EPO

Education and Public Outreach

A GUIDE FOR SCIENTISTS

Contents

About this Guide

Introduction

This guide provides basic information for scientists who wish to engage in education and public outreach (EPO) activities. Engaging in EPO can be an excellent way to address funding agencies' requirements that proponents articulate the broader societal value of their research. Whether or not you happen to be preparing a proposal, this guide can help you recognize and contribute to high-quality EPO.

In this guide, EPO refers broadly to efforts to increase awareness and understanding of science. Audiences targeted can include students, teachers, children, adults, and just about any conceivable subset of these (e.g., economically disadvantaged youth, adult education instructors, museum visitors, parents, newspaper readers, high school students). We broadly define informal education as lifelong learning in science, technology, engineering, and mathematics (STEM) that takes place across a multitude of designed settings and experiences outside the formal classroom (see the Center for Advancement of Informal Science Education website at http://informalscience.org). The guide reflects our experiences in ocean sciences EPO, however, the strategies presented are readily applicable to scientists in other disciplines.

Throughout the guide we emphasize the benefits of scientist-educator partnerships. Effective partnerships result when ideas are shared, each partner's expertise is respected, and both scientist and educator work toward the common goal of delivering high-quality products and services to the

EDUCATION

The teaching and learning of knowledge, skills, and cultural beliefs through formal (in school) or informal (self-directed) activities.

PUBLIC OUTREACH

Activities that generate awareness, interest, and engagement, and may also support education.

intended audience. Although it is not necessary for scientists and educators to become experts in each other's fields, it is desirable for each to learn enough of the other's domain to be able to appreciate and discuss the viewpoints and constraints characterizing each discipline.

Scientist and educator partnerships are win-win. Scientists benefit from leveraging the science communication expertise of an EPO professional who has experience translating research findings and data into formal and informal learning experiences, including museum exhibits, after-school programs for young people, or K–12 STEM curricula. Educators benefit from scientists' expertise, and products or programs resulting from the partnership can reach diverse student, teacher, and public audiences. Scientists who prefer to embark on more independent efforts may be especially interested in the section "Communicating Effectively."

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Most High-Quality EPO Project Plans:

1. Have specific, clearly stated goals that are both ambitious and realistic.
2. Identify an appropriate audience, and address the needs of that audience.
3. Identify outcomes that are measurable.
4. Include a time frame for accomplishing objectives.
5. Leverage or build on other EPO efforts rather than duplicate existing resources.
6. Involve professionals with appropriate scientific, technical, and pedagogical expertise.
7. Include a budget and funds to sufficiently complete the proposed work.
8. Include plans for sufficient staffing.
9. Create something of enduring value.
10. Include a plan to evaluate the success of the project.

Tips for Preparing EPO Proposals

Proposal preparation is often done under the constraint of limited time. These tips may be useful to those preparing the EPO portion of a research proposal.

1. **Start early, ideally six weeks or more before your proposal is due*.** Initiating partnerships that are productive and result in enduring and valuable EPO products take time and energy. Afford yourself the time to think creatively about who can help support your work.

2. **Inform yourself about what constitutes a high-quality EPO project*.** There are guidelines in place that can help you frame your EPO project using the established, effective practices in the field. Use EPO collaborators to help define and articulate your project and advance the field.

3. **Prepare a brief lay-language synopsis of the proposed research that describes the broader scientific context of your particular research.** A few sentences may be sufficient. This passage will facilitate your dialog with potential EPO collaborators. You may wish to draw on text from your proposal summary, particularly if your proposal is a resubmission.

4. **Enlist the support of an EPO collaborator.** If you lack sufficient experience, skills, time, or contacts to accomplish the EPO you aspire to do, consulting or partnering with an EPO professional is highly recommended. Identify and contact potential EPO collaborators to discuss your ideas and solicit theirs. It is highly advisable to ask how your research may relate to and support existing or planned EPO efforts by their organization or organizational partners. Remember that EPO professionals can often help identify opportunities for supplemental funds and cost-sharing.

5. **Determine your EPO goals and then the appropriate audience(s)*.** Setting clear and appropriate goals, while challenging, is the hallmark of a well-conceived EPO project. Explicitly articulate your EPO goals and describe activities and objectives that reflect the needs of your specific audience(s).

6. **Determine if what you are considering has already been done, in part or in whole, by others.** The education community has a body of literature similar to the STEM research disciplines. If appropriate, cite foundational work for your idea in your proposal. Describe how your proposed project will augment existing EPO programs or resources.

7. **Determine if the proposed program, product, or service will be useful.** Consider informally asking representative members of the audience you intend to address how valuable what you propose would be to them. Consulting or collaborating with leaders in the community you hope to impact (e.g., science education leaders in formal or informal STEM education organizations) is a good way to ensure that your efforts will address priority needs and have lasting value. You also can access published needs assessment work in the education literature. For example, there is extensive work on the needs of K–12 educators for professional development in STEM or the need for information related to climate change that can be used to educate the public.

8. **Determine what expertise and resources will be needed to accomplish your goals*.** For example, you might need to engage experts in areas such as social media, event organization, curriculum development, product dissemination, and evaluation. Budget accordingly (e.g., salary support, facilities, supplies, travel funds), just as you would for the research-related elements of your project. Your EPO collaborator also can be helpful in outlining potential costs to achieve your project goals and objectives.

9. **Make plans to measure and document the success of your EPO efforts*.** If resources allow, the EPO team may also engage an independent professional evaluator to help design the EPO project, get feedback from the audience while the project is underway, and assess the impact of the project.

* These steps can be greatly facilitated by consulting with an experienced EPO professional.

EPO Project Ideas

These EPO efforts can be stand-alone activities or support larger, existing efforts.

- Interact with teachers at a professional development workshop.
- Consult with informal science center staff on the development of exhibits or public programs.
- Give a public presentation on your science at your own or a nearby facility.
- Volunteer at an organization dedicated to promoting STEM career pathways for groups underrepresented in science.
- Be interviewed by a journalist about your work.
- Create a media (audio or video) piece for public radio, social media, or the commercial market.
- Host an intern(s) from a minority-serving institution.
- Support your graduate students' professional development by providing them with opportunities for EPO training and participation in proposed outreach activities.

Sustained EPO efforts such as the following may allow you to develop more substantial relationships with the education community.

- Virtually mentor a student for a research project.
- Host an educator or student in your lab, on a cruise, or in the field.
- Serve on an EPO-oriented advisory or review panel.
- Be a scientist-in-residence at a school, science center, museum, or aquarium.
- Serve as a science expert on an initiative aimed at improving science instruction in a local school or district.

You may contribute to the development of a tangible EPO product.

- Be a content expert on a curriculum development team.
- Partner with educational technology professionals to develop and maintain a data access portal for non-expert users.
- Write a general audience article about your work.
- Collaborate with an education expert to create a student-friendly data set and activity based on your research.
- Work with web designers and educators to produce online resources for non-scientists.
- Create visualizations tailored for classroom or educational program use.

10. **Write a clear, detailed description of the EPO project for inclusion in the proposal*.** Specify goals and objectives, and state with whom you will work. Describe what you, personally, will contribute to the project. Explain who will benefit, how, and over what time period. Say why your project is likely to succeed (e.g., you've engaged the appropriate collaborators, are leveraging resources, creating something of lasting value) and how you will measure progress/success.

11. **Notify the appropriate staff in your institution's business office early in the proposal-development process if you plan to include funds for EPO in your budget.** Depending on how business is done where you work, this notification may ensure that funds designated for EPO will be readily transferable to your EPO collaborators once the proposal is funded.

12. **Follow funding agency guidelines about letters of collaboration or support from your EPO collaborators in your proposal and when allowed or required, include them.** If the information a collaborator can include in a support letter is limited, remember that you can often use other sections of a proposal such as the budget justification or the section describing resources and facilities to outline some of the details of the collaboration. As always, checking with a program officer about restrictions is advised.

13. **During proposal preparation and after submission, keep your EPO collaborators apprised of major developments regarding the proposal.** Updates are especially important if your budget requires changes. Provide your EPO collaborators with copies of any proposal reviews, which can provide important feedback, regardless of whether or not the proposal is funded.

Looking for EPO Partners

A concern commonly expressed by scientists is: *My science is extremely complex. How can I hope to base an EPO project on my work when it is difficult for some of my colleagues to understand?*

Partnerships with science educators can be the key to addressing this understandable concern. Rather than teaching the details of your work, the goal of most EPO projects is to convey fundamental concepts that underpin your research, your excitement about your investigations, and the broader relevance of your discoveries. Professional science educators are adept at translating complex scientific concepts into materials appropriate for a variety of audiences. They are able to readily extract the most exciting and relevant aspects of your research for inclusion in quality EPO. Together, scientists and educators can ensure that the messages conveyed are both scientifically accurate and understandable.

Where can you find an EPO partner?

The National Alliance for Broader Impacts is a network of professionals who support the development of sustainable and scalable engagement in broader impacts activities. Additional places to look include nearby science centers, aquariums, museums, nonprofit education and workforce development organizations, and organizations that offer teacher training or professional development programs. Such organizations may include traditional or online university and/or community college education and extension departments. It is also worth exploring connections through national and regional educators' professional societies and federal and state agencies. Scientific professional societies are also excellent places to find connections to knowledgeable educators.

How might you approach an organization to explore potential collaboration? Seek out the individual(s) responsible for the EPO activities of the organization. Explain your interests and timeline; ask how your research may relate to and support existing or planned EPO efforts by their organization.

Starting Points for Finding EPO Partners

- American Geophysical Union
- American Meteorological Society
- Association for the Science of Limnology and Oceanography
- American Zoo and Aquarium Association
- Association of Science-Technology Centers
- Center for Advancement of Informal Science Education
- Consortium for Ocean Leadership
- Consortium for Ocean Science Exploration and Engagement
- Geological Society of America
- Institute for Broadening Participation
- National Alliance for Broader Impacts
- National Association of Interpretation
- National Marine Educators Association
- National Science Teachers Association (and associated state/province chapters)
- North American Association for Environmental Education
- Sea Grant
- The Oceanography Society

Communicating Effectively

Whether you will be preparing a presentation for non-scientists, developing a website*, or participating in a teacher professional development program, think carefully about how you'll get your points across. Consider the following:

- Strive for clarity and appeal to intrinsic human interests. *The most important consideration is to tell a story about your work.* Explain not just what you do, but why you do it. What questions are driving you? What is the larger context for your work? Why do you find it exciting? What is still unresolved about your work? Humor can be helpful in telling a story. People may remember what you say or write better if you make them laugh.

- Minimize jargon. Remember you are an expert in your field and your audience is not. Try to use terms that your audience will understand. If you must use a technical term, define it clearly.

- Use analogies and metaphors to explain physical or biological phenomena in terms of the familiar: bathtubs, swimming pools, cooking/eating, traffic, etc. There are several techniques that can be applied to help you "decode" your discipline (e.g., Decoding the Disciplines at http://decodingthedisciplines.org or the COMPASS Message Box at https://www.compasscicomm.org/message-box-online).

- Show photographs of people doing fieldwork, instruments, and the animals, plants, rocks, or waves you study. Be sure to explain carefully what is in the photo. Be careful to be culturally sensitive in what photos you use to share your message.

- Use plots, diagrams, and complex animations carefully. Newer data visualization techniques can be used to generate images that enhance researchers' ability to communicate information and concepts effectively. In general, strive for ways to make data more understandable to your audience through visualizations and infographics.

*Before you add to the millions of documents available on the web, consider that many "general purpose" websites are of limited value to those their creators hope to reach. If you decide to go this route, pay special attention to conveying credibility and navigational ease.

Links of Possible Interest

The Broader Impact Wizard, Center for Ocean Science Education Excellence Networked Ocean World (NOW)
- **http://coseenow.net/wizard**: This online wizard walks you through a series of steps to creating an effective broader impacts project for your National Science Foundation proposal.
- **http://coseenow.net/scientist-resources/broader-impact**: This site offers pre- and post-award resources for scientists, including case studies of effective broader impact projects.

National Alliance for Broader Impacts (NAB)
https://broaderimpacts.net
This site includes a downloadable list of guiding principles for developing and evaluating broader impact projects.

Communicating Science Effectively: A Research Agenda
https://doi.org/10.17226/23674
This 2017 publication from National Academies Press provides approaches to communicating science that will be most effective for specific audiences and circumstances.

Center for Advancement of Informal Science Education (CAISE)
http://www.informalscience.org
CAISE builds and advances the informal STEM education field by providing infrastructure, resources, and connectivity for educators, researchers, evaluators, and other interested stakeholders. Their website provides access to over 7,000 resources that include project descriptions, research literature, evaluation reports, and other documentation.

Institute for Broadening Participation (IBP)
http://www.pathwaystoscience.org
IBP connects underrepresented students with STEM funding and research opportunities, and provides faculty and administrators with tools and resources to help promote the positive factors that keep underrepresented students on the STEM pathway into successful STEM careers.

Getting Feedback

Evaluation, however simple or sophisticated, involves the collection of information that allows one to assess the value or usefulness of a product, service, or experience. Think of it as a way to get feedback before, during, and after you conduct your EPO. You may be quite familiar with assessment through your experiences giving and taking exams, with course evaluation forms completed by university students, and with the peer-review process by which colleagues weigh in about the merits of proposed research and the quality of manuscripts submitted for publication.

With a level of care comparable to that taken in designing a research program, a plan should be developed for getting from "where you are" to "where you want to be" in your EPO project. A good evaluation plan provides a structure for clearly understanding the need for your contribution to EPO, the desired outcomes of your project, and how the resources invested will address particular needs of the audience.

Soliciting feedback or collecting data from your intended audience at various stages in the implementation of a project is an essential component of project evaluation. Evaluation can help address questions such as:

- Was this project successful? To what extent did the project meet stated goals and objectives?
- Was this project valuable to your audience? Were your activities appropriate for them?
- Did your audience change as a result of this project, and in what ways (i.e., knowledge, skills, or behavior)?
- To what extent have the stated goals and objectives been met?

Asking such questions and devising a plan to answer them are hallmarks of high-quality EPO. The answers may prompt mid-course corrections, influence the design of future projects, and help justify the expenditure of resources to funders, colleagues, and the participating institutions.

We suggest you consult an expert, unbiased evaluator to guide you through this important process. Whether you partner with a professional or conduct your own assessment, we recommend the following three-step approach for EPO product or program development.

Useful Links when Considering Professional Evaluation

Information about EPO Evaluations
http://www.informalscience.org/evaluation/developing-evaluation-plan

The 2010 User-Friendly Handbook for Project Evaluation
http://www.informalscience.org/2010-user-friendly-handbook-project-evaluation

Finding an Evaluator — American Evaluation Association
http://www.eval.org

Relating Research to Practice
http://rr2p.org

Evaluate Before, During, and After

Step 1. Analyze Audience

Begin with an analysis of the audience so that the project can be tailored to best suit users' needs. The objective is to understand users' interest in, familiarity with, and preconceptions about a subject area and product(s) to be developed. Reading the appropriate educational literature, or conducting surveys or focus groups, are some of the ways to solicit feedback and ground truth an EPO project idea.

Typical questions asked during this phase (called front-end evaluation) are:
- What is the intended audience's current state of awareness, knowledge, or skill?
- What product/program are they already using? Do they need a new, different product/program? Do they have the capabilities/skills to use the proposed product/program?
- What are their preferences for such products/programs?
- What would enable them to use, and what would prevent them from using, the proposed product/program?

Step 2. Design, Develop, and Launch

During these phases, formative assessment is used to ascertain the strengths and weaknesses of what is being designed/developed/launched to ensure it works for the users. Users are often presented with design criteria, storyboards, and/or prototypes for review and asked to provide feedback on the usability of product(s). This phase may be iterative until you get the desired feedback from your user group.

Step 3. Final (Summative) Evaluation

This phase involves reflecting on and accounting for the resources that went into a project, the activities undertaken, and the changes or benefits that have resulted.

Typical questions include:
- Whom (number of people and their demographics) has this project reached or benefited?
- How profound, deep, lasting were these benefits?
- What were the most valuable/successful elements of the project?
- What elements of the project were less successful/valuable?
- What, if any, understanding or action did the project inspire?
- How does this project/product/service compare with others like it in terms of effectiveness, reach, cost:benefit ratio?
- To what extent were the stated goals and objectives met?

Frequently Asked Questions

Do funding agencies support inclusion of $$$ for EPO in research proposals?

Although policies on this vary among agencies and even among programs within a single agency, the short answer is, "yes." It is widely acknowledged that conducting research requires money for such things as salaries, equipment, and travel. Reviewers, panelists, and program officers are increasingly recognizing that designing, executing, evaluating, and disseminating quality EPO programs also require funding. Scientists and their education-focused partners should allocate sufficient funds to carry out their EPO plans.

Will including EPO give me any advantage in the review process?

There are many variables in the proposal review process. For large, multimillion dollar awards, a strong EPO section will often enhance your chances of getting funded. Although the intellectual merits of the proposed research are paramount, many funding agencies are starting to place more emphasis on the impact of your proposed research outside of academia. The level of attention paid to EPO is still very much in the hands of reviewers and program managers. It is recommended that you check in with the program manager to make sure that your proposed EPO project fits within the program purview. The National Alliance for Broader Impact is active in this debate and can provide the most up-to-date assessment.

What is NSF's policy regarding broader impact?

In 1997, NSF's National Science Board approved the use of two merit review criteria for NSF proposals: (1) the intellectual merit of the proposed activity and (2) the broader impacts resulting from the proposed activity. In October 2002, NSF began returning proposals that did not include the required broader impact sections. This shift in policy encouraged scientists to participate in a variety of EPO projects as a way to satisfy the requirement. In 2011, the National Science Board issued a report, *National Science Foundation's Merit Review Criterion: Review and Revisions* that, in addition to reaffirming the two merit review criteria, set forth three merit review principles:

- All NSF projects should be of the highest quality and have the potential to advance, if not transform, the frontiers of knowledge.
- NSF projects, in the aggregate, should contribute more broadly to achieving societal goals. These "broader impacts" may be accomplished through the research itself, through activities that are directly related to specific research projects, or through activities that are directly supported by, but are complementary to, the project.
- Meaningful assessment and evaluation of NSF projects should be based on appropriate metrics, keeping in mind the likely correlation between the effect of broader impacts and the resources provided to implement projects. If the size of the activity is limited, evaluation of that activity in isolation is not likely to be meaningful. Thus, assessing the effectiveness of these activities may best be done at a higher, more aggregated level than the individual project.

For a succinct summary of NSF's Merit Review Criteria visit: https://www.nsf.gov/bfa/dias/policy/merit_review/overview.pdf.

I am submitting my proposal to XYZ federal agency. What are their particular requirements with respect to engaging in EPO activities?

Requirements vary significantly across federal, state, and private funding agencies. Careful reading of a solicitation is always the best way to determine if an EPO activity is required or recommended. As stated above, all NSF proposals are required to address both intellectual merit and broader impact, and many proposers use educational activities to fulfill the broader impact requirement. Mission-driven agencies often have strategic plans for how they will advance their mission through education, and may encourage education activities in research proposals that are directly aligned to these plans. For example, a high-priority need for many agencies is development of a well-prepared and diverse STEM workforce, and including activities that support this goal may enhance a proposal. Speaking with a program manager is advisable if you need information on how proposed contributions to the agency's educational mission are treated for research solicitations.

How can I showcase my EPO activities in my promotion and tenure file?

Ask your EPO partner or the sponsor of the project to which you have contributed to write a letter of support outlining your contributions and the impact of your participation. Include this letter in the materials you submit to your department. EPO activities are increasingly considered in promotion and tenure deliberations. You might also consider sharing broader impacts stories with NSF, if applicable, via e-mail (broaderimpacts@nsf.gov; see also this page: https://www.nsf.gov/od/oia/special/broaderimpacts).

I understand that workforce diversity is a major challenge for the STEM community and am interested in working to bring more diverse individuals into my field. Are there specific resources that can help me understand the challenges and find education partners with expertise and experience in this arena?

The Institute for Broadening Participation is a national clearinghouse and advisory group focused on addressing this challenge. Resources on its website include an extensive annotated list of peer-reviewed articles, seminal studies, and intervention strategies for broadening participation as well as descriptions and contact information for over 140 precollege projects across the nation. In addition, the 2016 Summit of the National Alliance for Broader Impacts was focused on diversity and contains presentations and guidance from both experienced diversity project directors and federal program managers. Closer to home, check to see if your home institution has an office focused on equity and diversity. Moving into the broader community, is your area served by diversity-focused federal programs such as Upward Bound or community nonprofits such as the Boys and Girls Clubs? One strength of such national programs is that they go beyond "stand-alone one-shot" experiences to provide a continuum of services and experiences over time.

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