

insults to working mothers  
e.g. "you can't do this job with  
small kids at home"

Sexual Harassment of Women:  
Climate, Culture, and Consequences in  
Academic Sciences, Engineering, and Medicine  
<https://www.nationalacademies.org/sexualharassment>

The National Academies of SCIENCES  
ENGINEERING  
MEDICINE



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Following the National Academy of Science, Engineering and Medicine (NASEM, 2018), we define three categories of sexually harassing behavior:

1. Gender harassment (verbal and nonverbal behaviors that convey hostility, objectification, exclusion, or second-class status about members of one gender)
2. Unwanted sexual attention (verbal or physical unwelcome sexual advances, which can include assault)
3. Sexual coercion (when favorable professional or educational treatment is conditioned on sexual activity)

Sexually harassing behavior may directly target an individual and/or operate at a cultural level within an organization. Although unwanted sexual attention and coercion grab the most headlines – and certainly exist in academia – by far the most prevalent form of sexual harassment is gender harassment, which is also the least reported (see Figure 1).

### **Working Off-Site and in the Field**

Sexual harassment is particularly pervasive in “off-site” work situations outside the usual physical boundaries of a person’s home institution or campus. This is particularly relevant to the geosciences, where field camps and fieldwork are critical components of training and research. In a recent study of trainees in field experiences, 64% reported being subjected to sexual harassment, unwanted jokes or gender bias, and only ~4% were aware of the mechanism for reporting (Clancy et al, 2014).

Some factors commonly associated with fieldwork include lack of privacy, lack of control, macho culture, long days filled with physically strenuous work, and alcohol. All of these increase the likelihood of sexual harassment. In contrast, working in teams, setting clear and manageable expectations, working reasonable hours, and excluding alcohol from work activities can mitigate harassment (ADVANCEGeo, 2020; John and Kahn, 2018).

Any REU student who spends the summer at a different institution becomes more vulnerable, even if field work is not involved. Perhaps for the first time, these students are in a new environment without their trusted social safety nets. They may feel socially isolated from their peers and instructors. Furthermore, these students are unlikely to be familiar with the policies, reporting mechanisms for misconduct, or cultural norms at their new institution. It is the responsibility of REU staff to recognize and reduce vulnerability by building social support structures and developing trainings and materials that clearly communicate essential information about sexual harassment, including resources and reporting mechanisms.

## ➔ Designing a Safe and Inclusive REU Program

The work toward creating a harassment-free environment must begin well in advance of the REU program, and it is essential for the PI to take a leading, visible role in the process. Some key steps involve:

Establishing expectations for behavior within the program, and integrating your efforts with those of your institution or department. See the Resource section for examples of Codes of Conducts.

Increasing awareness of sexual harassment, and the impact it has on both individuals and organizations. People who have not personally experienced harassment may dismiss it as unlikely to occur or simply “not a big deal”.



Empowering participants with strategies to respond should they witness or experience harassment. The training should focus on gender harassment, the most common form of sexual harassment. Mentors must be trained in these techniques before the REU program begins and actively participate in the student training.

Educating participants about the reporting and investigation processes at your institution, and the support systems available, should a situation arise.

## ➔ Proactive Strategies and Solutions

The National Academy of Science, Engineering and Medicine has determined five factors that enable sexual harassment to flourish ([NASEM \(2018\)](#), [Johnson \(2019\)](#)):

1. Perceived tolerance for sexual harassment
2. Male-dominated work settings
3. Hierarchical power structure
4. Symbolic compliance with Title IX and Title VII
5. Uninformed leadership

Here, we present strategies that pro-actively tackle each of these factors.

## 1. Communicate No Tolerance for Sexual Harassment

While it's important to state that sexual harassment will not be tolerated, a statement alone is insufficient. You need to demonstrate intolerance. Within your REU program, establish clear lines of communication for reporting and designate a person(s) for students to contact if there is a problem. This person must be on-site and available during the entire REU session, including fieldwork, evening, and weekends. Follow up quickly on any complaint. Consequences for misconduct must be immediate and applied equitably.

Building student trust and encouraging students to report incidents can be promoted by:

- » Clearly defining a policy
- » Establishing procedures for reporting and investigations
- » Providing support for those victimized by harassment
- » Having dialogue with any groups that were affected by an incident



One of the most effective ways to communicate that your program or organization does not tolerate sexual harassment is to regularly publish information about the number and types of sexual harassment claims, how they are investigated, and the outcomes of those investigations (NASSEM, 2018). Such reports communicate that sexual harassment allegations are taken seriously and investigated appropriately, thereby contributing to a safe and welcoming work environment. The vast majority (80%) of the top ten geoscience institutions in the country release such detailed reports ([Douglas and Bruno, 2020](#)), although most institutions do not. If your institution does not publicly release such data, strongly encourage them to do so. At a minimum, you can share the data for your REU program.



## **2. Ensure Racially/Ethnically and Gender Diverse Work Settings**

Without proactive recruitment of diverse mentors, it is likely that your research advisors will be predominantly White men, although the ocean sciences have more women than do the Earth, polar, atmospheric, or geospace sciences. Strategies to increase gender diversity could include:

- » Seek mentors from related STEM disciplines, such as engineering, biology, chemistry, or environmental science.
- » Engage graduate students or post-docs as mentors.

## **3. Safeguard Against Power Imbalances in Hierarchical Structures**

A hierarchical power structure is one in which students and junior employees are heavily dependent on those at more senior levels. Here are some ways to safeguard against potential abuses of power that can occur in these situations:

- » Have more than one REU program leader.
- » Assign multiple mentors to each student, including peer mentors and near-peer mentors.
- » Encourage research advisors to invite REU students to their research group meetings.

## 4 & 5. Move Beyond Symbolic Compliance to Proactive Leadership

REU managers can't simply "check the box" by attending mandatory *Title IX* training. They must move beyond symbolic compliance and take a leadership role to prevent harassment. A good way to start is by educating yourself about sexual harassment and best practices for harassment prevention. Then, take a leading role in delivering the training to REU mentors and students; don't simply outsource that role to others. Such best practices include ([NASEM, 2018](#)):

- » Focus the training on gender harassment, the most prevalent form of sexual harassment.
- » Work toward changing behavior (not beliefs) using geoscience-specific case studies.
- » Focus on bystander intervention approaches that aim to develop participants' skills so they can intervene and interrupt inappropriate behavior.
- » Address common fears that students face concerning reporting, including not being believed, retaliation, or of being sent home.
- » Evaluate the training to determine whether it is effective, and use the evaluation results to improve training in future years.



**Highlight: Anti-harassment and anti-discrimination workshop  
(submitted by Michael Hubenthal, IRIS)**

Provide training on anti-harassment to staff and students prior to or early in the REU program. Either find a workshop facilitator at your institution in HR or the office of diversity, equity, and inclusion, or use the workshop curriculum developed by members of the GEO REU community, outlined here and found at the [IRIS Internship Program website](#).

**Are students in your research program vulnerable to harassment or discrimination?**

The curriculum is designed to be engaging and educational for undergraduate students who may have little formal training in the terminology and concepts surrounding such topics, are likely to be unaware of policies and procedures regarding harassment, discrimination, and fraternization, are unlikely to know how to respond if they were to witness an incident, and unlikely to know how to report incidents. Through this curriculum we seek to empower students, who might otherwise be vulnerable.

**Audience:**

Undergraduate students participating in science, technology, engineering, or math summer research opportunities, or participating in short-duration field campaigns such as geoscience field camps or workshops.

**Learning Objectives:**

Following instruction, participants will be able to:

- » Describe a work environment that
  - consists of mutual respect,
  - promotes respectful and congenial relationships, and
  - is free from all forms of harassment and discrimination
- » Summarize who is responsible for creating the work environment described above
- » Distinguish between behavior that is harassing or discriminating and non-harassing or non-discriminating
- » Describe how to report harassment or discrimination to the program, the program's investigation procedures, and possible disciplinary outcomes
- » Plan how they would use the bystander interventions to respond to incidents of discrimination or harassment, including sexual harassment
- » Apply the program's anti-harassment, anti-discrimination, and non-fraternization policy to a series of case studies

**Highlight: Anti-harassment and anti-discrimination workshop**  
(submitted by Michael Hubenthal, IRIS)  
*Continued*

**Curriculum and Materials**

- » Slides (PPT) from "Train-the-Trainer" webinar for the GEO REU community, May 2020
- » Recording of the "Train-the-Trainer" webinar (59:00 minutes)
- » [Sample slides from a virtual version of the training facilitated on June 10, 2020](#)
- » [Original full curriculum - Last Update: May, 2019](#)
- » [IRIS's Internship Program Handbook \(Version 1.4\) - Last Update: May 2019](#)

**Are you running this curriculum virtually?**

If so, check out the variations on the workshop that have been documented by REU managers for virtual implementation. These may be helpful in considering how to adapt the curriculum to fit your needs or different workshop lengths (range is 60 min to 2 hours).

- » [Modifications for virtual implementation](#) with a selection of options.
- » [Slides from "Train-the-Trainer" webinar](#) for the GEO REU community (May 21, 2020) (PPT)
- » [Recording from the "Train-the-Trainer" webinar](#) (59:00 minutes)

**Use and Feedback Encouraged!** This curriculum is intended to be a community resource. Therefore feedback, input, and the development of new supplemental modules from others are strongly encouraged! Michael Hubenthal at [hubenth@iris.edu](mailto:hubenth@iris.edu)

Also, we would love to get feedback from your students on how the virtual implementation went! To accommodate this you can point your students to this [anonymous survey](#), or [download this pdf version](#) to send to them. Responses can be tallied and returned to Michael Hubenthal ([hubenth@iris.edu](mailto:hubenth@iris.edu)). We will only be using the data for improving the curriculum.



## Resources

### [ADVANCEGeo Partnership](#)

- Harassment, bullying, and discrimination
- Codes of conduct examples
- Field-based resources
- Bystander training

American Geophysical Union. [Safe AGU](#).

Earth Science Women's Network. [Resource Center](#).

National Science Foundation. [Sexual Harassment](#).

Woods Hole Oceanographic Institute. [Harassment Resources for Students, Postdocs, and Staff](#).



## Further Reading

ADVANCE Geo (2020). In the Field. Retrieved on Aug. 1, 2020, from: [https://serc.carleton.edu/advancegeo/resources/field\\_work.html](https://serc.carleton.edu/advancegeo/resources/field_work.html).

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Crenshaw, K. W. (2017). *On intersectionality: Essential writings*. The New Press.

Douglas, M. and Bruno, B.C. (2020). Silence comes at a cost: Sexual harassment reporting in STEM. *GSA Today* 30(8), 24-25. <https://doi.org/10.1130/GSATG463GW.1>.

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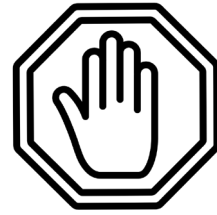
## SAFETY

*Barbara C. Bruno  
Rebecca Haacker  
Diana Dalbotten  
Valerie Sloan*

Safety doesn't just happen by itself; we have to make it happen. The key is to plan ahead and to anticipate what could go wrong. Every REU PI or site manager should be familiar with potential hazards—whether on campus, in the field, online, or at a conference—and plan accordingly.

## → Introduction

Most accidents can be prevented with proper planning and training, and most emergencies can be mitigated by having an emergency plan. Safety is an issue of teamwork and cooperation. Engaging participants in safety planning, and working toward creating a sense of team camaraderie during orientation and throughout the REU program, will go a long way toward keeping everyone safe. Actively working to create a safe and inclusive environment free of harassment and discrimination is critically important, and discussed both in this chapter as well as the [chapter on Developing an Anti-racist REU Program](#).



This chapter shares some general safety guidelines, based on the resources provided by the Geological Society of America (GSA), National Association of Geoscience Teachers (NAGT), Science Education Resource Center (SERC), and the ADVANCEGeo partnership. The common thread in these guidelines is the importance of advance planning.

Since all REUs are different and pose different safety risks, it is essential to identify and assess risks specific to your REU. A sample risk assessment is provided under “Additional Resources” below.

## → Leadership

Leadership is essential to safety. Ensure that all REU leaders and staff understand that they are role models. Leaders should adhere to all rules and guidelines, and validate their importance as guiding principles for the whole group.



REU leaders and staff should be prepared to deal with any emergency at any time, which requires they have 24/7 access to first aid kits, medical forms, communication, and transportation.

To ensure preparedness, leaders should complete relevant training, which (depending on your program) could include Basic or Wilderness First Aid, CPR, field safety and/or laboratory safety. A designated leader should be available 24/7 to respond to emergencies, and their contact information should be shared with students.

## ➔ Policies and Forms

Before the REU begins, have participants (including program leaders) complete various forms to acknowledge and agree to policies, as well as to share information. (See “Additional Resources” for sample forms). At a minimum, these forms should include:



1. Code of conduct agreement form: As part of program design, develop a code of conduct that specifies behavioral expectations for all program participants, including during times when they are not participating in program activities. Clearly articulate your alcohol policy, as a disproportionate number of incidents (including injuries and harassment) have been linked to alcohol use. If you allow alcohol in your program, restrict its use to evening socializing after all work is completed for the day. Alcohol should never be included in work functions, lunch breaks, or where minors are present. You can look to professional societies such as the Geological Society of America (GSA) for Codes of Conduct examples.
2. Medical form: Participants should provide information about health conditions, insurance, physicians, and emergency contacts. Participants with health conditions (e.g., allergies, diabetes) should describe what they will bring to care for themselves (e.g., epi pens, snacks). Medical forms must be accessible to REU leaders at all times, and be destroyed after the REU, for confidentiality. Note that some universities offer insurance plans for summer students.
3. Liability waiver: To ensure students understand the risks inherent in program participation as well as to protect trip leaders and their institutions, have all participants sign a liability waiver. Many examples are available that can be used as models, and some are joint waivers for liability and media release with liability. However, be sure that your waiver complies with the regulations of both your institution and state.

## ➔ Indoor Work Spaces

### Student Work Spaces

For on-site programs, identify and inspect student workspaces before they arrive and ensure that they comply with your institution's safety regulations. Your institution might have an ergonomics expert who can visit with participants after they have arrived to set up desks and monitors to avoid workplace injuries. If participants will work in climb towers or assemble equipment, they should receive safety briefings.

### Safe Dorms and Living Quarters

When contracting housing for your REU, ensure that the facilities are safe and up to standard. Double-check what the safety regulations of the dorms or housing are, and make sure to share them with your participants when they arrive.

### Laboratory Safety

All laboratories used in REU programs should meet or exceed institutional and governmental safety standards and have up-to-date inspection certificates. All students working in a laboratory should be trained in basic safety topics such as: appropriate usage of protective equipment and clothing; safe handling, transport, and disposal of materials; safe operation of equipment; hazard assessment; applicable government regulations and emergency responses (*Institute of Medicine*, 2009). Students should never work in laboratories unsupervised.



## ➔ Field Safety

### Field Safety Policies and Procedures

For an example of a detailed safety planning document for field excursions, see the Geological Society of America's [field safety policies and procedures](#). This document includes three sections:

- » Trip Leaders' Responsibilities
- » Participants' Responsibilities
- » Reporting Unacceptable Behavior

Using this document as an example, go ahead and create a safety planning document appropriate to your program's field excursions. Even better, make it a team exercise.

### Designating a Safety Officer

Designate one trip leader as the safety officer. They would check in regularly with students who have disclosed medical issues as well as generally monitor everyone's condition (e.g., for exhaustion, sun overexposure, dehydration). This person would also be responsible for watching the time and monitoring the weather.

### Communication

If you will be outside of normal cell phone coverage, purchase a satellite communicator (e.g., satellite phone or inReach device). Each participant and leader must have phone access, 24/7. Two-way walkie talkies can also be useful. Remember to carry extra batteries or power sources/chargers, and be sure to test all devices before going into the field each day.





### File a Travel Plan

Let someone at your home institution know who's going, where you're going, when you're expected back and how to contact you. They should have a copy of all participants' medical forms, which lists their emergency contacts. Remember to let this person know when you return safely, as well as what to do if you do not return on time.

### Preparing Students

Make sure that students and teaching assistants are aware of potential hazards, how to mitigate them, and what you would like them to do in case of an emergency. A leader may not always be around to help.

### Personal Equipment and Clothing



Your REU program may require students to provide certain types of clothing (e.g., warm jackets, rain gear that is truly waterproof, hiking boots, life jackets, water shoes, wetsuits) or equipment (e.g., camping gear, compasses, anemometers, hard hats, hammers, hand lenses). However, not all students have this gear or can afford to purchase it. Whenever possible, purchase essential items for all students to ensure everyone has access to appropriate gear, without being shamed or stigmatized. Even small items such as sunscreen or mosquito repellent should be purchased for the group. Ensuring that all students are adequately equipped before departure is a key safety precaution.

### Transportation and Drivers



First, check your institution's driver policy. While it is tempting to accept anyone who is willing to be a driver, this can be disastrous. If allowable by your institution, select drivers from your team but take the time to select drivers carefully.

Drivers should be at least 25 years old, have a clean driving license, and have taken a course in defensive driving or driving high occupancy vehicles. (GSA Field Safety Policy). Drivers should never use personal



vehicles or be expected to provide their own insurance. They should always follow speed limits and other posted signs, and all participants should wear seat belts. Consider developing a Driver Agreement Form, along the lines of a code of conduct.

### Head Counts

Have you ever returned from a field trip and later learned that someone was left behind? It has happened! This can easily be avoided by taking a head count at the beginning and end of your trip and at every stop in between. If multiple vehicles are used, participants should remain in the same vehicle for the full day, to facilitate keeping track of everyone. When outside of vehicles, use the buddy system; no one should ever be working alone. Working in groups of at least three is even better: if someone is injured, one person can stay with them while the other gets help.



### Common Sense Safety & Security

Certain safety practices we might think of as “common sense” include having a companion when walking at night, taking rides from others, or keeping one’s belongings in sight. It is still important to mention these practices to students. Don’t assume that your students are knowledgeable about – or comfortable with – walking around big cities, using public transportation, or working by the ocean or in remote areas.



## ➔ Dealing with Emergencies

Be prepared rather than caught by surprise, and things will go more smoothly if an emergency occurs. Here are some strategies to help.

### Emergency Gear



If your REU involves a field component (even if only a short excursion), it’s important to be prepared for all eventualities by carrying [The Ten Essentials](#): navigation, headlamp (with extra batteries), sun/rain protection, first aid, knife, lighter/matches, space blanket, extra food,

extra water, and extra clothes. Such preparation will both mitigate the need for rescue, as well as ensure that participants can survive until emergency personnel arrive. It is also wise to carry a whistle and something brightly colored, in case a rescue is needed. For work on water, ensure adequate access to flotation devices such as safety throw rings.

### First Aid Kits



First aid kits should fit the situation, be numerous, be visible, and be readily available to all participants at all times. A first aid kit should be taken on all field excursions, regardless of duration. Directions to the nearest urgent care facilities and emergency rooms should be printed and put inside the kit.

### Emergency Response

In the event of an emergency, first assess whether the danger has passed. For example, if a rockfall injured a student, move all students away from the area immediately. This exemplifies the importance of having at least two leaders: one leader can move the other students to a safe location while the second can attend to the injured student. Lastly, fill out an incident report form, in accordance with your institution's policy.

If a situation requires a rescue, follow these tips (*HTMC*, 2019):

- » Call 911 – ask for Fire Rescue
- » Be Visible
- » Be Audible
- » Stay Calm
- » Stay Put
- » Stay Warm

## ➔ Inclusivity and Respect

### Inclusive Practices



In addition to setting clear policies, it's important to pro-actively work to create a safe and respectful environment where all participants can thrive. This entails respecting that everyone has different thresholds for safety and comfort. Explicitly state that participants should always feel free to share concerns and should never feel pressured to engage in activities or perform tasks that they find unsafe or uncomfortable.

Women, LGBTQ+, ethnic/racial minorities and people with disabilities are at particular risk of experiencing discrimination or harassment from community members, program mentors and leaders, and other students. These concerns are often exacerbated during fieldwork, where privacy is limited, work/personal boundaries are blurred, and students lack access to support networks and reporting mechanisms. Hierarchical power structures, alcohol, long hours, and stress all increase the likelihood of harassment (see *Developing an Anti-racist REU Program*).

A recent survey revealed that 40% of women of color reported feeling unsafe in the workplace because of their gender or sex, 28% reported feeling unsafe because of their race; and 18% reported skipping professional events, including fieldwork, because they did not feel safe (*Clancy et al., 2017*).

Students might be hesitant to share such concerns with an REU director, particularly if they are of a different race, culture, or gender. It can be helpful to employ undergraduate peer mentors or graduate teaching assistants that reflect the diversity of the student population. It is essential to ensure that, regardless of location, all students have 24/7 access to communication without gatekeepers, in case they need to report an incident.

## Preventing Sexual Harassment

The [chapter on Sexual Harassment Prevention](#) provides information strategies related to preventing sexual harassment in the office and in the field. Be sure that mentors and other staff are trained in this area, along with the students.

Note that sexual harassment can involve unwanted interactions in virtual work settings as well. Be sure to identify what these are for the students and provide guidance on who they can speak to about any incidents.

[Virtual sexual harassment](#) includes behaviors such as:

- » Comments or rumors about the victim's sexuality
- » Comments or rumors about the victim's sexual activities
- » Sharing sexually explicit photos without consent
- » Using sexual or gender-based derogatory terms to describe the victim

Harassers may post this content on their social media pages or online forums, or send it to others via email, text message, or other digital application.

Tell students to be cautious about posting photos of themselves or others on social media. A good litmus test is whether they would be comfortable with an employer or colleague seeing the photos.

Show your REU's commitment to a harassment-free workplace. Write a strong [anti-sexual harassment policy](#) including online behaviors, and enforce the policy without exception.

Encourage students to speak up if they are experiencing harassment. All students should be informed of who they can talk to and where they can file a complaint.

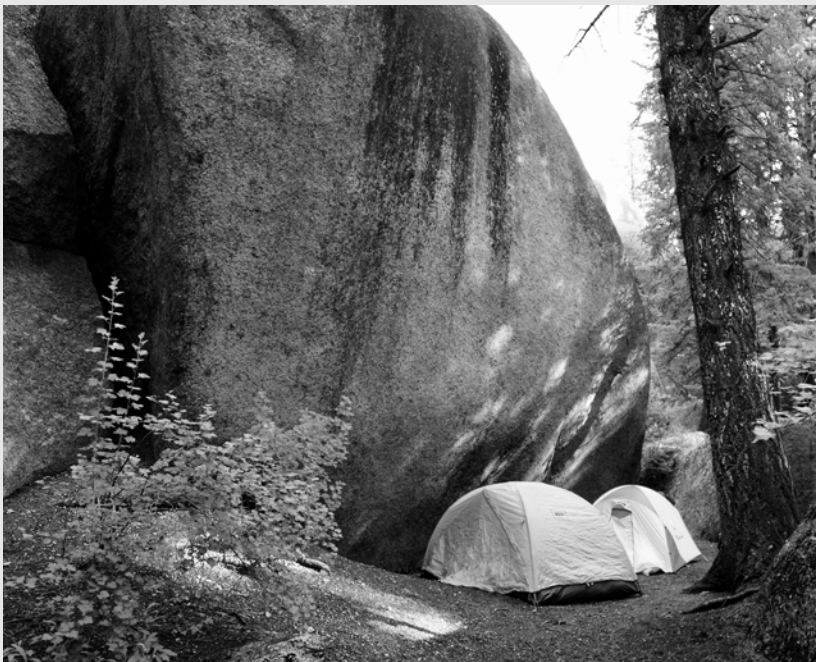
## Preventing Racism and Discrimination



Current events relating to issues of racism are prominent in the news, heightening awareness to the topic and calls for anti-racist action. With the increased online activity in recent years—particularly amongst young adults—the incidents of racist behaviors in the digital world and cyber-bullying have increased. Here are some tips to consider:

- » Acknowledge that racial discrimination is entrenched in public policy and the history of racial oppression of Black people, Native Americans, and others
- » Have a strong anti-racist policy statement
- » Enforce rules to make clear those behaviors that will not be tolerated
- » Don't tolerate the normalization of hate through seemingly harmless humor
- » Teach about the importance of impact rather than the intent of statements and actions
- » Create a supportive environment among students, and acknowledge events in the news as being upsetting
- » Encourage the development of empathy as a way of understanding differences in interpretation
- » Ask everyone to play a part in reducing harm online

### Camping While Black



In an article on [the experience of being in the great outdoors as a Black woman](#), Lauren G. shares the following:

“As a woman, I’m often fearful about doing certain things alone and I take as many precautions as I can. However, as a Black woman I have yet another set of circumstances to consider. I have to reconcile that as much as I love being in nature and seeing the world,

there are those who wholeheartedly believe someone like me has no right to be there — simply because I am Black.”

“Camping while Black shouldn’t be this anomaly or strange occurrence. Enjoying nature or traveling to a lesser-known destination shouldn’t produce admonition and insulting commentary or worse, question your perceived blackness. No really, it has happened to me. I was told traveling to find waterfalls was a “white people thing” and I must not be a real Black girl. Needless to say, I had to set them straight.”



## Resources

Field trip policy documents, Hamilton College:

- » [Field trip policy form for students to sign](#) (doc)
- » [Field trip itinerary and emergency contact form](#) (doc)
- » [Field trip health form](#) (PDF)
- » [Field trip report form for injury, accident, or illness](#) (doc)
- » [Field trip liability form](#) (doc)

Geological Society of American Field Safety Guidelines:

- » [Field Safety Policy](#)
- » [Code of Conduct](#)
- » [Liability Waiver](#)



## Further Reading

ADVANCEGeo. In the Field. Retrieved Aug. 1, 2020.

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Clancy, K.H. et al., 2017. Double jeopardy in astronomy and planetary science: Women of color face greater risks of gendered and racial harassment. *Journal of Geophysical Research: Planets* 122: 1610-1623.

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## SCIENCE COMMUNICATION TRAINING

*Lorena Medina Luna*

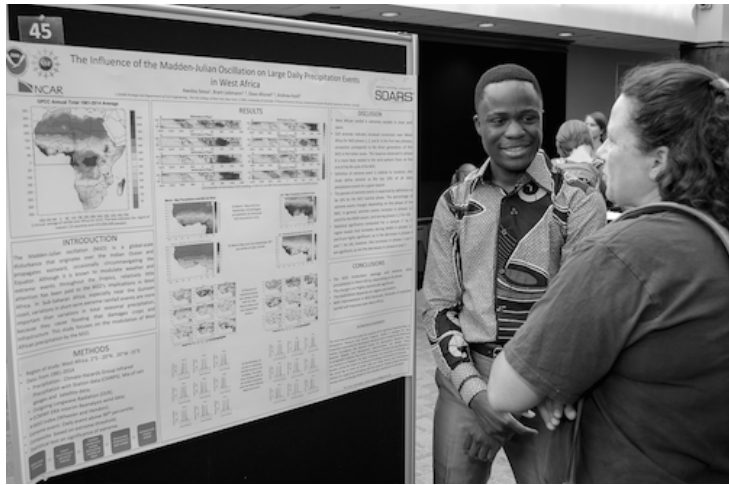
*Valerie Sloan*

*Rebecca Batchelor*

The GEO REU community generally aims to provide undergraduate students with training in communicating their science, in addition to providing mentoring, cohort-building activities, and an authentic research experience. Our hope is that this chapter will offer a menu of ideas and strategies on models, materials, and expectations to support your efforts in training young scientists in their writing and presentation skills.

## ➔ Introduction

Graduate schools and employers sometimes comment that college graduates have shortcomings in their writing and presentation skills. An important component of the REU internship is to provide experience and training in communicating science clearly to different audiences.



## ➔ Deliverables and Timeline of Deliverables

In identifying deliverables for your REU students, consider the following:

- » Which scientific communication skills and deliverables will best prepare undergraduates for their future educational and career pathways? Options include a scientific poster, an oral presentation, a research paper, a proposal, a blog, podcast, or newspaper article. Increasingly, presentations are being given via video conferences.
- » Are you proposing that your students will attend a conference? Will they develop an abstract and poster that they can use for that conference?
- » What skills do they already have? Don't depend on their university to teach scientific writing or presentation skills.
- » How can you break up deliverables into small milestones throughout the REU program that students can feel proud of, and that build towards the final deliverables of the program?

## Menu of Scientific Communication Deliverables

Think of deliverables as landmarks and final goals for students to achieve. Consider these small and final deliverables for your REU program:

### **Small deliverables**

An elevator speech  
 A two-page proposal with references  
 A research abstract  
 An online blog (biweekly, monthly)  
 Sections of a report/paper

### **Final deliverables**

A scientific poster and presentation  
 An oral presentation or a lightning talk  
 A paper or report (e.g., 5-page)  
 An article to post on LinkedIn  
 A podcast for a general audience  
 Abstract submission to a conference

## Provide Students and Mentors with Guidelines

- » Have students get regular feedback from their research mentors and from their peers.
- » Have common deadlines for the deliverables for students, as they bond over this work.
- » Make sure to announce deliverables and deadlines to students and mentors at the start of the program.
- » Be clear about expectations, for example, when drafts are due, when materials should be approved by mentors, and the final deadline for poster printing, for example.
- » Put events, deadlines, and milestones on a calendar and on a list and share it with students and mentors.

### **Example list of deadlines**

Week 1: Elevator speech  
 Week 2: Small annotated bibliography  
 Week 3: Research proposal  
 Week 4: Draft of abstract  
 Week 5: Practice research talk  
 Week 6: Break (4th of July)  
 Week 7: Finalize and submit abstract to conference  
 Week 8: Draft of poster, final deadline for poster printing, practice presentation  
 Week 9: Poster session

| May 2020 |        |         |           |          |        |          |
|----------|--------|---------|-----------|----------|--------|----------|
| Sunday   | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday |
|          |        |         |           |          | 1      | 2        |
| 3        | 4      | 5       | 6         | 7        | 8      | 9        |
| 10       | 11     | 12      | 13        | 14       | 15     | 16       |
| 17       | 18     | 19      | 20        | 21       | 22     | 23       |
| 24       | 25     | 26      | 27        | 28       | 29     | 30       |
| 31       |        |         |           |          |        |          |

| June 2020 |        |         |           |          |        |          |
|-----------|--------|---------|-----------|----------|--------|----------|
| Sunday    | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday |
|           | 1      | 2       | 3         | 4        | 5      | 6        |
| 7         | 8      | 9       | 10        | 11       | 12     | 13       |
| 14        | 15     | 16      | 17        | 18       | 19     | 20       |
| 21        | 22     | 23      | 24        | 25       | 26     | 27       |
| 28        | 29     | 30      |           |          |        |          |

| July 2020 |        |         |           |          |        |          |
|-----------|--------|---------|-----------|----------|--------|----------|
| Sunday    | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday |
|           |        |         | 1         | 2        | 3      | 4        |
| 5         | 6      | 7       | 8         | 9        | 10     | 11       |
| 12        | 13     | 14      | 15        | 16       | 17     | 18       |
| 19        | 20     | 21      | 22        | 23       | 24     | 25       |
| 26        | 27     | 28      | 29        | 30       | 31     |          |

### Begin with the End: Plan the Final Events

Having a poster session or a talk symposium? Planning the event in advance is key. Here is a to-do list for REU managers or administrators.

1. Choose the date and time of the session. Afternoons can be good for attracting local scientists.
2. Create a video-conferencing session/reserve a space for the poster or oral session.
3. For poster sessions, identify a method of hosting it online; if in-person, reserve or find poster boards and stands.
4. Plan other logistics (AV support for talks, push pins for posters, water & snacks, etc.).
5. Communicate this deadline to interns and mentors at the start of the program.
6. Convey that family and friends are welcome (and encouraged!) to come.
7. Recruit poster or talk reviewers a few weeks beforehand. If you have ten interns, get ten judges and ask them to review three posters each. Provide them with an evaluation form, aiming especially to collect positive and constructive feedback.
8. Advertise the poster session or talk symposium via email, social media, flyers, or word of mouth 2-3 weeks in advance. Let your organization's communications person or office know to cover the event via social media, if your organization has one.
9. Set a deadline for poster/presentation submission for digital poster review/printing of paper posters.
10. Give a role to prospective attendees by asking them to fill out a simple feedback form. This form could ask what the main message of the poster or talk was, two things they liked about the talk or poster, and two suggestions.
11. For a virtual poster session or talk symposium, consider what platform you'll use, having potential breakout rooms where guests can "stop in" and visit student posters, and a separate time for poster judges to meet with students.

### ➔ Models of Teaching Scientific Communication

Many REUs hold a weekly workshop to support scientific communication training. These meetings also provide an opportunity to check in regularly with the interns and to keep the dialogue going with them.

The models for training vary widely, from having more intensive sessions up front in the first week or two to having workshops spread throughout the program.

Some REUs interweave science communication workshops with career awareness and development workshops and short field trips as well.

Having these workshops can help build a student cohort, and can encourage students to support each other and work together to solve problems. These workshops offer relief to mentors by having students help each other before seeking help from mentors.

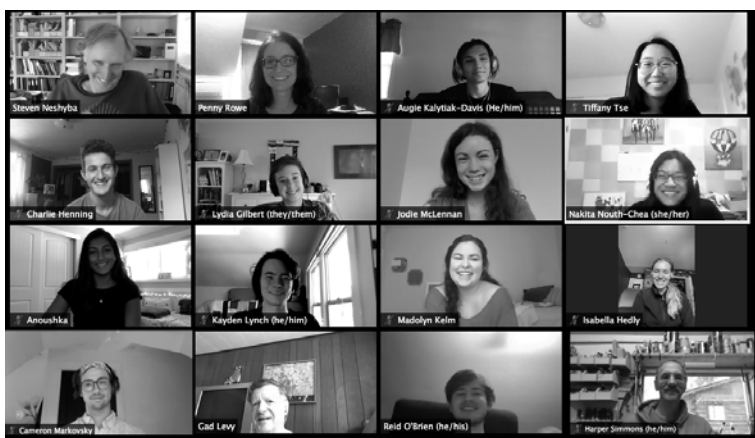
Here are a few models for workshops:

- » Regular weekly meetings of 1.5 - 2 hours including check-ins, workshops on communication, career and grad school panels, and virtual/real field trips.
- » Workshops on producing abstracts, posters, talks, or resumes.

The GEO REU community is active via the email listserv and is a great place to ask others what they have been doing for science communication in terms of deliverables and training. Ideas and program details constantly evolve, including modifications to programs that have moved online.

### Virtual Programming

With the onset of COVID-19, many programs have moved online. A few successful models for online workshops have been adopted by REUs since the onset of the pandemic. Refer to the [GEO-REU network website](#) for some examples on transitioning online.



**Panels:** One model is to host virtual panels with professionals from different work sectors, with graduate students, and with faculty discussing graduate school applications.

**Hybrid workshops:** Another model is to hold workshops with a blend of presentation time, discussion time, and work time, either individually or in small groups. It is important to have at least two presenters so that one can help with technical pieces and potentially co-present. Consider providing an opportunity for students to share or teach what they have learned or present with their group as a discussion period. A 1.5- to 2-hour period is recommended.



## Guidance and Materials for Training

The GEO-REU network has a (growing) collection of resources and example activities for various methods of scientific communication on their website (<https://ncar.ucar.edu/what-we-offer/education-outreach/faculty-resources/geo-reu-resource-center>), including:

- » An elevator speech
- » A two-page proposal with references
- » A research abstract
- » A scientific poster
- » An oral presentation or a lightning talk
- » A paper or report (e.g., 5-page)
- » An online blog (3x per summer, biweekly, etc.) for a general audience
- » An article to post on LinkedIn
- » A podcast for a lay audience
- » Abstract submission to a conference, including online sessions like AGU's virtual student poster session.

Examples of this guidance are shown below for three formats.







## Workshop Activity: How to Give an Elevator Speech

Every scientist needs a short speech to introduce themselves and their work at conferences or in interviews, and when talking to potential funders and collaborators. The following is a brief outline of this activity. For more details, see the [full document](#) online.

### **1. Introduce the topic**

Discuss what students think an elevator speech is, how it should vary between audiences, and provide them with some guidance on it.

#### *Recipe for an elevation speech*

What is the topic (start with the big picture)?

Why is this important (make it relevant to the audience)?

How are you helping to solve this question?

Why is it important (again)?

### **2. Give students a few minutes to draft points**

### **3. Break students into pairs or small breakout groups, with these instructions:**

- » Decide who is the speaker and who is the listener in the first round.
- » Get a timer out and set it to 45 seconds.
- » The speaker gives their pitch in 45 seconds.
- » The listener gets two minutes to provide feedback, starting with the positive.
- » Switch roles.

### **Resources on Elevator Speeches**

Jill Hopke summarizes and shares resources and tips about creating an elevator pitch and science talks from presentations that she participated in back in February 2013. Hopke, J. 2013. [Communicating Science: From the “Elevator Pitch” to Research Presentations](#). JillHopke.com. Accessed July 18, 2019.

Watch as Dr. Rafael Luna shares his elevator speech about his cancer research at Harvard University with postdoctoral students. Luna, R., 2013. [Luna Scientific Storytelling Innovative Elevator Pitch on Cancer](#) (2:39 min), Research at Harvard University 2013. YouTube.



## Workshop Activity: How to Write a Research Abstract

This is a relatively simple but effective exercise in teaching students how to critically read and dissect a research abstract, write an abstract for someone else, and then write one for their own research. For more details, see the [full description](#) online.

### ***Process:***

1. Introducing the abstract
2. Group dissection of an abstract
3. Abstract dissection with a partner
4. Draft an abstract (see below for ideas)

### ***Choose from the following activities:***

- » Writing an abstract from a published article: Provide students 40 min to read a short, published journal article with a partner, discuss the article, and write an abstract for it. After the time's up, allow students to read the article's abstract and talk about how their abstract compares.
  - Strassmann, J.E., 2017. Teaching Effectively and efficiently: abstract writing. Sociobiology. <https://sociobiology.wordpress.com/2017/03/01/teaching-effectively-and-efficiently-abstract-writing/>
- » Writing for someone else: Ask students to interview a partner about their project. Now write a short abstract for their partner's project. Ask a couple of students to read theirs to the group.
- » Writing your own abstract: Give the students 15 - 20 minutes to write their own abstract. You can give individual assistance. Once the time is up, have them show it to a partner and get feedback on it.

### ***Conference submission***

Now that students have an abstract, they can submit it to a conference or online conference (e.g., [American Geophysical Union Virtual Showcase](#)). Provide information on where and when to submit!

## Resources on Writing Abstracts

Bastian, H., 2018. Building a great scientific abstract: a quick checklist. Plos Blogs: Absolutely Maybe. <https://blogs.plos.org/absolutely-maybe/2018/06/06/building-a-great-scientific-abstract-a->

Jump, P., 2013. Unusual introduction to the abstract. Inside Higher Ed. <https://www.insidehighered.com/news/2013/06/28/professors-use-personal-ads-teach-students-how-write-abstracts>

How to write an abstract activity: Quite fun, and challenging, too. Strassmann, J.E., 2017. Teaching effectively and efficiently: Abstract writing. Sociobiology. <https://sociobiology.wordpress.com/2017/03/01/teaching-effectively-and-efficiently-abstract-writing/>

SERC activity on writing an abstract from an article. The student does it on their own. Musselman, Z. A., 2008. Writing abstracts. National Association for Geoscience Teachers. <https://serc.carleton.edu/NAGTWorkshops/geomorph/activities/23370.html>

Prothero, W. Question of the day: writing an abstract. National Association for Geoscience Teachers. Retrieved Aug. 1, 2020. <https://serc.carleton.edu/introgeo/interactive/qotd/abstract.html>

Strazdes, D. and Clarke, A., UC Davis Undergraduate Research Center. How to write an abstract for the undergraduate research, scholarship, and creative activities conference. <https://urc.ucdavis.edu/how-write-abstract>



### Workshop Activity: How to Give a Scientific Talk

Most REU programs have students present their research at the end of the program and sometimes do a practice talk earlier on. Talks are a common way of presenting project results both in the workplace and in graduate school. This is likely becoming more true given the transition to a virtual workplace. Here we provide some guidance on doing a workshop with the students on preparing a talk. It is worth doing this several weeks before the presentation so as to ease the



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students' minds and reduce anxiety around presenting. It can also help the student to clarify what their project is really about in a more concise way.

**Timing:**

This can be a ~90 minute workshop if you want students to come away with a rough draft of their presentation.

**Materials:**

[How to give a bad talk \(and prepare a good one\)](#) - PPT slides

[How to give a bad talk \(and prepare a good one\)](#) - Recorded video of a workshop (43:36)

**Process:**

1. Look through the slides and watch the video.
2. Modify the slides for your use if you are going to give the presentation. Otherwise, you can show the video to your students.
3. Have the students work on drafting a PPT presentation on their project for 45 minutes.
4. Bring people together and ask for volunteers to give a 3-5 minute presentation using their slides.
5. Have 3-4 people present.
6. Take photos or screenshots of them presenting and share the photos with their mentors.

**Tips:**

- » This workshop can be done earlier in the internship than you might expect; in fact, students are relieved to get started on their presentation. Even if the students haven't done much research at all, this process can help them to think about their project.
- » Hold a practice talk session a few days before the final presentations.
- » Take photos or screenshots during their presentations.

**Resources on Giving Presentations**

[How to Give an Awesome \(PowerPoint\) Presentation \(Whiteboard Animation Explainer Video\)](#).

Fleming, N. 2018. [How to give a great scientific talk](#) - Expert presenters share advice on how to capture and hold the attention of a conference crowd. Nature. Dec. 19.

Larkin, M. 2015. [How to give a dynamic scientific presentation](#). Elsevier. Retrieved Oct. 26, 2020.



## Workshop Activity: How to Make a Scientific Poster

Poster sessions are commonly used at scientific meetings large and small, and the process of creating a poster can be truly daunting. By the end of this workshop, students will have made a serious inroad into creating their own poster. For more details, see the [full document](#) online.

### Process:

1. Share the templates with students before the workshop.
2. Do a poster-critiquing activity with the students (15 min).
3. Outline the essential elements of a poster with the students' help (20 min).
4. Give student an hour to work on their own poster (1 hour).
5. Ask a few students to present their poster (15 min).
6. For a process to host a poster session online, see this guidance.

### The Poster Template

The poster template can vary from a traditional layout, to new layouts where the title text is larger than usual and a QR code is added to direct people to their online poster. Starting with a traditional poster template can make the process of creating a poster less daunting. Stress that students can adjust boxes, layouts, fonts, backgrounds, etc. to suit their own research. It can also be helpful to pre-fill the poster template with necessary logos.

The image shows a scientific poster template with the following sections and content:

- Header:** SOARS logo, "My title goes here", "My name<sup>1</sup>, coauthor names<sup>1,2</sup> and affiliations go here", and icons for chat, smile, and a gear.
- Abstract:** "If you need to include your abstract (many people don't), stick it near the top and keep it short! You might want to skip the title and just put the abstract in directly."
- Introduction:** "This is where you set the scene for the research (can also be called motivation)"
- Methods:** "This is where you describe what you did. It might have a more descriptive title relevant for your work"
- Results:** "Figures, pictures etc... don't forget captions!" with a 3x3 grid of boxes.
- Discussion:** "This is where you describe a bit more about what you found from doing this" followed by "Blah. Blah. Blah. Blah. Blah."
- Conclusions:** "Key findings highlighted here!"
- References:** "Please be referenced by other scientists. Make sure you acknowledge them! There can be credits that say their other names."
- Acknowledgements:** "Thank like to thank... don't forget your mentors who are not credited!" and a disclaimer: "This work was performed under the auspices of the Department of Education, Research and Innovation, South Australia. It is supported by the University of Adelaide Research and a grant by the Department of Education, Research and Innovation, South Australia. The Department of Education, Research and Innovation is not responsible for the content of this poster and does not guarantee the accuracy of the information presented." Below this is "For more information, contact me@myemail.com".

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***Poster creating activity - Asynchronous Activity***

Provide students with a poster template such as one in Powerpoint, and suggest that they start by filling in the blanks of the template. This can be done with in-person workshops and online workshops. Make sure to provide available times when students can ask you questions, during this session and “office hours.”

**Resources on Making a Poster**

Flaherty, C., 2019. #Betterposter. Inside Higher Ed. <https://www.insidehighered.com/news/2019/06/24/theres-movement-better-scientific-posters-are-they-really-better>

Johnson, N., 2014. How to create a poster in powerpoint. YouTube. [https://www.youtube.com/watch?v=1c9Kd\\_mUFDM](https://www.youtube.com/watch?v=1c9Kd_mUFDM)

Morison, M., 2019. How to create a better research poster in less time (including templates) #betterposter part 1. YouTube. <https://www.youtube.com/watch?v=1RwJbhkCA58>

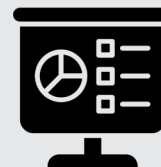
[Slides from an intern workshop at the National Center for Atmospheric Research.](#)

Swedberg, T., 2014. Research Posters. YouTube. <https://www.youtube.com/watch?v=UylugmaCHk>



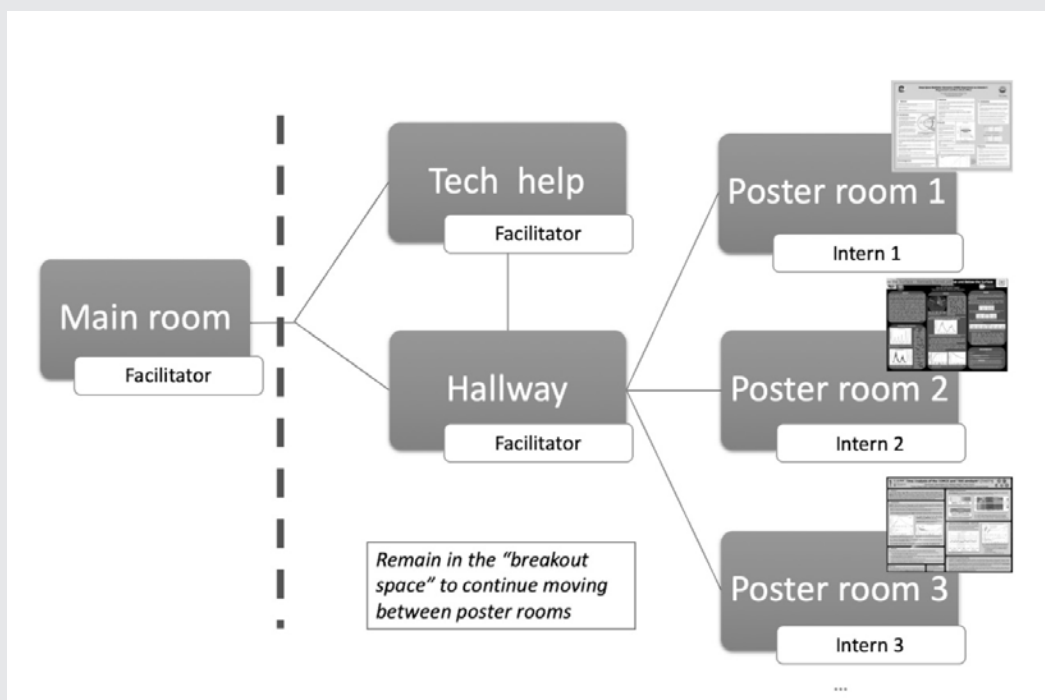
### Virtual Poster Sessions

It is possible to hold these Our REU program's virtual poster session was on Friday, and it was a great success. We were able to simulate an in-person poster session for 24 presenters. A document describing how we set it up is found [here](#).



We put each poster presenter in their own breakout room. The main obstacle is that people on Zoom cannot freely move from the main room to the breakout room of their choice. By creating a “hallway” breakout room and assigning all the visitors to it, people then had the ability to move from one breakout to another. They could see which students had no visitors and self-assign to that room. We had about 60 people circulating around the posters at one point, and it all went smoothly.

- Martin Snow, LASP, University of Colorado at Boulder.





## Further Reading

Crowe, D., 2019. Visual and User Experience (UX) design principles can improve the effectiveness of poster sessions. DerekCrowe.net. <https://derekcrowe.net/butterposter>. [Visual and User Experience \(UX\) design principles can improve the effectiveness of poster sessions.](#)

Rafferty, C., M. Snow, and Y. Zhu. 2020. [Running a Scientific Poster Session over Zoom](#). White paper. National Solar Observatory and University of Colorado Boulder / LASP.



## CAREER AND PROFESSIONAL DEVELOPMENT

*Valerie Sloan*

*Pranoti Asher*

*Reginald Blake*

*Jennifer Nocerino*

*Gabriela Noriega*

*Janet Liou-Mark*

Most REU students are eager to learn about graduate school, careers beyond academia, and how to get there. Some know little about how to apply to graduate school, what the grad school experience is like, and have limited information about career opportunities for early-career scientists. Learning about how to navigate their educational and career path, along with getting tips on how to network and be professional, is much appreciated by these students. This chapter will introduce elements of career development and provide relevant tips and materials.

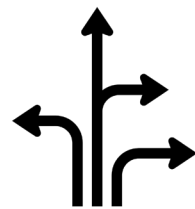
## ➔ Career and Professional Development Topics

Given that students in research internships are interested in educational and career paths in the sciences, several activities are useful for helping them to figure out their own path and to develop the needed skills.

- » Panels with multiple speakers sharing insights, such as:
  - REU alumni panel
  - Graduate school: Faculty panel & grad student panel
  - Careers outside of academia (private for profit, non-profit, government)
- » Graduate school application preparation workshop
- » Resume/CV writing workshop
- » Cover letter workshop
- » Career webinars
- » Membership/participation in professional societies
- » Conference participation/membership (discipline-specific) or research teams

## ➔ General Tips Applicable to All Career Development Events

- » **Aim for diversity:** In finding speakers for your events and workshops, be sure to aim for diversity in demographics, subdiscipline, and type of organization. Consider other types of diversity such as how people identify across many realms. Diverse representation in panels is important for everyone to see and will improve student involvement.
- » **Share career paths to different destinations:** Ask everyone involved in the program or speaking to students to spend five minutes describing their own career path. This illustrates the wide range of winding paths that people take to get where they are, and the breadth of careers that can involve STEM backgrounds.



## ➔ REU Alumni Panel

Holding an REU alumni panel can give students near-peer mentoring and allow them to hear from alumni on what they got out of an REU experience.

To prepare, provide the alumni panelists with a list of questions, and then facilitate a Q&A discussion. Avoid asking panelists to answer all questions in one go; instead, go around the panel with a couple of questions, and then go around again. This breaks it up.

Questions for the alumni could include:

- » Give your name and what school you're from/graduated from.
- » Share a tip to success in the REU program.
- » Share the thing you liked most about the REU program.
- » Share your successes since the program and if you think the REU helped with that.
- » Include tips on how you got your current employment.
- » Encourage students to network and suggest coursework they might consider taking.
- » Anything else you think is important.
- » Open up to questions from this year's students.

## ➔ Graduate School Panels

### Faculty Panel

Organize a panel with faculty discussing the application process and their hopes and expectations for graduate students. This panel of graduate school advisors and faculty can give their perspective on reviewing student applications and what they look for. You might also consider adding a graduate student to this panel who can offer advice on this process from a student perspective. This will help to reinforce what the faculty advise.



For an example of a faculty panel hosted in 2020, see this one-hour video:

[Graduate school panel: faculty perspectives](#) (video).

\*Note: To see the names of panelists, click on "CC" (Closed Captioning) while watching the videos on YouTube.

### Graduate Student Panel

Have three to four graduate students answer questions about how to find a graduate advisor or school, their experience in applying, and their impressions of grad school.

For an example of a graduate student panel hosted in 2020, see this one-hour video:

[Graduate school panel: grad student perspectives](#) (video).

#### Tips for a Successful Panel

- » It is possible to hold these two panels consecutively, e.g., the faculty panel in the first hour, and the grad student panel in the second hour. You could also hold a panel with both students and faculty for both perspectives in one hour.
- » Invite speakers at least two weeks in advance, if possible. Provide them with information on what they will need to prepare in advance, how the program will be operated, and contact information for additional questions. Reach out to them a second time a few days before the event with your final logistics.
- » Advertise the session with some encouraging text such as: This is your chance to get an honest, insider view about what it's like to apply to, and complete a graduate program. "We hope that you will see it is a highly individual decision for both students and faculty."
- » Provide students with a link to a place where they can submit questions in advance, and possibly vote on others' questions, e.g., using a tool like [Slido](#).
- » Format:

*Introductions (5-10 minutes):* After welcoming the REU students and panelists, ask each panelist to briefly introduce themselves, discuss their career trajectory, and perhaps offer one tip that they have for the students. This should be very brief to allow a lot of time for questions.

*Discussion (40 - 50 minutes):* Open up Q&A from the students, using the "raise hand" and chat functions in Zoom. If you meet in person, consider providing a way for students to ask questions verbally and written. Some students might be nervous speaking in front of a group.





### Workshop on Preparing Graduate School Applications

Hold a workshop in which you and two graduate students provide examples and walk the REU students through:

- » How they sought out and evaluated graduate school options. See the excellent advice from [Callan Bentely's blog](#) here.
- » How they prepared documents for graduate school, such as the statement of research or personal statement.
- » How to prepare materials for the NSF Graduate Research Fellowship, and tips they have. NSF Graduate Research Fellowship Application links are:
  - [FAQ](#)
  - [Tips on applying](#)
  - [A collection of quotes and data from past recipients](#)
  - [A webinar on preparing for the NSF GRFP](#) by the American Geosciences Institute.

### ➔ Career Panel

Holding career panels is beneficial to students, especially if you can invite professionals who work in different sectors within STEM. These sectors can include private, small organizations, non-profit organizations, industry, government, research labs and academia. Some REUs host a panel for each of those sectors. Try to expose students to work outside of research and teaching, such as:

- » Scientific data collection, data analysis, and modeling
- » Instrument development and testing
- » Careers with the government
- » Careers in industry
- » Science journalism
- » Education and outreach
- » Policy development

## Tips:



**Do rounds:** Ask panelists to address your questions in rounds. For example, ask each panelist to say who they are, where they work, and briefly what kind of work they do in the first round. In the next round, ask each panelist to talk about their career path, and in the third round, ask them to speak to the joys and challenges of their work. Limit their time in each case, reminding them to be brief.

**Leave Time:** A panel is not really a panel if the speakers use up the whole time; then it is a series of talks. Students will have numerous questions, so leave **plenty** of time for them to ask the professionals their questions.



### Example Invitation

#### Career Panel in the Ocean Sciences

Join us for a career panel in the ocean sciences. Panelists will include speakers from a variety of work sectors, including the private sector, policy, scientific companies, government, and a museum.

After each panelist briefly introduces themselves, we will discuss your career interests, how you ended up in the position you are in now, and what mentorship and support systems were valuable to you. Students will be interested in your career challenges, and any advice you might have for undergraduates seeking to enter a similar career “track” - especially if your career path was a winding one!

#### Ocean Science Career Panel

**Time:** Wed. July 8, 12:00 - 1:30 pm PST / 3:00 - 4:30 PM EST

**Registration:** Register in advance for this panel (include hyperlink).

After registering, you will receive a confirmation email containing information about joining the meeting.

#### Agenda:

12:00 - 12:45 pm PT: Career panel responses

12:45 - 1:30 pm PT: Student Q&A

**Faculty Panel Members** (examples; include hyperlinks to each panelist):

- » **Panelist's name**, Wildlife Biologist, NOAA National Marine Mammal Laboratory (Government, he/his)
- » **Panelist's name**, Environmental Journalist, National Geographic (Journalism, she/hers)
- » **Panelist's name**, Ocean Policy Analyst, Center for American Progress (Policy and Government, she/hers)
- » **Panelist's name**, Scientist, INSPIRE Environmental (Consulting, he/his)
- » **Panelist's name**, NSF Postdoctoral Fellow at American Museum of Natural History (Applied Science and Academia, they/them)

#### Action items:

1. Upload your questions for panelists and vote on others' questions in advance. (include hyperlink)
2. Mark your calendar!

## ➔ Resources for Students on Careers

*Career Tools:* Share the [Career Compass](#) which provides options, tips, suggestions, and strategies for how students can obtain critical skills, experiences, and competencies in order to launch their geoscience career. Students will also be interested in the [workforce infographic](#) to help identify career possibilities in the geosciences. The American Geosciences Institute (AGI) has developed these and [other excellent resources](#). See the videos on geoscience opportunities, including [one on types of work in the different sectors](#) and another with [guides by field of interest](#).

*Individual Development Plans (IDPs):* This is a helpful tool for scientists at all levels to identify the training they need, getting guidance from mentors, and being proactive about their own careers. IDPs are a planning tool that identifies professional development needs and career objectives. Point students to these or have them fill one out before meeting with a mentor or you.

- » [Create Your Individual Development Plan](#) - A brief description
- » [MyScienceCareers](#) - A website with interactive questions to help find the right career path
- » [Building Your Individual Development Plan - A Guide for Undergraduate Students](#) (by SACNAS)
- » [Individual Development Plan](#) - A more comprehensive version designed for grad students and postdocs.

*Video:* [Career panel in the ocean sciences](#) from the NSF Ocean Sciences REU 2020.

*Not for Profit Organizations:* Do some research on the Not for Profit organizations that offer scientific meetings in your area of interest. These organizations will usually have online resources, webinars, career panels and workshops that you might find helpful.

*Readings:* Send articles to the students such as the following to indicate your comfort with their pursuing a non-academic career in science, as students are sometimes nervous to reveal this interest:

[Academia is the alternate career path.](#)

[Why it is not a 'failure' to leave academia](#) (in Nature)

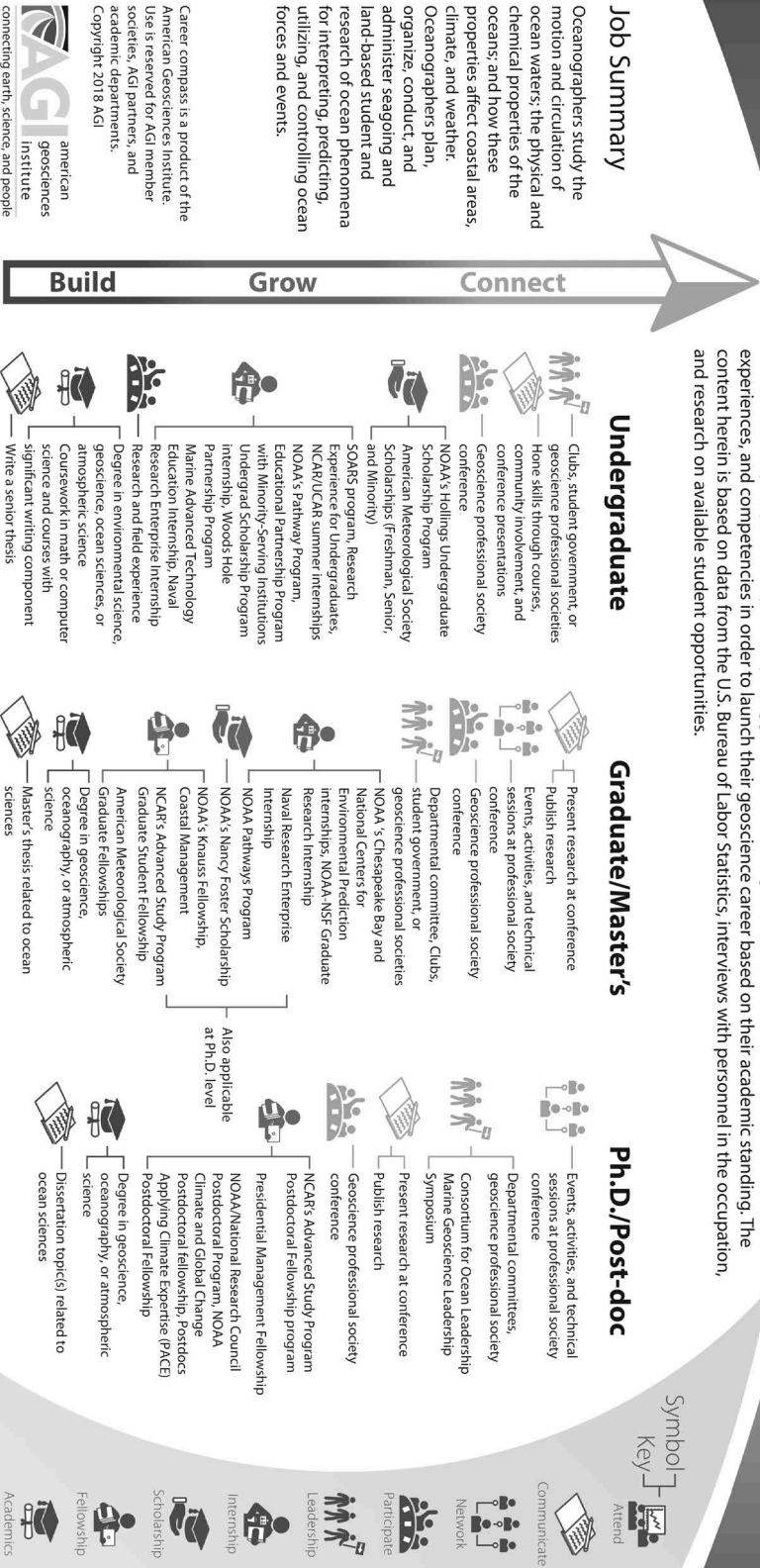


# Ocean Sciences



# Career Compass Geosciences

This career compass provides options, tips, suggestions, and strategies for how a student can obtain critical skills, experiences, and competencies in order to launch their geoscience career based on their academic standing. The content herein is based on data from the U.S. Bureau of Labor Statistics, interviews with personnel in the occupation, and research on available student opportunities.



## Job Summary

Oceanographers study the motion and circulation of ocean waters; the physical and chemical properties of the oceans; and how these properties affect coastal areas, climate, and weather. Oceanographers plan, organize, conduct, and administer seagoing and land-based student and research of ocean phenomena for interpreting, predicting, utilizing, and controlling ocean forces and events.

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## ➔ Resume, CVs, and Cover Letter Workshop

Most REU students are hungry to learn about the dos and don'ts of writing resumes, CVs, and cover letters. Students often undersell their REU experience and need help with creating a rich description of this research experience for their own materials. Topics might include:

### Factors to Consider in a Job Search

- » Which sectors geoscientists work in
- » Self-assessment of skills, values, interests, and personality
- » Creating an Individual Assessment Plan (see example)
- » Networking is the key to most jobs. Make sure you network with professionals whenever you can
- » How employers find employees vs how job seekers approach things

### Resumes and CVs

- » When do we use a resume or a CV?
- » Review a few good resumes, noting the idea of describing accomplishments and not simply listing the skills out of context
- » Provide a list of categories typically in a CV
- » Tailoring and ordering headings in a resume according to the job description
- » Identifying the skills applied during this REU internship - have them brainstorm on this
- » Order the experience and skills by importance or relevance to the job
- » Common mistakes made in resumes (typos, irrelevant detail, too little, poor layout, etc.)
- » If possible, provide them with some poorly prepared resumes or CVs

### Cover Letters

- » Go through a couple of bad examples and then a good example. This gives students an idea of how many letters are too generic, brag too much, and need detail about skills and experience.
- » Review the components by paragraph in a template
- » Have them work in small groups and read several bad examples of cover letters to critique them. This is a good learning exercise of what not to include in their own letter
- » Have them write a pretend cover letter for a specific job ad, if time allows



## ➔ Scientific Societies and Conferences

Attending conferences and joining scientific societies are an excellent way for students to network, as well as to demonstrate their productivity. Undergraduates will be mostly unaware of this world of meetings, and so providing them with some opportunities can be extremely helpful.

### Engaging Students in Conferences

- » Share deadlines for conference abstract submissions
- » Coach students on writing an abstract (see the [chapter on Science Communication Training](#))
- » Require that students submit an abstract to a conference
- » Provide funds for their membership and registration if you want students to attend a conference



### Provide Students with Support Before a Conference

- » Check in with the student(s) before the conference
- » Ensure that they have the funds for registration
- » Organize a session for students to do practice talks or poster presentation
- » Give tips on presenting on Zoom (having lighting in front, avoid having a window behind, minimize interruptions, check audio before a presentation, etc.)
- » Watch the student presentations if possible
- » Give positive feedback, and if needed, suggestions for improvement

### Assist Students with Networking

- » Encourage students to identify talks/posters/meetings to attend prior to the conference
- » Suggest that they write to scientists presenting at the meeting who are in a field of interest or who are potential grad school advisors and ask to meet for 15 minutes remotely after the conference
- » Encourage students to attend 'Town Halls' and sessions on topics outside of their familiar topics, such as education, diversity, science policy, and science communication sessions
- » Suggest that students join committees at the science societies, as most committees seek students, and some societies have heavy student involvement



 **Resources****Videos:**

[Resumes, CVs, Cover Letters and More: Finding the Right Match](#). This was part of a professional development workshop series in the NSF 2020 Ocean Sciences REU program.

[Graduate school panel: faculty perspectives](#)

[Graduate school panel: grad student perspectives](#)

**Slides:** [Powerpoints of the Resumes, CVs, Cover Letters, and job exploration](#).

**Interactive Website:** [MyScienceCareers](#) - A guide to identify professional goals, skill strengths and weaknesses, and the right career path.

**Articles:**

[Academia is the alternate career path](#).

[Why it is not a 'failure' to leave academia](#) (in Nature)

**Note:** There are many other resources available on the web that can be found at university career center websites.





## ETHICS AND CODE OF CONDUCT

*David Mogk  
Valerie Sloan*

The topic of research ethics has taken a front burner in recent years. It is important for students to learn what the expectations are for protecting the integrity of data, protecting ourselves, and respecting each other. Here we use the term “geoethics” to encompass the ethics of the broader geoscience community. This chapter will outline the topics to be covered and provide resources, including case studies.

## ➔ Ethical and Responsible Research

According to [National Science Foundation \(NSF\)](#) website, the responsible and ethical conduct of research involves not only a responsibility to generate and disseminate knowledge with rigor and integrity, but also a responsibility to:

1. conduct peer review with the highest ethical standards;
2. diligently protect proprietary information and intellectual property from inappropriate disclosure; and
3. treat students and colleagues fairly and with respect.

Many resources to assist researchers and educators with incorporating responsible and ethical conduct of research into their teaching and mentoring are [available here from NSF](#).

## ➔ Why is ethics training important?

Ethics training provides a reference framework that we can refer to when we are witness to, experiencing, or considering the ethics of our own choices. Reasons to teach ethics include:

- » Ethics Education is an increasingly important component of the pre-professional training of (geo)scientists.
- » Funding agencies (NSF, NIH) require training of students in the responsible conduct of research.
- » Employers are increasingly expecting their workers to have basic training in ethics, and
- » The public demands the highest standards of ethical conduct by scientists.

Examples of ethics education might include:

- » Learning about the falsification of data in one's research project.
- » Hearing about a researcher using a student's ideas without acknowledgement.
- » Choosing to go into an area recently hit by an earthquake to collect data and displacing first responders.
- » Dealing with unethical treatment based on gender or race.



Note: In this chapter, we refer to ethics in the geosciences as “geoethics.” *“Geoethics consists of the research and reflection on those values upon which to base appropriate behaviours and practices where human activities intersect the Geosphere. Geoethics deals with the ethical, social and cultural implications of Earth Sciences research and practice, providing a point of intersection for Geosciences, Sociology and Philosophy. Geoethics represents an opportunity for Geoscientists to become more conscious of their social role and responsibilities in conducting their activities. Geoethics is a tool to influence the awareness of society regarding problems related to geo-resources and geo-environment.”* -- IAPG Constitution, visit the International Association for Promoting Geoethics at: <https://www.geoethics.org/>

## ➔ Aspiring to a Professional Code of Conduct

A **virtue** is a trait or quality that is deemed to be morally good and thus is valued as a foundation of principle and good moral being.

What are the human virtues that are encompassed by Geoethics?

- » Power (used to enhance and enable or abuse)
- » Trust
- » Respect
- » Responsibility
- » Fairness
- » Justice (environmental, generational, distributional)
- » Integrity

These virtues are reflected in our professional codes of conduct. They typically include a *microethics* component - how we behave as individuals and in relations with colleagues - and a *macroethics* component - how we look beyond the profession to society and Earth. Some professional codes of conduct include those written by science societies like:

- » [Council for Undergraduate Research \(CUR\)](#)
- » [American Geosciences Institute](#)
- » [Geological Society of America](#)
- » [American Geophysical Union](#)



We need to make students aware of these codes of conduct as they enter the community of practice. The idea is to understand what the expectations and responsibilities are, and how to hold these up and be a good model for others. A good resource is the book [On Being a Scientist: A Guide to Responsible Conduct in Research](#) (*National Academy of Sciences*, 2009).

## ➔ Responsible Conduct of Research

Significant ethical problems in research include the handling of data, publishing, and reviewing ethics, including authorship. These are the day-to-day things we do in the lab or field that have ethical considerations. Some big issues in this realm include:

1. **Fabrication** – making up data/results and recording/reporting them
2. **Falsification** – manipulating research materials, equipment, or processes or changing/omitting data
3. **Plagiarism** – appropriation of another person's ideas, processes, results, or words without giving credit

A pillar of scientific integrity is trust: within the scientific community colleagues and collaborators must trust that scientific research is done to the highest standards regarding data collection and interpretation, and reporting of results; the public must trust that scientific research results are an honest and accurate reflection of a researcher's work, that funding is used appropriately and ethically, and that scientific results are used appropriately to inform public policy decisions. Ethical issues that reflect violations of trust may include:

- » Treatment of data and data management; documentation and quality of lab notes
- » Mistakes and negligence
- » Research misconduct
- » Response to violation, whistleblowing
- » Laboratory safety
- » Sharing results - who has access to and right to use data, instruments?
- » Authorship - credit; rights and recognition in publication
- » Intellectual property
- » Peer review, performance review, letters of recommendation
- » Conflicts of interest, transparency, confidentiality, privacy issues
- » Competing interests, commitments, values

Additional resources on Responsible Conduct of Research can be found at: [https://serc.carleton.edu/geoethics/rcr\\_responsible.html](https://serc.carleton.edu/geoethics/rcr_responsible.html)

**7 Step Guide to Ethical Decision Making (Davis, 1999)**

- 1. State the problem**
  - » For example, "there's something that makes me uncomfortable" or "do I have a conflict of interest?".
- 2. Check the facts**
  - » For example, persons involved, laws, professional codes.
- 3. Identify relevant factors** (internal and external)
  - » Who is involved, who is impacted, who benefits, who loses, what are the risks, can permanent damage be done, ...?
- 4. Develop a list of options**
  - » Be imaginative, try to avoid "dilemma"; not "yes" or "no" but whom to go to, what to say, what to do. Beneficence: Do no harm!
- 5. Test the options** - Use some of the following tests:
  - » *harm test*: Does this option do less harm than the alternatives?
  - » *publicity test*: Would I want my choice of this option published in the newspaper? Could I define the decision/action to the public?
  - » *defensibility test*: Could I defend my choice of this option before a congressional committee or committee of peers?
  - » *reversibility test*: Would I still think this option was a good choice if there were adverse effects? Could I go back and try something else?
  - » *colleague test*: What do my colleagues say when I describe my problem and suggest this option as my solution?
  - » *professional test*: What might my profession's governing body for ethics say about this option?
  - » *organization test*: What does my company's ethics officer or legal counsel say about this?
- 6. Make a choice** - based on steps 1-5
- 7. Review steps 1-6** - How can you reduce the likelihood that you will need to make a similar decision again?
  - » Are there any cautions you can take as an individual?
  - » Is there any way to have more support next time?
  - » Is there any way to change the organization (for example, suggest policy change at the next departmental meeting)?

**Having made a decision based on the process above, are you now prepared to ACT?**

## ➔ Ethical Responsibilities in Society

*How to act and communicate responsibly with the public with respect to geohazards*

Geoscientists have an ethical responsibility to work for the benefit of society. More generally, [AAAS \(2015\)](#) conducted a survey of scientists, and reports that “if the U.S. is to respond effectively to the challenges of the 21st century, we must find ways to reorganize our science and technology enterprise to address tomorrow’s needs and aspirations”:

### Authorship

Authorship can be a point of conflict for most people in science, particularly because we collaborate with each other in writing proposals, carrying out research, and writing papers. It is not always clear who should be an author, or in what order authors should be listed. The following has been adapted from a Yale University Website “Guidance on Authorship in Scholarly or Scientific Publications”:

All co-authors should have been directly involved in all three of the following:

1. Significant involvement in study conception or design, data collection, or data analysis/interpretation;
2. Involvement in writing or revising manuscript;
3. Approval of final version of manuscript for publication, at least as it pertains to their roles in the project; and
4. Responsibility for accuracy and integrity of all aspects of research.



Those who have made other contributions to the work (such as data collection without interpretation) or only parts of the above criteria should be credited in the acknowledgements, but not receive authorship.

A more complete treatment of ethics in publishing can be found at the Committee on Publication Ethics: <https://publicationethics.org/>

- » Maintaining global sustainability,
- » Improving human health,
- » Addressing economic disparities,
- » Understanding our place in the universe,
- » Promoting peace and security, and
- » Directing the products of technology toward the betterment of society, nationally, and worldwide.

*What are one's professional ethical responsibilities when:*

- » Going into consulting (confidentiality, safety, liability),
- » Serving as an expert witness (litigation in courts; conflicts of interest),
- » Assisting with public planning of projects (transparency, not overstating credentials),
- » Responsibly communicating with the public (via numerous media, e.g., with journalists, posting on your own blog) about topics such as geohazards, resource utilization, public safety and health issues, particularly when there is often a high degree of associated uncertainty.
- » In consideration of cultural sensitivity when working with diverse populations; being respectful of cultural norms.

## ➔ Responsible Conduct of Research

The primary responsibility is to be respectful of each other. This is awareness of how we behave towards each other, as this ultimately impacts the overall scientific enterprise, and workplace climate. Resources are available on [building an inclusive and diverse workplace](#). To ensure an inclusive workplace, we need to talk about microaggressions, bias, harassment, bystander intervention (responsibility to be prepared and act); and make our workplaces welcoming, inclusive, safe and productive, so that everyone can do their best work. Note that the updated [American Geophysical Union Scientific Ethics and Integrity Policy \(2017\)](#) specifically calls out sexual harassment and bullying as forms of scientific misconduct, with consequences of formal sanctions or expulsion. These behaviors ultimately impacts the ability of all scientists to work in a safe, inclusive, and productive workplace which also impact the overall progress of Science. Ethics are an individual choice and we must decide every day how to act. There are consequences for unethical behavior. An ethical breach can destroy a career and tarnish an institution.

 **Resources**

Who should get credit? [Clip from the Big Bang Theory show](#). (2:45)

TED Talk: [Trust in research -- the ethics of knowledge production](#) by Garry Gray (12:24)

TED Talk: [We have to change the culture of science to do better research](#) by Uri Alon (16:15)

[Building an inclusive and diverse Department/Program/Profession](#) from the National Association of Geoscience Teachers (NAGT) On the Cutting Edge: Teach the Earth.

Mogk, D. [Geoethics and Professionalism: The Responsible Conduct of Scientists](#). from the National Association of Geoscience Teachers (NAGT) On the Cutting Edge: Teach the Earth.

Mogk, D. [Responsible Code of Conduct](#). from the National Association of Geoscience Teachers (NAGT) On the Cutting Edge: Teach the Earth.

Mogk, D. [Teaching Geoethics Across the Geoscience Curriculum](#) from the National Association of Geoscience Teachers (NAGT) On the Cutting Edge: Teach the Earth.

 **Further Reading**

Davis, M. 1999. Ethics and the University, New York: Routledge. p. 166-167.

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Mogk, D. 2018. [Geoethics and Professionalism: The Responsible Conduct of Scientists](#). Annals of Geophysics, [S.I.], v. 60, an. 2018. ISSN 2037-416X.

Whitmeyer, S. and D. Mogk. 2013. [Safety and Liability Issues Related to Field Trips and Field Courses](#). EOS. Oct. 1.





## EVALUATING YOUR REU PROGRAM

*Barbara C. Bruno*

*Anne U. Gold*

*Valerie Sloan*

Evaluation is essential for assessing progress in reaching program goals, and for identifying ways to improve your REU program.

Although program evaluations are not required per the NSF solicitation, evaluating your REU program is a good idea. Limited funds may be used for evaluation purposes. If you have results, it is a good idea to include them in your annual project report to NSF. Evaluation can also be an invigorating and rewarding way to learn about the impact of your REU program on students and mentors!

This chapter aims at demystifying the evaluation process. It describes the different types of evaluations, shares a range of tools, and provides examples and resources. Talk to your program officer about evaluating your program.

## ➔ What should we evaluate?

Evaluating the program's impacts on students and the achievement of REU program goals is vital in program assessment, while mid-program feedback can provide important insights that prompt change.

### Achievements Through the Lens of REU Program Goals

The overall question that evaluation can help answer is whether or not the program is reaching its goals. Revisit the objectives stated in your REU proposal, and collect the necessary data on demographics and other relevant measures. For example, collecting demographic data during the application process can show the level of success in recruiting and selecting students from the target demographic group.

### Program Impacts on Students

Investigate student satisfaction with programmatic elements that may have impacted the student's sense of accomplishment or belonging. These might include the:

#### Overall internship experience:

- » Project scope and progress
- » Mentoring and staff support
- » Sense of belonging in the cohort and lab/group
- » Handling of logistics and any issues of concern



### Mentor Perspectives

Check in with the mentors at least a few times during the program. Mentors can be surveyed at the program's end to obtain an independent evaluation of the student's work and the program's impact. This gives a triangulation on the student's and staff's perspective. Topics could include:

- Frequency of interactions with the student
- Student's progress or accomplishments on the project
- Issues that may have arisen
- Preparedness for mentoring and support provided by the REU staff
- Feedback about the program

A survey example is available in this chapter's Appendix.

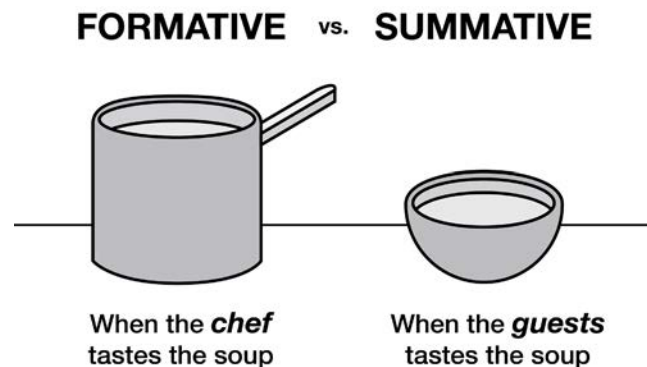
## ➔ Which tools are best for evaluating an REU program?

Different types of evaluation serve different purposes (see Appendix for a summary table). Two evaluation types are commonly used by REU site managers:

**Formative evaluation:** Methods of obtaining feedback during the program that can prompt changes to the program right away and for future years.

**Summative evaluation:** Measurements that reveal whether program goals have been reached.

In addition, **longitudinal tracking and surveying** of alumni can provide further information on the program impact, on students' career pathways, as well as on any changes in student perceptions of the REU experience.

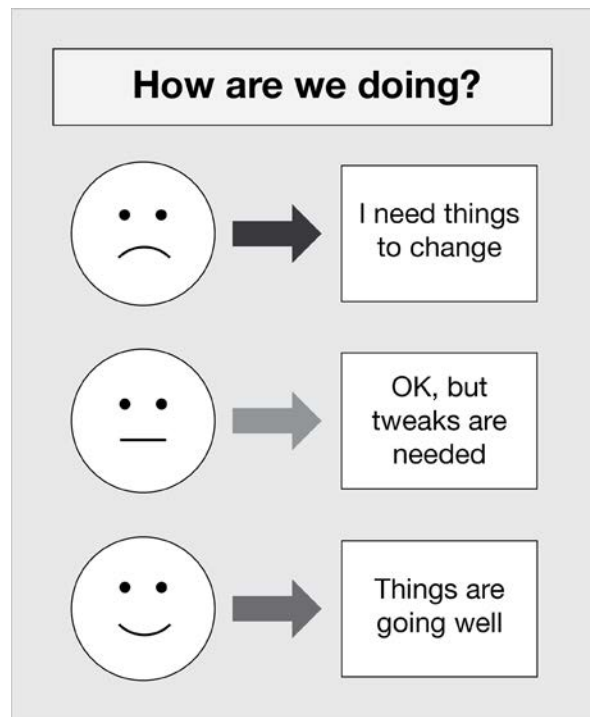


*Fig. 1. There are different reasons to use different types of evaluation. Figure adapted from Willow Education (2017).*

## ➔ Formative Evaluation: How do we get information during the program?

During the REU, formative evaluation data gathered from students and mentors allow you to improve the program and make mid-course changes as needed. Here are ideas on how to do this.

- » Meet regularly with the cohort to check in with students on what is working and what needs changing.
- » Conduct a mid-program or weekly survey to give students an opportunity to provide feedback anonymously.
- » Meet individually with the students near the beginning of the program to allow you to get to know them. Even a 30-minute meeting greatly helps to establish a connection and facilitates brief check-ins later in the program on what is working well and what they might need support with.
- » Have students present an update of their research and initial findings in a short white-board talk (no slides, just drawing on a board) in the early to middle part of the program. This informal presentation provides an excellent opportunity to assess the student's research progress, to provide feedback to the student, and to determine whether the project design might need to be tweaked.



| Evaluation Type<br>(& when/why collected)                                                                         | Can be used to collect data on...                                                                                                                                                                                   | Sample instruments                                                                  |
|-------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Baseline<br>(before REU begins; before participants are selected), used to establish a baseline to measure change | <ul style="list-style-type: none"> <li>» Student demographics of students in your field</li> <li>» % of undergrad research projects in your department that result in publication</li> </ul>                        | NSF Database<br>Faculty survey                                                      |
| Front-end<br>(before REU begins, after participants are selected), used to inform program design                  | <ul style="list-style-type: none"> <li>» What students and mentors want, expect or fear from your REU program;</li> <li>» Students' graduate school plans;</li> <li>» Students' technical skills</li> </ul>         | Student Surveys<br>Mentor Surveys<br>Interviews<br>Skills pre-test                  |
| Formative<br>(during REU), used to make mid-course corrections to better attain objectives                        | <ul style="list-style-type: none"> <li>» Quality of mentor-student relationship</li> <li>» Research progress</li> <li>» Attitudes toward program activities</li> </ul>                                              | Student Surveys<br>Mentor Surveys<br>Focus Groups<br>Weekly logs/blogs              |
| Summative<br>(after REU), to learn whether program objectives have been met                                       | <ul style="list-style-type: none"> <li>» Perceptions of program usefulness</li> <li>» Students' graduate school plans</li> <li>» Students' technical skills</li> <li>» Students' attitudes and behaviors</li> </ul> | Exit Interviews<br>Reflections<br>Skills post-test<br>Retrospective pre/post survey |
| Longitudinal<br>(months to years after REU), to determine long-term program impacts                               | <ul style="list-style-type: none"> <li>» Academic paths of program alumni (e.g., persistence in STEM majors, enrollment in graduate school)</li> <li>» Career paths of alumni</li> </ul>                            | Annual surveys<br>Personalized emails<br>National Student Clearinghouse             |

Table 1. Types and uses of program evaluation and examples of instruments for measuring.



### A Formative Assessment Tool: The Start-Stop-Continue Discussion

Formative feedback discussions can be very informal or guided through facilitation tools. One such tool to guide discussion is “Start-Stop-Continue,” in which students are asked to identify program aspects that positively or negatively impact their experience, or that they would like to see introduced.



To facilitate this discussion, add the headings “Start,” “Stop,” and “Continue” to three flip-charts or blackboards. Ask students to brainstorm and to put thoughts on sticky notes (working individually or in pairs), and then put the notes under each heading.

Once they are finished, ask students to cluster the sticky notes thematically. Ask if a student will read the sticky notes aloud to the group. Encourage and facilitate discussion along the way, while stopping to address points.

Note: Be sure to give each category adequate time, and don’t allow the discussion to dwell on the (negative) “Stop” category.

If desired, give each student five sticky dots to place beside the points that they feel most strongly about. They can put all dots beside one point or spread them out. This gives a sense of which issues are most important to the group.

| <p style="text-align: center;"><b>Start</b><br/>"What should we start doing?"</p>                                                                                                                                                                                                                                                             | <p style="text-align: center;"><b>Stop</b><br/>"What should we stop doing?"</p>                                                                                                                                                                                               | <p style="text-align: center;"><b>Continue</b><br/>"What should we continue doing?"</p>                                                                                                                                                                                                                                        |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>List ideas/items that:</p> <ul style="list-style-type: none"> <li>» <i>The group is not doing, but think they should be</i></li> <li>» <i>Are new and have either come up or not been considered before</i></li> <li>» <i>Address new situations or factors that may not have existed at the beginning of a project or task</i></li> </ul> | <p>List ideas/items that:</p> <ul style="list-style-type: none"> <li>» <i>Are not working for the team</i></li> <li>» <i>Are not having the desired outcome</i></li> <li>» <i>May have proved to be impractical</i></li> <li>» <i>The team just plain dislikes</i></li> </ul> | <p>List ideas/items that:</p> <ul style="list-style-type: none"> <li>» <i>Are working well and the team wants to keep</i></li> <li>» <i>The team likes and thinks are successful</i></li> <li>» <i>The team may want to "stop" pieces of processes — keep team from "throwing the baby out with the bath water"</i></li> </ul> |

Tables adapted from <https://www.people-results.com/start-stop-continue/>.



## ➔ Summative Assessment: How do we collect final data?

At the end of the REU program, a summative evaluation is conducted to assess the extent to which program goals and objectives were met. It may provide insight into the reasons why some goals or objectives may not have been met, and point to changes that might be needed in the following year.

For the summative assessment, REU site managers generally conduct a post-program survey of the students. Some programs also have an independent person conduct an interview using a script. In these evaluations, students are asked to provide feedback on the program and its elements. Sample topics include:

- » The overall internship experience
- » The student's research project scope or role in the team
- » The level of support received from mentors, staff, and peers
- » Amount of time spent working alone, with mentors, or with other interns
- » Exploration of learning experience through their participation in the program.
- » Professional trainings (e.g., science communication workshops, field trips, resume workshops)
- » Program organization and logistics (the application process, lodging, travel, administrative support)

Examples of questions commonly used in REU site post-surveys are provided in the sample survey in the chapter Appendix.

Results from the summative evaluation of your REU can be helpful to include in your annual report to NSF.

## ➔ Who does the evaluating?

The **REU Site PI or manager** may write the survey or interview script using their knowledge of the program, perhaps by customizing the sample surveys provided in this chapter or from other resources. Either they should have experience in evaluation, or they should get someone with evaluation training and experience to review the survey before administering it. This will reduce the chance of including biased questions, such as leading questions. Questions should be neutral.

An **experienced evaluator** from within the institution can be a good resource for writing or reviewing a survey or interview script, and is usually low cost. Such an evaluator will need to be educated about the program.



**Tip:** Be sure to customize materials to your REU program and to have an experienced evaluator review them before administering them.

An **external evaluator** can be paid to provide the expertise and support of writing and administering of assessment tools. The REU PI should check with their NSF Program Officer for permission to use funds this way unless it was specified in the proposal. The REU PI will need to educate the evaluator about the goals and details of the program.

Consult your NSF Program Officer on their perspective on who can or should do the evaluation and whether funds can be spent on an external evaluator.

### Institutional Review Board Approval

Check with your program officer on whether a formal Institutional Review Board (IRB) to assess your data collection plan is needed. These are sometimes needed in projects that collect data from people that will be used in publications. It is important to protect the identify of REU interns, for example, by avoiding specific references that will allow a reader to identify the subject.

You will need to submit a summary of your data collection plan in the form of a protocol to your IRB. This board may be called something different at your institution, such as the Human Subjects Review Committee. Information will be requested about your project, the data that will be collected, and the ways that the data will be used. The board will decide on the level of oversight they want to have on your data collection. Each IRB works slightly differently, so check with your board.

As a rule of thumb, if you are only using your data to improve the program, very little to no IRB oversight of your project will be necessary.

If you plan to publish or report publicly on your project you will likely need to ask students and mentors for permission (“consent”) to collect data.

## ➔ Tips on Creating and Administering a Survey

### Finding a Survey Tool to Use

There are several online tools that can be used to create surveys such as Google forms, Survey Monkey, and Qualtrics. Paper surveys can also be administered, but data will then have to be entered into a spreadsheet. If desired, you can email the GEO REU listserv with a request for sample surveys on these forms.



#### **Optional, confidentiality and anonymity:**

Explain that the survey is optional. Inform the participants how their data will be used, e.g., if the data will be de-identified, aggregated, or shared with mentors.

**Introducing and ending the survey:** Introduce the purpose of the survey before asking students to fill it out, and add a thank-you note at the end.

**Keeping the survey short:** Aim to have no more than about fifteen questions. Avoid surveying students excessively or giving them long surveys, because that can result in survey fatigue.

**Asking for comments** can provide useful information. If you ask students to rate experiences, it is helpful to also provide a comment box.

**Designing demographic questions:** Collect voluntary, confidential information on gender, race/ethnicity, disability status, veteran status, and first generation college student status. There is no "right way" to do so, but there are practices that cover a lot of areas and do so in a way that is respectful. See the GEO REU website and the GEO REU Email Archives for more on this hefty topic. Consider asking for demographic information in your application form so that you have it for all candidates and not just the selected applicants.

**Avoiding bias:** Be sure to ask questions in a way that does not lead the respondent to give a biased response. For example, the question “Did you have a positive internship experience?” provides a bias versus “Please rate your overall internship experience on a scale of one (poor) to five (excellent).” For open-ended questions, start your questions in a way that is not leading, asking them to describe their experiences.

**Post-program survey timing:** Having students complete the post-program survey while still on-site will likely increase the response rate. At the latest, have students complete the survey during the first week after the program ends.

**Long-term tracking:** The NSF program solicitation says “it is highly desirable to have a structured means of tracking participating students beyond graduation, with the aim of gauging the degree to which the [REU experience] has been a lasting influence in the students' career paths.” Consider sending out a post-REU survey six months out, and an annual alumni survey. This can help you learn where students are at in their career and about their view of the REU program's impact on their career. Keeping in touch with students through an alumni email list or a Facebook group enables continued data collection on the students' career paths.

**Give a survey deadline:** Giving a short-term deadline to complete the survey (such as two weeks) can increase your response rate. Follow up with those that haven't completed the survey if your tool allows.

## ➔ Conducting Educational Research

Beyond program evaluation, you may be interested in collecting data to address educational research questions such as

- » In what ways were recruitment strategies effective in attracting diverse applicants?
- » In which ways do REU students improve their research skills over the course of the summer?”
- » In what ways do mentors benefit from mentoring an REU student?

For more information, see the [chapter on Publishing Educational Research](#).



## Resources

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## PUBLISHING EDUCATION RESEARCH

*Anne U. Gold*

*Barbara C. Bruno*

Program evaluation is quite different from the rigorous educational research standards required for publication in the peer-reviewed literature. Although not required by NSF, systematically studying and publishing the impacts of your REU program on students and mentors can be highly satisfying, as well as beneficial to REU programs nationwide (as well as to your research career!). To do this, you will need to go beyond the basics and develop a full research design. As many REU PIs may not have a background in education research, this chapter demystifies the process by providing guidelines.

## ➔ Key Steps

### Conduct a Literature Review

A literature review can help you identify:

1. research designs and methods that have been implemented successfully in other REUs;
2. gaps in the knowledge around REU programs; and
3. unique aspects of your REU program which could become the focus of your evaluation.

A list of recommended reading around researching REU programs is provided at the end of the chapter. The National Academies (2017) report on STEM undergraduate research programs is a good place to start. This report summarizes the research around REU programs as measuring their impact on:

- » Knowledge, scientific thinking, and skills
- » Scientific identity and self-efficacy
- » Persistence along the STEM pathway, including retention in STEM majors and enrollment in graduate school.



### Construct a Logic Model

A helpful first step in designing your educational research plan is to visualize the connections between what you plan to do and what you hope to accomplish. A “logic model” will map available resources (“*inputs*”) and planned activities to outputs (concrete deliverables), and desired *outcomes*.

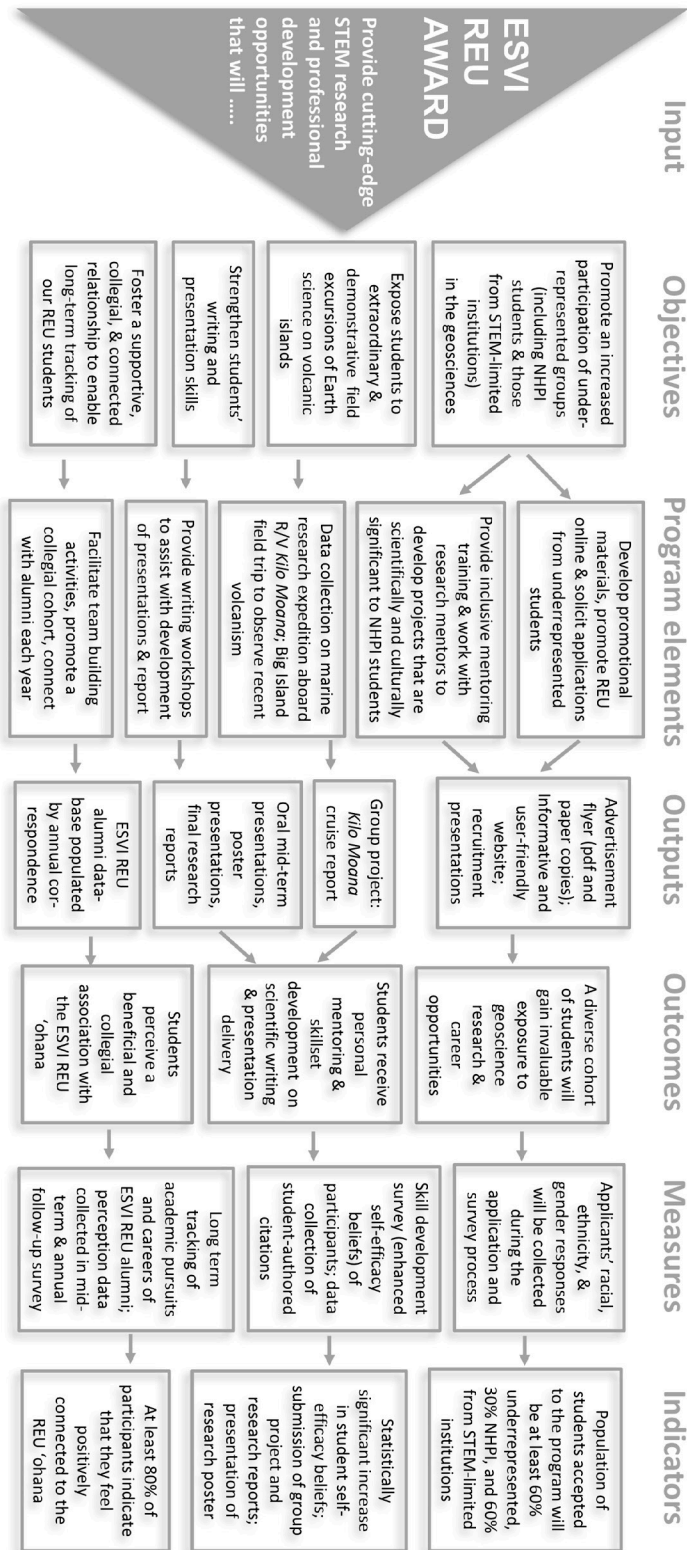


Fig. 1. Logic model example (courtesy of Bridget Smith-Konter, Earth Sciences on Volcanic Islands (ESVI) REU, University of Hawaii).

## Develop Your Research Question



Research questions may emerge from your logic model, from knowledge gaps in the literature around REU programs, or from your direct experiences with REU students and mentors.

A research question that could be drawn from the above logic model, for example, might be: “In what ways were recruitment strategies effective in attracting diverse applicants?”

Other research questions might include “In which ways do REU students improve their research skills over the course of the summer?” or “In what ways do mentors benefit from mentoring an REU student?”

Once you decide on one or more research questions, it is helpful to conduct a second, more focused literature review to put your research into context within the existing body of knowledge.

## Select the Research Design and Instruments

Educational research at the most rigorous level, such as a randomized control trial, is not feasible within REU programs because of the small participant numbers, non-random participant selection processes, and the challenges in finding appropriate control groups. However, small-scale, quasi-experimental studies provide important insights into program impacts and advance our knowledge on best practices around REUs (National Academy of Sciences, 2017).

## ➔ Designing the Study

It is not possible to study every aspect of your program. Time and resources are finite, and excessive data collection can result in respondent fatigue. So, it is important to be selective and focused.

To help you focus, ask yourself some key questions:

- » What is the purpose of the study?
- » Who will use the results and in what way?
- » What resources do I have to invest?

Focusing your research design on unique aspects of your REU, using strong measures, is recommended. The small size of most REU programs and/or the lack of control groups can prove challenging. Combining results from multiple years, or from different REU programs, is one possible solution to these challenges.

## ➔ Choosing Research Instruments or Tools

Based on your research question(s), select the type of data you want to collect, and identify the research methods that align with your intended research outcomes.

Research methods can be *quantitative* (e.g., skills tests, attitude surveys) or *qualitative* (e.g., interviews, focus groups, open-ended survey questions). The former quantifies skills, attitudes, and behaviors with the goal of finding patterns in the data. The latter is exploratory research aimed at understanding why those patterns occur. Often a combination of both (“mixed methods”) is necessary to tackle a research question.

The [Evaluate handbook](#) (Frechtling Westat, 2010) nicely summarizes advantages and disadvantages of many methods.

### Surveys

Due to the small study population in typical REU programs it is usually best to collect a mix of qualitative and quantitative data through surveys. The qualitative data provide important context for the quantitative data that are collected.

Open-ended survey questions will encourage students to broadly reflect on the question. These open-ended responses are usually coded in order to allow for themes to emerge from the student responses (see *Braun & Clarke, 2006* for a great description of thematic coding). Some of the responses can also be used as direct quotes in publications. Quantitative data are usually collected through closed-ended surveys using either multiple-choice or Likert scales.





*Validated* instruments are the gold standard for surveys. They have been tested on populations that are large and diverse enough to ensure that they measure what they claim to measure. These instruments are ideally used with the populations for which they have been developed and validated. Shortlidge & Brownell (2016) provide a list of validated research instruments relevant to REU programs. In cases where validated research instruments appropriate to your research questions do not exist, see DeVellis (2016) for guidelines in developing your own instruments.

### Interviews

In addition to surveys, a tool that is often used in REU programs are interviews. The [Evaluate handbook](#) (Frechtling Westat, 2010) summarizes the many pros and cons for conducting interviews.



#### *Advantages of interviews:*

- » Usually yield richest data, details, new insights
- » Permit face-to-face contact with respondents
- » Provide opportunity to explore topics in depth
- » Allow interviewer to experience the affective as well as cognitive aspects of responses
- » Allow interviewer to explain or help clarify questions, increasing the likelihood of useful responses
- » Allow interviewer to be flexible in administering interview to particular individuals or in particular circumstances
- » Effective data collection for small study populations

#### *Disadvantages of interviews:*

- » Expensive and time-consuming
- » Need well-qualified, trained interviewers
- » Interviewee may distort information through recall error, selective perceptions, desire to please interviewer
- » Flexibility can result in inconsistencies across interviews
- » Volume of information very large; may be difficult to transcribe and reduce data



## ➔ Collecting Data

Your research question, research design, and research tools drive how, what, and when you collect data. Data can be collected before the REU begins, at any point during the program, and/or after the program ends. For example, demographic data collected at the time of REU application will enable a demographic comparison of the applicant pool with the selected pool, while longitudinal data collected long after the REU program ends can measure long-term program impacts on participants. Here are some tips:

Don't oversurvey your students. Only collect data that are necessary to answer your research question and, if relevant, to improve the program. To avoid survey fatigue, limit each survey to 15 questions or 20 minutes.

Collect data anonymously or, in cases where you will need to pair survey responses (e.g., pre-post) to measure change, replace names with unique codes and then de-identify the data for analysis to avoid any bias in the analysis.

Consider timing. For example, avoid surveying students prior to a presentation, when feelings of insecurity or presentation anxiety may affect their answers.

Be careful when generalizing your research findings (e.g., to other programs, other student populations).

### Measuring Change and Avoiding Bias



If your research question involves changes that may occur in students (e.g., in skills, attitudes, behaviors), one common approach is a *pre-post* study design, in which the same questions are asked in surveys administered before and after the REU.

As you design your survey, consider that students' baselines might change.

If for example the survey asks students to self-report their ability to interpret graphs or write Python code before the REU program, they might rate themselves highly, largely due to past success with simple examples.

If during the program they realize how much they have yet to learn, they could rate themselves lower in the post-survey, even though their skills may have increased.

To avoid this bias, we propose several work-arounds:

- » Use a retrospective pre-post survey design. That is, at the end of the program, ask students to rate themselves in various areas at two different time points (before and after program participation) or, alternatively, ask students to report the changes in the parameter you are exploring (e.g., skill, confidence, science identity) they experienced over the course of the program. One widely used validated survey instrument is the online [Undergraduate Research Student Self-Assessment \(URSSA\)](#), hosted on the [Student Assessment of their Learning Gains \(SALG\) website](#).
- » If there is a goal to measure the change in a specific skill (e.g., science literacy), try to measure that skill directly (as objectively as possible), rather than asking students to report self-perceptions.

### Benefits and Challenges of Longitudinal Studies

Collecting data well after an REU program ends can help you measure long-term program impacts. Moreover, longitudinal studies can reveal whether, in the months or years following REU program participation, alumni develop a greater appreciation of what they learned. However, conducting a longitudinal survey long after the program ends can be challenging, due to funding limitations and difficulties tracking down the students and getting them to respond. Given the value of post-program data collected once students have gained a greater perspective about their experience, it would be worth considering conducting an online survey one year after the REU ends. Tip: Gift Cards as rewards greatly increase the response rate!



### Get Feedback

Presenting your research methodology at geoscience education conferences (e.g., Earth Educators Rendezvous) or at education sessions at geoscience meetings (e.g., American

Geophysical Union or Geological Society of America) can be a useful way of getting constructive feedback on your research study. You can also reach out to a community member, either directly or through the [GEO REU email listserv](#), and ask for a review of your research design.

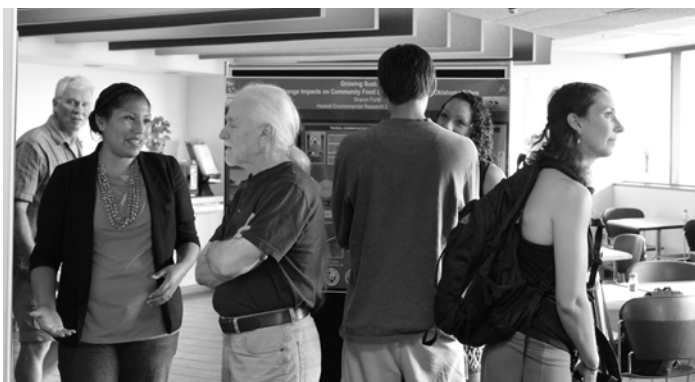
### Obtain Institutional Review Board Approval

Educational research involving human subjects always requires consent of the study subjects and approval by your institutional review board (IRB), to ensure that your research is ethical and that program participants are protected. This requirement holds true regardless of whether or not you plan to publish your results, and even if your study is exempt from federal regulations. Check with your local IRB office for guidance on the details for the application, as they vary from institution to institution.

IRB approval must be obtained before you begin your research study. If you plan to use any of the information from the REU applications in your study, IRB approval must be obtained before the application is opened to students.

### ➔ Analyze the Data

Quantitative data are summarized using descriptive and inferential statistics. Published descriptions of the research instruments usually suggest paths for analysis.



It is possible to convert qualitative data into quantitative data by quantifying the number of times certain themes show up in survey responses.

Qualitative data including interview and focus transcripts as well as open-ended survey responses require coding in order for findings to be reported.

Coding involves matching words or statements with codes that represent meanings or concepts.

Many qualitative analytical methods exist; one intuitive one is thematic analysis (see *Braun & Clarke, 2006* for a helpful description).

Depending on the methodology, there are variations in the way coding is conducted. Many analytical techniques include these steps:

1. In the first step, read through all transcribed data and outline broad themes in a code book. The list of codes can be informed by work from others or it can emerge from your research question or data.
2. In a second iteration, the responses will be coded using your list of codes.
3. In a third step, a second person will use the same list of codes and data sets to code the responses.
4. Next, compare the results of the coding (interrater reliability).
5. After coding has been completed, you can summarize the prevalence of themes in each data source. This process allows synthesis of the qualitative data.

Make sure to note the absence of certain themes or ideas as you review your data.

## ➔ Select an Appropriate Publication Venue



Both disciplinary science journals (e.g., *Oceanography*, *Climatic Change*) and science education journals (e.g., *Journal of Geoscience Education*, *Scholarship and Practice of Undergraduate Research (SPUR)*) are appropriate venues for publishing geoscience education research. There are also non-peer-reviewed publications (e.g., *In the Trenches* from National Association of Geoscience Teachers) to consider.

The appendix provides an extensive (although not complete) list of relevant journals. When choosing a journal, aim to find a good fit to both your research topic (e.g., geoscience discipline, type of data you are collecting) and your intended audience (e.g., geoscientists, education researchers). For example, the *Journal of Geoscience Education* accepts submissions in four categories: Curriculum & Instruction, Research, Literature Review, and Commentary. Each journal has different submission guidelines, review processes and timelines, and some offer special issues on particular topics.



### Summary & Checklist

- Review the literature on REU program findings
- Construct a logic model to guide your evaluation plan
- Develop your research question
- Select your research design and instruments
- Get feedback
- Obtain Institutional Review Board (IRB) approval before beginning your research study
- Collect and analyze your data
- Select a journal based on your research topic and intended audience



### Further Reading

Brownell, J.E., and L.E. Swaner, 2010. Five High-Impact Practices: Research on Learning, Outcomes, Completion, and Quality; Chapter 4 in Undergraduate Research. Washington, DC: Association of American Colleges and Universities.

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## Appendix

### Journals Relevant to Education Research on Geoscience REUs

In addition to journals in your geoscience discipline, consider publishing in the following:

#### Geoscience Education Journals

- » Journal of Geoscience Education
- » Journal of Earth System Science Education
- » Journal of Environmental Education

#### STEM Education Journals

- » Journal of College Science Teaching
- » Scholarship and Practice of Undergraduate Research
- » Science Education
- » Journal of College Student Development
- » Journal of Women and Minorities in Science and Engineering
- » Scholarship and Practice of Undergraduate Research (SPUR)



#### Geoscience Newsletters & Bulletins

- » Bulletin of the American Meteorological Society
- » \*Limnology & Oceanography Bulletin
- » EOS (from American Geophysical Union)
- » The Earth Scientist (from National Earth Science Teachers Association)
- » \*In the Trenches (National Association of Geoscience Teachers)

\* = not peer reviewed



## **GEO REU HANDBOOK**

A Guide for Running Inclusive and Engaging Geoscience  
Research Internship Programs

Edited by Valerie Sloan and Rebecca Haacker,  
National Center for Atmospheric Research



Whether you are new or experienced at running a Geoscience Research Experiences for Undergraduates (GEO REU) internship program, this handbook provides best practices, tools, and tips for site managers, from how to prepare mentors to suggested team-building activities.



### **For Citation**

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