Basic and beyond: Next steps on the path to effective and meaningful science communication

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Executive Summary

In 2022, leaders of the Science-Public Engagement Partnership (SciPEP) published *Charting a Path for Public Engagement in Basic Science: A Prospectus*. This prospectus, together with a set of landscape reports commissioned by SciPEP, revealed that little is known about effective science communication and engagement *specifically on basic science topics.* The prospectus articulated a number of high-level questions, which we build on in this phase of work by exploring how researchers, practitioners, and others in the field of science communication and engagement might approach those open questions, sparking new ideas and initiatives. Rather than focusing extensively on key ideas—already articulated in the prospectus—we engaged with the details of *why* and *how* these ideas could be actioned, and what challenges exist that might make realizing these goals difficult. To this end, we interviewed basic scientists, practitioners, and social science researchers to understand individual and collective field-wide priorities and potential approaches. These interviews yielded the following key insights.

Practitioners and researchers alike see a need for detailed and context-specific approaches over general and large-scale approaches

When interviewees described the kinds of questions and insights they felt would enable effective communication and engagement, they described a desire for deep, comprehensive, and context-specific information that cannot be inferred from broad data collection aimed at producing generalizable results. They noted that while surveys of U.S.-based and international publics can provide a general sense of public opinion, it is challenging to know what a set of statistics (e.g., the level of agreement with a range of statements about science) means for their specific efforts to engage a particular community on a particular topic in a particular way. Consistent with the questions included in the prospectus, many interviewees emphasized that the future of effective basic science communication and engagement relies on the ability to understand perceptions of basic science, what various publics' needs and goals are, and why science is (or isn't) important to them; crucially, however, these questions must be asked and answered at the level of individual contexts and communities.

Understanding individual communities' unique and diverse responses to these questions, interviewees noted, will facilitate effective communication and engagement.

Interviewees were unsure about whether and when "basic science" is a helpful focal point

All interviewees provided definitions of "basic science" that were consistent with the definition included in the prospectus. However, after defining the term, many participants expressed uncertainty or skepticism about a distinction between basic and applied sciences, both in distinguishing different types of research and types of communication or engagement.

Many interviewees described struggling with the distinction because they see scientific research on a continuum, with the concepts of "basic" and "applied" as theoretical poles and particular fields, topics, and research programs occupying various gray areas in between. Perhaps because of this uncertainty, or because communication and engagements focused on basic science topics were not salient for interviewees, even when they were explicitly asked about basic science topics, interviewees frequently defaulted to talking about "all science" and provided examples of communication or engagement on clearly applied science topics (e.g., health recommendations related to COVID-19).

Basic science was most often associated with one-way communication, rather than multi-directional, collaborative forms of engagement

With the recognition that the prospectus included questions pertaining to both one-way communication and bi-directional engagement because of the paucity of research on either topic specific to basic science, our interviews revealed that the answers to many of our questions (e.g., what kinds of trainings are most effective?) are likely to be quite different for these two different modes of sharing scientific information. Notably, *communication* was much more salient and concrete for participants when thinking about basic science topics. When asked generally about communication and engagement, most offered prototypical communication examples, such as media (e.g., press releases, YouTube videos), education (e.g., scientists volunteering in classrooms), and other events (e.g., public lectures). Those who offered examples of more multi-directional engagement tended to share examples of exchanges on applied science topics. Some participants explicitly noted that they couldn't picture what engagements like dialogue, deliberation, or knowledge co-production would look like for basic science topics. They were unsure what such activities would be designed to accomplish or what they could accomplish in reality. Others stated that engagement is much more difficult for the basic sciences because it's more challenging to equip public audiences to be effective partners and to determine what they would gain from activities like collaborative research. Still others asserted that for basic science topics, engagement is not really relevant; rather, the field should focus on communication.

Interviewees found it challenging to articulate potential approaches to addressing the unanswered questions they identified

Each time we discussed a question or challenge related to basic science communication and engagement, we asked interviewees how they thought the field could make progress on addressing it. Many interviewees found it challenging to articulate what could be done—whether particular research, convenings, or resource development were needed, what those activities would look like, and who would be responsible for catalyzing and contributing to them. The three takeaways described above may all contribute to this challenge. Specifically, the desire for detailed, context-specific insights may have made it challenging to think about what can be done to support a diverse field (especially given resource limitations). Similarly, for the majority of participants who were uncertain about what should or must be learned about "basic science" specifically, it may have been challenging to articulate what activities would be most fruitful, since they were not yet fully convinced of the premise upon which any approach would be based. Finally, recognizing that the idea of basic science engagement (as opposed to one-way communication) was hazy or irrelevant for most interviewees, it may not be surprising that many struggled to come up with activities that could inform such diverse—and perhaps unclear—forms of sharing science.

In addition, we recognize that especially for those who do not often (or ever) think about basic science communication and engagement, coming up with approaches the field could take—especially when most are used to thinking at individual- or institutional-levels in their day-to-day work—was a difficult request. This would be true even if the questions at hand were relatively simple or unidimensional, but as our conversations confirmed, many of the questions and challenges facing stakeholders committed to public engagement with basic science are complex and do not lend themselves to straightforward activities that will reveal clear-cut answers.

Conclusion and next steps

There were a number of questions and challenges that were repeatedly raised in our interviews (many of which reiterate and emphasize those surfaced in the prospectus), and a number of interviewees had some ideas about how these could be addressed. We supplemented their suggestions with our own insights, as social scientists who have experience employing a range of methods for diverse projects and stakeholders, to arrive at a set of recommended questions and approaches that will meaningfully advance the field's understanding of effective and equitable basic science communication and engagement:

- ***Articulating values:*** Organize field-wide discussions to articulate and discuss values, addressing questions such as: why are communications and engagement important? As new experiences and insights emerge, follow-up discussions can help refine and update field-wide thinking about values.
- ***Supporting context- and community-specific research:*** Support small-scale,

community-specific qualitative research initiatives to understand the unique audiences a communicator is attempting to engage. For individual communications or engagements, champion ethnographic work to shape hypotheses about framing best practices, then test the hypotheses in experiments.
- **Sharing findings:** Create a clearinghouse to share qualitative research projects widely so that communicators can learn from others.
- **Supporting comprehensive evaluation:** Catalyze a set of comprehensive, longitudinal evaluation efforts to assess a diverse set of short- and long-term changes resulting from both training programs and from communication and engagement efforts. To the greatest extent possible, make evaluation tools and processes usable for the broader field.

Most importantly, given the significant challenge interviewees faced in articulating ways to address the complex questions they identified, there is a need for creative ideas and approaches from the science communication and engagement field. This report aims to be a resource that the field can draw on as they collaborate to take on this challenge.

Introduction

Questions surrounding how to share science—especially topics in the field of *basic* science—are complex and multifaceted, and thus quite difficult to answer. Stakeholders invested in science communication and engagement in its many forms have taken on this challenge.

In 2022, leaders of the Science-Public Engagement Partnership (SciPEP) published *Charting a Path for Public Engagement in Basic Science: A Prospectus*. This prospectus, together with a set of landscape reports commissioned by SciPEP, revealed that little is known about effective science communication and engagement *specifically on basic science topics*. The prospectus articulated a number of high-level questions, which we build on in this phase of work by describing how researchers, practitioners, and others in the field of science communication and engagement might approach those open questions.

The purpose of this report is to articulate a set of activities that will generate a deeper understanding of the challenges, opportunities, and best practices for basic science communication and engagement, as described in the existing prospectus. Taking the high-level questions in the prospectus as our starting point, we conducted interviews with a variety of stakeholders with the goal of translating these questions into specific potential next steps that will benefit scientists, communicators, institutions, funders, and public audiences.

This report contains two main sections. In the **Approach and Methods,** we describe our approach to this research: the methodology that guided our data collection, and how we synthesized these data to arrive at a cohesive set of recommendations. Next, in the **Insights** section, we outline the overarching themes and considerations for the field's pursuit of a

deeper understanding of basic science communication and engagement. We also articulate the high priority open questions specific to basic science communication and engagement, why it is valuable to address them, and how they might be answered.

Approach and Methods

Conducting interviews to hear from stakeholders

Our goal in conducting one-on-one interviews was to gather insights on what social science researchers, communication and engagement practitioners, and basic scientists currently know or believe regarding communication and engagement with basic science topics, what the field *does not* yet know, which areas of inquiry are the highest priorities, and how to address those priorities.

The first step in this interview process was to collaborate with the SciPEP team to compile a diverse list of candidate interviewees, ensuring representation across a range of demographics, types of communication/engagement work, and other expertises. We recruited in waves to encourage participation from people with particular backgrounds or areas of expertise and experience to ensure a diverse and balanced sample. We interviewed a total of 30 stakeholders, whom we designated as belonging to one of three categories:

- ***Researchers:*** Stakeholders who conduct social science research on science communication and engagement
- ***Practitioners:*** Stakeholders who develop and execute communication and engagement opportunities in museums, foundations, universities, nonprofits, and other institutions
- ***Basic scientists:*** Stakeholders who focus on basic science research topics, but who also participate in communication or engagement

We developed an interview guide (provided in full in the Appendix), based on the topics and questions discussed in the prospectus. For each topic in the interview guide (e.g., motivations and goals, training), we asked interviewees what they believe *is* known, what *is not* known, *why* some of the unknowns may be priorities (i.e., what would change if we understood these unknowns better?), and–particularly for communication and engagement researchers–*how* we might go about answering those questions. Many of the topics discussed in the interviews were first articulated in the prospectus, and our goal was to encourage interviewees to share *why* and *how* they thought the topic was important. These questions helped us assess the extent to which a given topic might be a priority for the field. We used a semi-structured interview approach, which allowed us to use a standardized set of questions as a guide while remaining responsive to the interviewees' comments, delving more deeply into topics that they were interested in and/or knowledgeable about, and omitting topics that were less salient. We recorded and transcribed the interviews.

Synthesizing the interviews

To synthesize the patterns we observed in the interviews, we developed a list of codes consisting of themes and topics of interest for this project, and reviewed all interview transcripts to code for the presence and absence of themes, as well as the content of interviewees' perspectives on the various themes. We cataloged the ideas interviewees were expressing, and crucially, noted the assumptions implicit in their comments, to better understand how interviewees were thinking about the topics covered in the interviews. As a result, our synthesis reflects some ideas that were explicitly mentioned by a number of interviewees and others that were implicit in interviewees' comments. For example, one of our goals was to document research questions prioritized by the interviewees; while many interviewees discussed recurring challenges, anecdotes, or assumptions, they did not often frame them as research questions per se. Even so, these contributions clearly suggested viable research questions and/or initiatives that the field could pursue.

Insights

Overarching considerations for next steps

A number of themes emerged repeatedly in the interviews across multiple topics. These themes lend themselves to recommendations about how researchers, practitioners, funders, institutions, and organizations might approach efforts to better understand basic science communication and engagement. While these themes are embedded in the recommendations articulated throughout this report, we note them here as overarching considerations.

#1: Prioritize detailed and context-specific approaches over general and large-scale approaches

When interviewees described the kinds of questions and insights they felt would enable effective communication and engagement, they described a desire for deep, comprehensive, and context-specific information that cannot be inferred from broad data collection aimed at producing generalizable results. Interviewees emphasized that the future of effective basic science communication and engagement relies on the ability to understand specific communities' baseline perceptions of basic science, what their needs and goals are, and why science is (or isn't) important to them.

For example, researchers discussed the value of **qualitative approaches** that can provide nuanced and holistic understandings of a range of topics, from scientists' motivations for engaging in outreach, to public perceptions of particular areas of basic scientific inquiry. Practitioners tended to point out the need for **audience-specific insights;** for them, understanding what particular scientists (e.g., those in a particular discipline or career stage) think, know, and do regarding science communication, or what particular public audiences

feel or want from basic science communication and engagement, was much more valuable than data about scientists or publics more broadly. This theme structured their recommendations to conduct a small number of in-depth evaluations of training programs and communication and engagement efforts, as well as interviews with members of specific public audiences.

#2: Interrogate "basic science" as the area of focus

All interviewees provided definitions of "basic science" that were consistent with SciPEP's definition. However, after defining the term, many participants expressed uncertainty or skepticism about the distinction between basic and applied sciences, both in distinguishing different types of research and types of communication or engagement.

Many interviewees described struggling with the distinction because they see scientific research on a continuum, with the concepts of "basic" and "applied" as theoretical poles and particular fields, topics, and research programs occupying various gray areas in between. Perhaps because of this uncertainty or because communication and engagements focused on basic science topics were not salient for interviewees, even when explicitly asked about basic science topics, interviewees frequently defaulted to talking about "all science" and provided examples of communication or engagement on clearly applied science topics (e.g., health recommendations related to COVID-19).

What should we make of interviewees' diverse reactions to the concept of basic science communication and engagement? Based on the interviews, we predict that for some specific questions about supporting effective and equitable communication and engagement, the basic/applied science distinction may be meaningful. Generating an understanding of how best practices, challenges, and field-wide needs for basic—as opposed to more applied—science topics may result in targeted approaches that increase success.

However, it may also be the case that this distinction is not the most useful one for all aspects of science communication and engagement. For some areas of exploration, discipline or topic may be more meaningful.

While we can make informed predictions about when the basic/applied distinction might be productive and when another one might be better suited to increasing our understanding of a particular topic, in many cases this will be an empirical question. Because much remains unknown about which particular elements of communication and engagement will be most productively addressed in terms of a basic/applied distinction, which topics will require different or more specific distinctions, and which will not require a distinction (e.g., those for which general "science" communication is sufficient), we have framed our insights and recommendations in terms of basic and applied sciences by default. However, we suggest that activities—especially those involving research—may be designed in a way that allows for interrogation of whether and when the dichotomy is useful, and when other distinctions

might be more actionable. For example, conducting evaluations of communication and engagement initiatives that occupy various places on the basic-applied continuum and that represent a range of scientific disciplines will allow researchers to explore the role that basic (vs. applied) topics play in bringing about particular outcomes in addition to the roles of particular scientific disciplines and other factors.

#3: Distinguish communication and engagement

With the recognition that the prospectus included questions pertaining to both one-way communication and bi-directional engagement because of the paucity of research on either topic specific to basic science, our interviews revealed that the answers to many of our questions (e.g., what kinds of trainings are most effective?) are likely to be quite different for these two different modes of sharing scientific information. Notably, *communication* was much more salient and concrete for interviewees when thinking about basic science topics. When asked generally about communication and engagement, most offered prototypical communication examples, such as media (e.g., press releases, YouTube videos), education (e.g., scientists volunteering in classrooms), and other events (e.g., public lectures). Those who offered examples of more multi-directional engagement tended to share examples of exchanges on applied science topics. Some participants explicitly noted that they couldn't picture what engagements like dialogue, deliberation, or knowledge co-production would look like for basic science topics. They were unsure what such activities would be designed to accomplish or what they could accomplish in reality. Others stated that engagement is much more difficult for the basic sciences because it's more challenging to equip public audiences to be effective partners and to determine what they would gain from activities like collaborative research. Still others asserted that for basic science topics, engagement is not really relevant; rather, the field should focus on communication.

From these diverse responses and uses of the terms "communication" and "engagement," we infer that this distinction is particularly pertinent for the basic sciences. Future efforts should be mindful not to collapse them unless there is an explicit strategic reason to do so, and instead to interrogate them as separate types of activities whenever possible. For example, a deliberation of the field's values for sharing basic science might include conversations about what can and should be achieved through basic science communication and, separately (though relatedly) through basic science engagement.

#4: Invest in field-wide communications that catalyze new approaches and insight sharing

Each time we discussed a question or challenge related to basic science communication and engagement, we asked interviewees how they thought the field could make progress to address it. Many interviewees struggled to articulate what could be done—whether particular research, convenings, or resource development were needed, what those activities would look like, and who would be responsible for catalyzing and contributing to them. Because few individuals have a vision for what should be done to improve the field's understanding of

basic science communication and engagement, it will be difficult to make collective progress without leaders who elevate and encourage the kinds of efforts that will improve the field's collective capacity in this area. Such leaders may come in many forms—funders might choose to fund efforts that contribute to the priority questions described in this report, institutions and organizations might highlight basic science communicators, especially when their efforts advance an understanding on one of the priority questions, and trainers and evaluators might build basic science-related considerations into the work they're already doing. In each case, progress will be hastened by widespread sharing of information, communicating with others: this is what we did, this is what we learned, and this is what we think should happen next.

Unanswered questions and suggested approaches

In this section, we describe questions prioritized by researchers, practitioners, and basic scientists. In the interviews, it became apparent that clarity on these particular questions would result in more effective and equitable basic science communication and engagement. Many of the priorities discussed in the interviews were first articulated in the prospectus. When such topics arose, we asked interviewees to share *why* they thought the question was important, which helped us assess the extent to which it might be a priority for the field. In addition, we asked interviewees *how* the questions they discussed could be pursued. In doing this, we aimed to advance the conversation a step beyond the prospectus, by distilling potential next steps that would improve the field's understanding of the most important questions on basic science communication and engagement.

In many cases, interviewees described challenges and open questions about science communication and engagement broadly (i.e., not specific to basic science). We followed up on these points by asking whether they felt there was an aspect of the challenge or question that was unique to *basic science*. In this report, we focus on the priorities and questions for which interviewees explicitly stated or implied that there may be unique considerations or insights for basic science topics with less direct application. As a result, this report does not cover some of the challenges that are well known to the science communication and engagement field, such as institutional incentives (e.g., promotion and tenure policies) or applying scholarship on communication and engagement in practice.

We have outlined these priorities with six questions:

1. What are the values that guide basic science communication and engagement?
2. What does the field need to know about audience perspectives?
3. What does the field need to know about the role of training?
4. What goals does the field want to achieve?
5. How should the field frame basic science topics?
6. What are the outcomes of communications and engagements?

What are the values that guide basic science communication and engagement?

In our interviews, it quickly became clear that there is a fundamental question that is important to elucidate: *why* does anyone do basic science communication or engagement?

Many interviewees made implicit assumptions about the most important reasons for communicating or engaging, and while there were multiple reasons listed, many appeared repeatedly across the interviews. For example, prevalent reasons included:

- Taxpayers have the right to information about basic science, because they have supported this work, and the field has a responsibility to give them what they paid for (quite literally).
- Communication and engagement is necessary to maintain funding streams, including tax dollars.
- Transparency must be supported; because basic science is often publicly funded, it is incumbent upon scientists to be transparent about their findings.
- Communication and engagement support equity by making science accessible to everyone.
- Communication and engagement are necessary to dispel unfavorable stereotypes of scientists (e.g., those portrayed in the TV show *The Big Bang Theory*).
- Communication and engagement can foster a sense of belonging and encourage careers in science.
- Communication and engagement can influence scientists' research agendas, potentially resulting in more responsive and impactful research.

What values should be articulated?

The interviewees demonstrated that there are values—or "whys"—that are mentioned repeatedly, and yet, the list of values is quite diverse, and different values have different implications for the types of goals communicators have and how they choose to meet those goals. It's not clear how conscious these values are for interviewees or the field at large, the degree to which they've interrogated them themselves, or the extent to which the values shape actions. **In short, there is an assumption that communication and engagement are valuable, but how they are valuable is often unclear. Specific reasons that communication and engagement are valuable must be articulated.**

Why is it important for the field to come together to articulate values?

The articulation of values underlies everything that happens with basic science communication and engagement; crucially, it forms an element of the measure of success. It adds clarity to key questions that were first raised in the prospectus and will be addressed in more depth throughout this report, including, for example:

- What public perspectives (i.e., what public audiences and what particular views) are most important to understand?

- What forms of training are needed for basic science communicators?
- What goals and framing strategies should be elevated and encouraged?
- What outcomes should the field be measuring, and how?

How can we gain clarity on values?

Some of these questions of values could be informed by empirical investigations (e.g., do communication/engagement activities have a measurable effect on public support for funding basic science research or on funding allocated to basic science research?), but ultimately most of these are questions for the field to answer collectively, ideally through **structured discussions.**

Based on our interviews and synthesis, **we recommend field-wide discussions** to grapple explicitly with these questions. These discussions could include convenings or conference sessions, for example. The goals of an initial values alignment discussions would be:

- ***Articulate preliminary values:*** An assessment of the values for which there is consensus and those that are less unanimously supported—or even in tension with each other—will guide individuals in their communication and engagement efforts.
- ***Generate research needs:*** Some values may be initially based on assumptions that could be refined with new evidence. If, for example, stakeholders agree that an important reason for communication and engagement is to maintain funding streams, then it would be valuable to support research to investigate the extent to which basic science communication and engagement actually influence funding.
- ***Establish an iterative conversation:*** Ideally, this conversation would build over time. Early discussions would surface candidate values and begin to assess areas of consensus and tension. As the field continues to learn about things like goals and outcomes, and as more individuals, institutions, and organizations begin working in areas of basic science communication and engagement, the community can continue to revisit this topic, enabling new ideas to emerge and others to be refined and explored in depth.

Example questions that may be explored in values alignment discussions

- What do we aspire to change through basic science communication and engagement?
  - What implications does this have for *who* shares basic science, *with whom* they share it, and *how* they share it?
- What changes do we *not* want to see as a result of basic science and communication?
- What do we need to learn to better align our values with our practices?

> *In summary: What are the values that guide basic science communication and engagement?*
>
> **Priority:** Explicitly articulate the "why" of communication/engagement.
>
> **Why this is important:** This articulation underlies everything that happens with science communication and engagement; it forms an element of the measure of success.
>
> **Recommended next step:** Organize field-wide discussions to articulate and discuss values: why are communications and engagement important? As new experiences and insights emerge, follow-up discussions can help refine and update field-wide thinking about values.

What does the field need to know about audience perspectives?

One theme present in the prospectus that emerged as a clear priority in the interviews related to audience perspectives. Much of what is not yet known about basic science communication and engagement relates to the perspectives of members of the public, or in other words, the potential audiences, partners, and collaborators for science communication opportunities or engagements.

All interviewees noted that "the public" is not a monolithic entity, and therefore, information about the "general public" is not necessarily applicable to an individual community. Many interviewees emphasized that what they need to know focuses on the details of the unique audience members and cultural contexts of a given engagement. Therefore, we're using the term "audience" to refer to those engaging with basic science communication and engagement opportunities.

What is important to learn about audience perspectives?

Interviewees generated a set of questions regarding audience perspectives that they positioned as particularly high priority. This list expands on the high-level questions about public audiences articulated in the prospectus by adding specificity about the dimensions of audience perspectives that would be most valuable for those in the field to understand.

- What do various audiences know or believe about **the scientific process** (including how science is funded, how long scientific research takes, how the scientific process requires iteration, uncertainty, and self-correction)?
- How **salient** is basic science (i.e., when people think of "science," to what extent are they thinking about applied vs. foundational topics or research)?
- What do audiences know or believe about **particular scientific topics** (especially those most likely to be classified as basic science)?

- What **motivates** audiences to seek out opportunities to engage with basic science topics? How do motivations differ by demographics, scientific topics, or communication/engagement format?
- When it comes to opportunities to encounter basic science topics, what are various **audiences' desires or needs** (topics, formats, or other features)?
    - To what extent are these audiences' desires or needs being met?

A note about the term "basic science"

A number of interviewees wondered, "to what extent do members of the public even know what 'basic science' means?" While exploring this question may seem like a low-hanging fruit in the category of public perceptions, the answer is unlikely to be useful for many in the field, since few communicators are actually communicating about the concept of basic science as such and no one expressed a goal related to raising awareness about the existence of basic science. (Awareness-related goals tended to be about particular research areas or about the scientific process more generally, neither of which rely on familiarity with the term "basic science" or synonyms.) Therefore, it isn't important for audiences to be familiar with the term in order to engage with basic science topics.

Why is it important to learn about audience perspectives?

Interviewees acknowledged that they know very little about the audiences they attempt to reach, especially because each audience is different; data from large-scale representative surveys are useful for characterizing trends in a population, but they are rarely useful for designing effective, meaningful engagements.

Investigating audiences' assumptions, experiences, and emotions related to science—and how science without direct application fits into that mental framework (if people think about it at all)—will enable the field and individuals working within it to formulate strategic goals, tailor approaches accordingly, and evaluate the impact of communication and engagement efforts.

How can the field investigate audience perspectives?

The most important next step will be to find ways for scientists and institutions to understand *their* audiences, rather than "the public" more generally.

Based on our interviews and synthesis, **we recommend qualitative research initiatives** (especially interviews, but including other approaches like case studies, ethnographies, and other creative ideas the field may generate) to help practitioners, scientists, and institutions find ways to know their audiences better and launch more effective communications and engagements. Qualitative research is recommended because:

- Its open-ended design allows investigators to surface themes and perspectives that they didn't know to look for.
- It provides context for some of the survey research the field has already conducted by clarifying what audiences actually have in mind when they respond to closed-ended survey questions.
- It allows researchers to understand patterns in thought that might not be explicit, but that shape the way people reason and navigate science communications and engagements.

Why qualitative research matters: One example

Survey research can reach many people and provide statistics, but we often can't know what to make of the findings. For example, [survey research](#) has found that "59% of Americans say they'd like more time to engage with science." Without qualitative research that allows us to explore this result by asking follow-up questions that provide context, we won't know what to do with this knowledge. For example: what kinds of topics and activities are people imagining when they say they would like more time to engage with science? What would need to change for more people to feel satisfied with the amount of time they spend engaging with science? How does their desire for more time to engage with science compare to potential desires for more time to spend doing other things? Ultimately, from this survey question, we can't understand what the challenges are and what the field could do to effectively meet more of the implied demand for science engagement.

However, qualitative research allows us to explore all of these questions with target audiences. For example, a project that seeks to provide engagement opportunities to a specific community might first ask members of that community questions like: *If you would like to engage with science more, what keeps you from doing so? What would need to change for you to engage more? What would an ideal engagement look like for you? What would you hope to get from such an experience?* Crucially, an interviewer would be able to follow up on members' responses in the moment, allowing for the collection of useful, specific data to inform communication and engagement design.

Of course, it can be more difficult and resource intensive to conduct specific audience research; for this reason, **we also recommend exploring opportunities for those who have done deep audience research to share their processes and insights widely.** Creating a clearinghouse of case studies can help stakeholders learn from what has already been done, and provide insights crucial for designing communications and engagements *even if* a communicator does not have the resources to conduct qualitative research on their own.

Example questions that could be explored through interviews with members of a target audience

- When you think about scientific research, what kinds of topics are you thinking of?
- If you heard of an upcoming event where you could talk with a scientist who does "fundamental" or "basic" research—work that doesn't yet have an application—what factors would influence whether or not you decide to go?
  - Have you been to events like this before? If so, what do you remember about them?
  - Are there particular science topics you'd be more or less interested in?
  - What questions would you have?
- How would you describe why it's important for scientists to conduct research that helps us understand the world, even if it does not have any immediate applications?

In summary: What does the field need to know about audience perspectives?

Priority: Focus qualitative research on individual audiences' experiences, assumptions, understandings, motivations, and priorities for engaging with basic science topics.

Why this is important: Understanding the specific audiences for specific communications or engagements is crucial for setting strategic goals, designing effective opportunities, and evaluating impact.

Recommended next steps: Support small-scale, community-specific qualitative research initiatives to understand the unique audiences a communicator is attempting to engage. Create a clearinghouse to share qualitative research projects widely so that communicators can learn from others.

What does the field need to know about the role of training?

Interviewees indicated that much remains unknown about how the culture of science influences the extent and types of communications and engagements on basic science topics. This includes the structures, resources, incentives, and norms of scientific institutions and communities. While the prospectus touched on all of these topics, and we explored each of these elements of scientific culture in the interviews, the stakeholders we spoke with revealed that understanding communication and engagement training—both the current landscape and needs for more effective and equitable communication and engagement—is the element of scientific culture that should be prioritized.

What is important to learn about the role of training?

Interviewees noted that there is a general assumption that training—whatever it may be—is valuable, but little is known about how or why it might be useful for a given engagement or for a specific scientist. Therefore, it is necessary to better understand the role of training in supporting effective, equitable sharing of basic science.

First, we need to understand the current state of training for basic science communication, including the following questions, which build on those articulated in the prospectus:

- To what extent are existing trainings designed with basic scientists (in various fields) in mind? In cases where they are, how do trainers adapt or tailor programming for basic science communicators?
- To what extent do basic scientists participate in communication or engagement trainings?
- What do existing trainings aim to achieve? To what extent are these aims relevant to or different for communicators of basic science?

Perhaps more urgently, we need to understand what the role of training *should be* for basic science communication. For example:

- What features of trainings (e.g., format, scope) are more and less valuable for basic scientists?
- What unique communications challenges do basic scientists (in various fields) benefit from training to address?
- How should we evaluate trainings to know if they are useful and effective for basic scientists?

Why is it important to investigate the role of training?

A stronger understanding of basic science communicators' training needs and the extent to which the current training landscape meets those needs will provide invaluable insights into what kinds of training efforts—existing or new—should be prioritized. For instance, if this work reveals that understandings or skills that are key for sharing basic science are largely missing from existing trainings, trainers, institutions, funders, and scientists can explore potential changes to existing programs or catalyze new training programs that target basic science communicators.

How can we investigate the role of training?

We **recommend field-wide investment in evaluations** of a sample of existing training programs that are diverse in duration, topics covered, and approaches. Investigating the training outcomes for science communicators who identify as basic scientists as well as those who do not will enable comparisons across researchers or practitioners whose foci are more or less fundamental, and provide insight into whether the value of various features of

trainings differs for basic and applied communicators. Funders, trainers, and evaluators all have opportunities to catalyze and/or prioritize the inclusion of a basic science lens in training evaluations. Ideally, the processes and tools used for these evaluations can be made available to the entire science communication and engagement field, as interviewees made it clear that more trainers would be able to evaluate their trainings if resources and guidance were more readily available.

As the field develops a stronger understanding of how trainings can be designed to benefit basic science communicators (and their audiences), we **recommend that funders, associations, and institutions committed to supporting basic scientists champion the training programs and elements of training programs** that are particularly important for fostering more effective and equitable basic science communication and engagement. Specifically, these stakeholders can collectively incentivize the design of trainings that meet basic science communicators needs; seek opportunities to promote and celebrate trainings that provide the most value for basic science communicators; and connect the basic scientists and institutions they fund with training opportunities that will provide the most value.

In summary: What does the field need to know about the role of training?

Priority: Determine the elements of training that are necessary and valuable for basic science communicators. Then, champion the programs or elements that provide the most value.

Why this is important: Effective and equitable basic science communication and engagement rely on communicators receiving quality training, little is known about what exactly that entails.

Recommended next step: Launch detailed and thorough evaluations of training programs to better understand what works and what doesn't, for whom, and why.

What goals does the field want to achieve?

When asked about communicators' motivations and goals, many interviewees admitted that their ideas about what motivates scientists and practitioners to share basic science topics and what goals those communicators might hope to achieve are based on anecdotes, introspection, and assumptions because they didn't know of any data on these topics.

Overall, interviewees tended to emphasize goals, rather than motivations, since goals are the targets a person or institution sets out to achieve, and are therefore crucial inputs to evaluations of outcomes and impact. Regarding goals, there was widespread agreement among interviewees that many science communicators do not set *strategic* goals. In some

cases, they said, no goal is articulated; in others, goals are vague and disconnected from specific decisions about a communication or engagement. There was also consensus that to have impact, communications and engagements must involve realistic goals that are used to guide all other decisions.

What is important to learn about communicators' goals?

The following questions emerged, echoing the prospectus:

- What do individuals and institutions currently aim to achieve through basic science communication and engagement?
- What strategic goals *should* individuals and institutions aim to achieve through basic science communication and engagement?
- What forms of field-wide support could enable more communicators to set strategic goals for basic science communication and engagement?

Why is it important to learn about communicators' goals?

A more robust understanding of the high-level goals that communicators hope to achieve (e.g., "I want members of the American public to think of science as a more iterative process") will be an essential input to the ongoing values conversation. Specifically, a systematic understanding of the range of communicators' goals and the frequency of different goals will address the broad question of why basic science communication and engagement should take place in a manner that is complementary to a convening of stakeholders.

In addition, surfacing communicators' goals and holding them up against outcomes will shed light on the extent to which the goals being set are strategic (i.e., tied to a justified theory of change). As many interviewees pointed out, it is entirely possible that many communicators are setting goals that are unachievable or may be disconnected from the ultimate impacts desired (e.g., while many assume that inspiring awe will encourage children, especially those from underrepresented backgrounds, to pursue science careers, it is not clear whether–or under what circumstances–this is the case).

Efforts that support more strategic goal-setting will in turn yield more equitable and effective communication and engagement efforts for basic science topics.

How can we investigate communicators' goals?

We recognize that the field is in the process of exploring this question in a variety of ways, and **we recommend conducting qualitative research to follow up on questions that emerge from initial studies** (if any). The in-progress research may provide the insights needed to inform the values discussion and evaluation of engagement outcomes, in which case it is not imperative to undertake specific work on goals in the short term. In the event that the ongoing work opens additional questions about goals that must be answered in order to pursue the other areas of work described here, interviews with a strategic sample of

basic science communicators will be best suited to providing context for patterns in the survey data.

> ### In summary: What goals does the field want to achieve?
>
> **Priority:** What are communicators' goals for sharing basic science? What factors shape those goals?
>
> **Why this is important:** This understanding will clarify field needs, including training, incentives, and other structures, in addition to providing a baseline for assessing the extent to which individuals or the field as a whole is achieving success.
>
> **Recommended next step:** Support and undertake qualitative research as needed. If key questions emerge, conduct one-on-one interviews with strategic groups of communicators for deeper understandings.

How should the field frame basic science topics?

Most interviewees asserted that it is important for science topics to be framed in ways that are *relevant* to their target audiences, but they acknowledged that it was unclear if this assumption is supported empirically. Further, the idea of "relevance" was described in different ways by different people, suggesting that there is no universal definition for this concept. For example, for some, relevance means that people can take action on an issue; for others, relevance means anything that sparks interest or connection.

What is important to learn about framing?

In general, interviewees' assumptions and questions on this topic reveal a high-level question: **How should communicators frame basic science topics?** Many interviewees pointed out that what makes this such a challenging question is that the answer is dependent on the particular topic, communication goal, and audience (and potentially on other factors).

Some interviewees discussed the framing challenge as a utility-vs.-curiosity question, consistent with the prospectus, while others saw these two frames as compatible and even complementary to each other. Still others articulated or implied that there may be additional valuable frames to consider, such as focusing on a relatable researcher's story or emphasizing connections to other areas of knowledge or lived experience.

Importantly, little is known about how to proceed when faced with framing questions relevant to the design and execution of a communication or engagement. Therefore, research that can offer ways for communicators to make decisions on a specific communication or engagement is crucial.

Why is it important to learn about framing basic science topics?

Our interviewees recognized that scientists' and practitioners' intuitions about effective frames are not a strong basis for framing decisions, and they also recognized that no communication or engagement is unframed—so they must always make a decision about how to convey basic science information. An understanding of what frames to use to achieve particular goals under particular circumstances can be useful for everything from marketing an engagement event to crafting headlines, descriptions, and visuals for popular media.

How can we investigate framing basic science topics?

The question of how to frame basic science information is actually a conglomeration of many questions, including a nearly infinite number of configurations of topics, audiences, goals, and other factors (i.e., how should we frame [particular topic] [to achieve particular goal] [with particular audience]…?). As a result, research on this topic will require nuanced approaches.

Researchers suggested a number of possible ways to explore this framing challenge, making it clear that a combination of qualitative and quantitative approaches would be well suited to addressing the set of questions related to framing. First, an ethnographic approach would help develop hypotheses about what frames might be effective for particular topics, goals, and audiences. To do this, a researcher or team would observe a range of communications and engagements that are already taking place to understand which frames are (and aren't) being used, by whom, for which topics, goals, and audiences. For instance, a researcher might select a strategic sample of diverse basic science communication and engagement initiatives to study, then observe each for a predetermined duration, taking note of the various frames used and the circumstances under which each is used.

Following the ethnographic approach, researchers would have a stronger understanding of which frames should be investigated empirically, under what circumstances. This would pave the way for a quantitative experimental approach in which researchers can test messages' effectiveness for achieving particular goals for particular topics and audiences. A quantitative study of framing (e.g., a large-scale experiment in which participants are randomly assigned to encounter one communication and answer a common set of questions) can provide more precision because there is more researcher control—the researcher knows exactly what information participants encountered and they all answer the same questions.

Example of a framing experiment design

If research determines that basic science communicators tend to frame their topic either in terms of *utility* or *awe*, an investigation into which frame to use (under particular conditions) might look as follows:

1. All participants watch a short video. In this video, a scientist describes their research

in either basic neuroscience or basic physics, framed either as something that creates awe or something that could someday provide tangible benefits to society. Thus, there are 4 conditions (neuroscience–awe; neuroscience–utility; physics–awe; physics–utility).

2. Following the video, all participants are asked the same questions. For example:
   a. On a scale of 1-7, how interested are you in hearing more about this topic?
   b. On a scale of 1-7, how important do you think it is for the government to fund research on this topic and similar ones?

3. All participants answer a range of demographic questions.

After data collection, a researcher can assess the extent to which the science topic and the frame influenced responses on the measures of interest. Specifically, they can examine whether utility or awe made people more interested in hearing more about the topic, and whether the particular scientific topic or certain demographics influenced the extent to which this is true. This simple design would begin to provide insights into the benefits (and limitations) for various frames. Given the many variables that are likely to influence the effectiveness of frames, a number of different studies, looking at varied frames, formats, and outcomes, will provide the richest and most robust insights on this question.

In summary: What is important to learn about framing basic science topics?

Priority: How should basic science topics be framed to achieve particular goals with particular audiences?

Why this is important: Every communication must be framed, yet interviewees expressed a great degree of uncertainty about effective (and ineffective) frames.

Recommended next step: For individual communications or engagements, champion ethnographic work to shape hypotheses about framing best practices, then test the hypotheses in experiments.

What are the outcomes of communications and engagements?

The topic of evaluation was frequently discussed by interviewees as a valuable practice, yet one that is not commonly undertaken. When it is undertaken, it is often short-term (i.e., collecting measurements immediately following an event, rather than after a delay) and focused on metrics (e.g., how many people came?) or participants' impressions (e.g., how much did the audience like the engagement?). Interviewees emphasized the value of rigorous evaluation extending beyond these measures.

What is important to learn about evaluation of outcomes?

In line with the prospectus, interviewees expressed that such minimal and surface-level evaluation efforts leave open many questions about the ways that engagements or communications about basic science topics might shape the ways audiences think about the topics explored, the ways their experience may have informed subsequent decisions or actions, and the effects of engaging for scientists or institutions. As a result, interviewees stressed that the field does not have a systematic understanding of engagement outcomes for public audiences or for communicators and their institutions.

Specifically, the following questions emerged:

- What is the range of potential outcomes, or, in other words, what outcomes are *possible* for different audiences and for communicators and their institutions?
- What factors are most important for various outcomes (e.g., what *must* happen for audiences to develop new mental models about science or scientists or to be inspired to continue exploring science in and outside formal education settings)?
- What evaluation tools or practices yield the most valuable insights for communicators, given generally limited time and resources for undertaking evaluation?

Why is it important to learn about evaluation of outcomes?

Understanding what outcomes are possible and likely under particular circumstances enables communicators to set strategic goals, tailor their approaches, and assess the extent to which they've achieved their goals. Similarly, a more robust understanding of outcomes is essential for developing a field-wide theory of change—collectively, what *can* scientists, practitioners, and institutions achieve through their public communications and engagements, and what *are* they achieving? Information on possible and common outcomes will also be a valuable input to the ongoing field-wide discussion of values, as the field works toward increasing alignment between values and practices.

Of course, an understanding of outcomes requires widespread adoption of effective evaluation practices. As many interviewees pointed out, with limited funding for evaluating communication and engagement efforts, the field will only begin to develop a more comprehensive understanding of outcomes if communicators and institutions have access to evaluation tools and guidance that is easy to implement and provides useful insights about impact.

How can we evaluate outcomes?

Since the field needs a stronger understanding of the range of outcomes over time, this challenge will be most effectively addressed by investing in a small number of deep evaluation efforts. Funders, associations, and institutions who support basic science and scientists can identify basic science communication and engagement efforts that collectively reflect diverse types of efforts with diverse audiences, and support comprehensive

evaluations of those programs or projects. Comprehensive evaluations would include pre- and post-initiative measures, which would likely be a mix of qualitative (e.g., interviews, ethnography) and quantitative (e.g., survey) measures, taking place multiple times (with measurement intervals depending on the particulars of each initiative). Ideally, the evaluations of the various communication and engagement efforts would be coordinated, using common measurements when possible, to provide insights into the factors that influence outcomes.

In addition to surfacing potential outcomes, common outcomes, and key factors that influence outcomes, a coordinated evaluation approach would establish models for what effective evaluation of basic science communication and engagement efforts can look like and would provide insights about what tools and evaluation practices provide the greatest return on investment for communicators. In turn, this would lower the barrier to entry for future evaluations.

In summary: What outcomes are possible, under what conditions?

Priority: Surface insights on what outcomes are possible and common, and how communicators and institutions can most effectively evaluate their efforts.

Why this is important: An understanding of possible and likely outcomes serves as the basis for setting strategic goals, tailoring approaches, and assessing success. Developing and sharing tools and models to enable more widespread evaluation will build the whole field's capacity to develop effective and equitable basic science communications and engagements.

Recommended next step: Catalyze a set of comprehensive, longitudinal evaluation efforts to assess a diverse set of short- and long-term changes. To the greatest extent possible, make evaluation tools and processes usable for the broader field.

Conclusion

This work confirmed a key point that SciPEP had already learned and shared in the prospectus: very little is known about the ways in which sharing basic science topics is similar to and different from sharing more applied science topics. Given the vast space of unknowns, we set out to explore these unknowns in a deeper and more iterative fashion, aiming to understand the extent to which there is consensus on priority questions to address and how they should be pursued. The 30 interviews we conducted with diverse experts revealed a number of areas of significant interest and energy, both for questions to address and approaches to do so.

While we have boiled the recommendations down into a list of six questions (values, audience perspectives, training, goals, framing, and outcomes), the work of addressing the questions can scale depending on resources and interest. Further, the suggested approaches surfaced in this initial round of interviews should be considered as starting points. We encourage anyone with a stake in basic science communication and engagement to adapt or tailor them, or to devise entirely different ways of exploring the various high-level questions. There are roles for funders, trainers, communications practitioners, social scientists, basic scientists, institutions, and other organizations. Each brings different expertise, assets, and goals, and can therefore contribute a unique piece of the puzzle of basic science communication and engagement. We don't expect any of these areas to be fully understood in the near future, but each step taken to better understand each of these questions will provide a significant return on investment, resulting in more equitable and effective science communication and engagement on basic science topics.

Appendix: Interview Guide

While interviews were designed to be conversational and adaptive to participants' expertise and interests, we also used a standardized set of questions to ensure that interviews were as standardized as was practical. Because the guide was comprehensive, we did not ask every question to any participant, but across the sample, we covered every topic with a sizable portion of interviewees. In many cases, we skipped from one topic to the next, not necessarily in the order listed in the guide, to ask follow-up questions on topics that interviewees brought up spontaneously. Therefore, the following guide should be understood as the default set of questions and sequencing–we followed this if the conversation did not obviously lend itself to different questions at different times.

About the interviewee and basic/applied science (5 minutes)

1. I'd like to know a bit more about your work; could you give me a 60 second overview?
   - *[If unclear]* Do you focus primarily on research, or public engagement?
2. What does "basic science" mean to you?
   - What role, if any, does basic science play in your work?
   - *[If participant explicitly asks for a definition or struggles to define basic science]* The SciPEP team is using this definition of basic science: exploration to advance knowledge regardless of short-term application of that knowledge [e.g. butterfly migration].
3. From your perspective, what are some of the main challenges for basic science communication and/or engagement?
   - How is that a challenge?
4. What is the most challenging aspect of basic science communication, for you (in your experience)?
   - What do you think would help you overcome this challenge?
   - What are the missed opportunities?
5. *[If unaddressed]* How is basic science communication/engagement *similar to* applied science communication/engagement?
6. *[If unaddressed]* How is basic science communication *different from* other types of science communication/engagement?

Discussion of goals (50 minutes)

[Repeatedly cue *basic science* to keep the interviewee focused on this specific topic.]

Let's shift to the topic of "unanswered questions."

1. *[If the interviewee is a researcher, cue "research" in this question.]* From your perspective as a [researcher/communicator], what unanswered questions do you think there are with respect to basic science communication and/or engagement?)

- ○ Why is this important?
- ○ What needs to happen to generate this understanding?
- ○ What would be different if we had a better understanding of this?

Q4: Public perceptions of basic science

This is all really helpful, and I'd like to turn now to talk a bit more about one specific aspect of public engagement with basic science: public perceptions of basic science.

1. To your knowledge, what do we know about what the public thinks or feels about basic science?
   a. How do we know this?
2. What do we still need to figure out about how the public thinks or feels about basic science?
   a. How could we go about figuring this out?
   b. What would be different if we knew this?
   c. *[Optional]* Why do you think we haven't yet figured this out?
   d. When you think about this unanswered question (or these unanswered questions), are you thinking about any specific groups or segments of the public?
3. *[Optional]* What do we know about the difference (if any) between the public's perception of basic science vs. applied science?
   a. How do we know this?

Q4: Strategic goals and motivations

The next general topic I'd like to discuss is motivations and goals.

4. What do we know about basic scientists' motivations and goals, or institutions' motivations and goals, for communicating with public audiences?
   a. How do we know this?
   b. *[If not addressed]* What do we know about incentives for scientists or institutions to communicate about basic science with public audiences?
5. What do we still need to figure out about basic scientists' motivations and goals, or institutions' motivations and goals, for communicating with public audiences?
   a. How could we go about figuring this out?
   b. What would be different if we figured this out?
   c. *[Optional]* Why do you think we haven't figured this out yet?
6. What do we know about what success looks like for basic science engagement?
   a. How do we know this?
7. *[Optional]* What do we still need to figure out about what success looks like for basic science engagement?
   a. How could we go about figuring this out?

        b.   What do you think would be different if we knew this?

        c.   *[Optional]* Why do you think we haven't figured this out yet?

8. Think of a time basic science communication didn't go or wasn't going as you might have wanted. What knowledge (or something else?) could have helped you, or could help you avoid a repeat?

Q4: Two-way engagement about basic science

Let's move on to our next topic, which is how public engagement with basic science affects basic scientists.

9. What do we know about how public engagement with basic science affects basic scientists?
    a.   How do we know this?
    b.   *[Optional]* Do we know anything about how it affects them personally?
    c.   *[Optional]* Do we know anything about how it affects their careers?
    d.   *[Optional]* Do we know anything about how it affects their research?
    e.   *[Optional]* Do we know anything about what basic scientists learn from public engagement?
10. What do we still need to figure out regarding how doing public engagement affects basic scientists?
    a.   How could we go about figuring this out?
    b.   What would be different if we knew this?
    c.   *[Optional]* Why do you think we haven't figured this out yet?
11. What do we know about how engagement from basic scientists affects the public?
        i.   *[Optional]* How do we know this?
12. What do we still need to figure out about how engagement from basic scientists affects the public?
    a.   How could we go about figuring this out?
    b.   What would be different if we knew this?
    c.   *[Optional]* Why do you think we haven't figured this out yet?

Q4: Communication and engagement training

The next general topic I'd like to discuss is communication and engagement training.

13. What do we know about the extent to which communication training is valuable for basic scientists?
    a.   How do we know this?
14. What do we know about the types of training that are most useful or necessary to basic scientists?
    a.   How do we know this?
15. What do we still need to figure out about training basic scientists to engage publicly?

a. How could we go about figuring this out?
b. What would be different if we knew this?
c. *[Optional]* Why do you think we haven't figured this out yet?

Thank you! Now let's talk about some other issues vital to basic science. Let's start with justice, equity, diversity, and inclusion.

Q1: JEDI

16. When I say "justice, equity, diversity, and inclusion," in the context of science communication, what does that phrase mean to you?

I have a few more questions about justice, equity, diversity, and inclusion, which I'm going to collectively refer to as "JEDI."

17. When it comes to basic science communication, what do we know about how to design [*tailor to respondent:* research/programming] that considers JEDI issues?
    a. How do we know these things?
18. What other JEDI-specific questions about basic science communication or engagement does the field need to address?
    a. What could be done to start addressing these questions?
    b. Why are these questions important? Or, in other words, what would be different if we had clarity on these questions?
    c. *[Optional]* Why do you think we haven't figured this out yet?

Q2-3: Pathways and incentives

Next I'd like to talk a bit about the relationship between scholarship on public engagement and actual public engagement on basic science topics.

19. What do we know about why a scientist or institution would or wouldn't integrate science communication scholarship into basic science engagement?
    a. How do we know this?
    b. What do we still need to figure out?
        i. How could we go about figuring this out?
        ii. What would be different if we had more clarity on this?
        iii. *[Optional]* Why do you think we haven't figured this out yet?
20. What do we know about typical practices for evaluating basic science communication and engagement?
    a. How do we know this?
    b. *[Optional]* What do we know about why an institution would or would not evaluate their public engagement efforts?
    c. What do we still need to figure out?

i. How could we go about figuring this out?
ii. What would be different if we had more clarity on this?
iii. *[Optional]* Why do you think we haven't figured this out yet?