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| REPORT | Landscaping Overview of U.S.Facilitators of Scientists’ Engagement Community**Interview Findings**  |

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| **HOW TO READ THIS DOCUMENT** |

The heterogeneity of the interviewed facilitators for this report made for a large number of excellent quotes that show best how they regard and understand their work. The authors decided that as this document’s purpose is to generate conversation among workshop participants, they should see as many of these verbatim quotes as possible. This document is long, thus a Table of Contents to guide readers’ interest:

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*Each venue theme follows the same sub-sections:*

*Who is the audience?
What value does the audience get? The scientists?
Who are the scientists and how do you find them?
How do you train/prep them?
What metrics do you collect and what do you think they’re telling you?
Where do you see this going?*

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Name and URL, same sectors as Appendix 2

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| **KEY ISSUE & BACKGROUND** |

Facilitators of science engagement create moments for scientists to directly interact with non-scientist publics. The interest is on both sides: many individual scientists have already undertaken, or at least expressed interest, in greater public interaction; while complex societal issues come to rely on more scientific insight, scientists are encouraged to increase outreach activities so that trust is sustained and conduits for dialogue are ready when needed in decision making. Thus the role of such facilitators for opportunity and success is of greater importance. Yet a variety of venues and reasons for bringing scientists and non-scientists together makes for a variety of facilitator types. The breadth of facilitators’ motivations and approaches has not to date been well catalogued or described so as to highlight successes and identify opportunity gaps.

People and organizations who facilitate engagement opportunities for and with scientists are driven by a diversity of motivations. Some may be seeking more informed policies, others may be seeking to excite (adults and youth) about science, and others may be pursuing many other possible goals. Knowing who these facilitators are, what motivates their approaches and ideas, what resources they rely on and could use more of, what measures of success and quality are possible, and what common opportunities and obstacles they share will help advance a sustainable system that supports scientists to communicate and engage publics more effectively. Note that in this document, “a public” generally means non-scientists, segmented into audiences by either venue or context, e.g. policy makers, youth, museum-goers. The audience members of one “public” may well exist as audience members of another; some publics may have more expertise in a particular topic that others, for example elected officials and their staffs (a public venue). The term “general public” is an aggregate of various “publics,” not defined by any one discipline focus.

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| **PROJECT DESCRIPTION** |

In this study, we sought to explore and understand the mechanisms, motivations, and outcome metrics utilized by individuals and organizations that facilitate scientists’ communication with the public. To capture the full range of engagement methods, facilitators from a wide variety of organizations were contacted and interviewed. For participant selection, we intentionally sought out individuals that facilitated engagements with various kinds of publics, from middle school students (and sometimes younger) to federal policymakers; and that ranged in size from small live events to highly-produced, to writing commentary/opinion (digital) magazine articles, to web videos viewed by many thousands, if not millions, of individuals. After contacting 30 leaders the realm of science communication and engagement facilitation, we were able to conduct 20 interviews during March and April 2018; all the facilitators were based in the U.S.

We elected to utilize a semi-structured interview protocol that would elicit approximately 30 minutes of conversation. The protocol provided sufficiently-structured questions such that a significant amount of data could be easily compared across participants, while also allowing the interviewer to probe more deeply into dimensions of participant responses that were unique or surprising. The questions focused on a) the overall nature and scope of the participants’ facilitation activities, b) the processes for recruiting, training, and preparing scientists for communicating with the public, c) the intended outcomes from their engagements as well as current (and desired) metrics that gauge success, d) the value of having scientists communicate with the public, e) ways they hope to improve their engagements in the future, and f) the resources used to stay up-to-date with the latest developments in science communication.

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| **SUMMARY OF FINDINGS** |

The facilitators interviewed comprise a heterogeneous mix of roles, categorized by venue type and target audience. We found there to be 7 types of facilitators in this group of 20. We do not think this is exhaustive, but a good starting point when this landscape has not been previously well characterized. We note that over 250 pages of interview transcripts were collated and summarized for this document. This document is intended to be a conversation starter for participants in a workshop further considering how to support scientists who want to engage with the public. Therefore, the prose and ordering of the selected quotes is to guide the reader as opposed to analyzing the responses or contextualizing them with other studies of science-public engagement. The bulk of this report is verbatim quotes.

Immediately below we summarize by aggregate themes shared across the 20 facilitators, then by those clustered into the 7 categories. The “How to Read This Document” provides a table of contents directing readers to the full treatments.

**Aggregate Commonalities**

Regardless of the motivation, audience, and approach, we found the following commonalities among those who facilitate engagement opportunities for scientists.

*Humanizing Science & Scientists*
Facilitators are motivated to help non-scientists regard scientists as people who are approachable and interesting to speak with. For science to best benefit society, conversations are necessary in decision making processes, and therefore scientists and the public need to be comfortable interacting with each other.

*Role Models*

The next generation of scientists and those studying it now benefit from seeing that science is performed and enjoyed by people like them. Facilitators therefore strive to connect as diverse a group of scientists as possible to inspire audiences such as young girls or underrepresented populations to consider themselves potential scientists. Additionally, training and encouraging the scientists themselves to harness their diversity through engagement can provide skillsets that make them better scientists. *Audience Interest*

Demand is high for scientists directly interacting with non-scientists and generating programming for these interactions. Facilitators are therefore encouraged to spend much time and effort into preparing and delivering scientists for public programming. By working to create dialogue between the public and scientists, approaches can be developed that are enjoyable and productive for both.

*Scientist Interest*

Scientists who engage with the public find themselves gaining skillsets, especially in communication, that help them to be better scientists. Facilitators therefore help science proceed forward better and reach more people.

*Facilitator Interest*
The majority (70%) of the facilitators interviewed had some academic training in science, with 55% having a PhD or research MS, but only 10% of the interviewees are still full time scientific researchers. Their hybrid career paths suggest they are motivated to answer the demand for scientists to engage with non-scientists and train the former to ensure high quality for the latter.

*Use of Science of Science Communications Literature*

Very few of the facilitators interviewed reported using and/or keeping up to date with the research literature on the “science of science communication”; we did not explicitly ask about the informal science education literature but it was noted by a few interviewees. Most seem to prioritize running events, recruiting scientists into engagement, and training those scientists for quality experiences and events. Some facilitators feel that as practitioners the research literature holds little use; while others report they tailor their programming based on what the research is reporting.

**Themes by Venue of Audience Context**

*Civic Groups*

Two facilitators specialize in either training scientists to engage with underrepresented populations or to deliver scientists into a venue co-supported by a civic-minded group. The facilitator for the former is focused on empowering scientists from underrepresented populations themselves with tools to serve the communities they meet. The facilitator working with a civic group delivers a science café program in a municipality distant from a major academic center and is satisfied that consistent attendance shows community interest in meeting scientists.

*Decision Makers*

Three facilitators bring scientists into contact with policy/decision makers and in one case interface scientific expertise with citizens to inform science policy decisions. Two facilitators who bring scientists directly into the working offices of elected officials spend much time on selecting appropriate candidates and ensuring they understand the context to best contribute. The facilitator who convenes citizens for science policy recommendations builds intermediary structures so that non-scientists know enough to make decisions drawing on their values as much as incorporating expert advice.

*Formal Educators*

Two facilitators bring professional scientists into classrooms to share the process of science with K-12 students. One facilitator provides a matchmaking service for scientists to video-conference into willing teachers’ classrooms and answering students’ questions, but the facilitator has insufficient time to train the scientists. Another facilitator is incorporating citizen science into classrooms across several schools in a particular district, but the project is new so no data exists on the efficacy of this type of engagement in that example.

*Media*

Five facilitators either help scientists create their own content for media distribution, interview scientists for media content, or media train scientists for future engagement with journalists. The content producers report scientists that are good at communicating with publics get encouraging feedback via expressed audience interest and reader/viewer measures. The media trainers find demand is increasing for their services from the scientists themselves, looking to better engage more often with the public and journalists.

*Informal Science Venues: Adult-Facing*

Three facilitators stage programming that targets 21+ audiences both in museums and at private, ticketed, venues. The programming seeks to upend traditional staging, looking for events regarded as “fun” and provocative as much as they may be informative. The facilitators report engagements that bring out emotional responses from both the scientists and the audiences.

*Informal Science Venues: Museums/Zoos/Aquaria*

Three facilitators are staff at a museum or aquarium; one institution puts its research staff into visitor engagement while the other two work with outside academic researchers for either direct engagement with visitors or to develop exhibits on their research. Putting active research topics on the floor of the museum is of institutional importance to all three facilitators. Much of their time is spent training the scientists for a quality engagement and deciding how to best use the scientists who are interested in engagements.

*Informal Science Venues: Youth*

Three facilitators work on programs that put STEM professionals in direct contact with activities and visits involving young people. Two target women in STEM engaging with girls, working as part of a nationwide network, with the scientists as role models and encouraging girls to pursue their science curiosities. The third, staff at a scientific society, manages a decades-long domestic outreach program that is also scaling internationally, looking for capacity development that avoids volunteer fatigue and brings branded programming to new communities.

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| **HOW MIGHT WE THINK ABOUT THIS MORE** |

Questions that the authors came up with while compiling the document. These questions are informed by the content but not necessarily answered by them.

**Factual questions**; probably already in the literature or could be answered by a simple survey:

Why do scientists engage with the public?

What types of engagements do scientists prefer? (demographic, discipline, geographic, sector, facilitation style)

How many facilitators exist?

**Facilitator questions**; issues concerning the structure, motivation and viability of putting on science engagement activities.

Economic impact of events? Free model, profit model or not-for-profit models of engagement programming.

Social media impact on live events? Historical, present … future?

Stereotypes & role models: are scientists in engagement representative of audience diversities? Scientists’ diversities? General population (municipality, national)?

Are there “gateway” engagements? I.e. if a scientist does “gateway”, do they then start to do many others? (museum leads to school leads to infotainment leads to …?)

What do these public attendees do after they’ve attended the engagement thing? Do they pursue more science? Go to other events? Apply to their lives?

How can cultural aspects of the scientists and also the publics be incorporated into recruitment, training, and venues more?

Why does someone become a scientist and why does someone engage with the public? Are these aligned? If different, is that discipline-dependent? Demographically dependent?

Longitudinal studies of facilitators in addition to facilitated?

Do facilitators want a professional distinction? Do they want a network dedicated to others like them? Certification? Are they covered by other professional organizations and/or content to define themselves by associated with more than one group?

Is it possible, or necessary, to ensure a source of professionals who will become science engagement facilitators? What fields best produce them?

What role do facilitators have to play in avoiding volunteer fatigue? Is it possible to develop training that minimizes “fatigue” in given scientists, or is this a question of attracting larger numbers to distribute the work?

**Communicator questions**; these focus on the practice of science communication by scientists.

How can digital native / younger scientists change prospects for facilitation?

Transition for audience from “understanding” to “caring” … same for scientists? How can emotional hooks of audience better inform facilitation modes?

Explicit post-experience questions of scientists: What did you learn from the audience?

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| **Appendix 1: AGGREGATE COMMONALITIES OF SCIENCE ENGAGEMENT FACILITATORS** |

**WHY IS ENGAGEMENT IMPORTANT TO DO?**

***Humanizing Science***

“Ok, so I see these sorts of people doing science. But are they human? I mean, really. All those cold unfeeling numbers and scary sounding names and scary machines and things. And everyone knows scientists stay to themselves. They’re not the sort of regular people I know. Are they?

But you know, I do trust scientists when it comes to science things – they’ve been to school and they work hard at whatever it is they do. And when they’re interviewed they seem to know what they’re talking about. They know and understand things that I don’t and couldn’t. So I trust scientists. I just don’t know any.”

The above is a fake quote, but such a fictional remark by a hypothetical audience member seems to motivate what many facilitators interviewed strive to achieve.

*F11*

*Unless and until scientists are prepared to engage rather than spew facts, people are going to increasingly, and especially at this moment in time in this country, increasingly see scientists as separate from them, you're going to see science and the output of their research as separate from their lives, and it's dangerous.*

*…*

*I'm taking a very US-centric look at this right now, but that feeling, unfortunately, is conflated with, or it is represented in many cases as like scientists are different people from us, don't have anything to add to us, or just taking our money and not giving us anything in return, and, yeah, that's just very dangerous for society.*

*…*

*When scientists are more comfortable having conversations, having dialogue with people then it undoes some of this othering that I was just talking about.*

The facilitators in this study all spoke to the importance of putting scientists into more engagement with non-scientists (“the public”), and that doing so humanizes the individual who does science.

*F18*

*One of the problems we had at the beginning is the scientists ... they just had one of our normal name tags on, and so most people just thought they were a member of our staff and didn't really think that they were a scientist. It's not like they had white lab coats on and they didn't look like a scientist so we actually had to go and put on these buttons that say “I'm a Scientist”. But they were very excited about actually interacting with a real scientist and seeing what that scientist is like … but they're kind of like me.*

Meeting scientists could inspire more people to become scientists themselves – in cases of citizen science realize they can do science now without extensive academic training. This human-to-human interaction can greatly affect the public’s view of who does and could do science and then science perhaps becomes less walled off.

*F16*

*Our core argument is that we believe that science can become more salient in a cultural sense if it doesn't feel so remote and walled off by this priestly, arrogant caste.*

*…*

*We also believe that science and technology, engineering, medicine is shaping our society and our cultures, but everybody's individual lives more than it ever has before. That means that everybody has science stories.*

*…*

*We think that having people feel like science is something we all do, some of us it's our professional job, and some of us encounter it in moments of disease or danger or disaster. It's something we all use, make use of, and have a say in how it shapes our world and our lives, that's our vision, that's why we operate the way that we do.*

*F13
I think when scientists are able, they should be talking with the public because it humanizes the process of science. It humanizes the information that's being passed along. It's not just coming from some very vague, over-arching they. Well, they said ... You know? It's a person who's telling you this, a person who's put time into learning something, a person who's put thought into the methods that they've used. So I think that the humanity that comes from the efforts of a person and that presentation of that information is absolutely invaluable.*

*F3*

*You have to find a way to, once in a while let the scientist go talk to the public and encourage scientists to really show their passion. I think that's something that's often missing and probably in school, that there is always an emphasis on being objective, effectual and organized and, in a way dry, and theoretical or very serious. What really can persuade people, or communicate a subject that's very complicated, is when you do it with passion. I think when you're looking for something that is sort of unifying in how to communicate science, I think passion and the authenticity that comes with it, for me, that would be really at the heart of it.*

*F22
I actually find that once they understand that concept about talking to about their hobbies, and who they are, that actually the way that they then describe their work is much more engaging, … The type of training in communication we do is more around presenting yourself as a human. As a person that has interests, that has a life, and then talking about the science of your work, and doing and activity, because ... Just talking about [your work alone] and having slides, that's great, but if we can help them find a great activity to do with the girls that's like a home run.*

Facilitators provide the opportunity for such potential, and guide and train and, yes, select, and place and support scientists to this end. Spaces and times are thus created where both scientists and non-scientists can have experiences that might develop or even change their worldviews.

*F17*

*It helps [scientists] along the path that understanding that science doesn't operate in a vacuum, that is one piece of society where there are real humans not just objects that interact with your results and what you're studying, and helps to reflect on maybe those influences that go a little deeper than you would normally consider if you're in a lab all day and not interacting with the public.*

*F15
Really, the scientist's job was to flip the script if you will. Instead of talking at these people and being like, here's this knowledge that I know, it was really designed with this principle of here's what I've been working on for the past whatever, 15, 20 years. What do you think about this? We tried to go to more interesting places that I really tried to push scientists to, which I think is hard but the most interesting learnings came out of it is when we delved into the areas that were considered taboo in some way.
…*

*[For an event where entertainment wrestlers were portraying celebrity scientists and prepared on content by research scientist advisors]*

*There was this moment backstage where the guy playing Neil Tyson and the guy playing Bill Nye, they had an argument about astronomy, and they're watching videos, and they had an argument from this place of, they'd been studying up their characters. I don't know about you, that felt special to me. That felt like these people who are actors, lack of a better term, really got so engaged in the topic by working with the scientists that they're having their own conversations about it, and then amazing things happened in the ring. I think that kind of engagement, where it's focused with another set of somebody else that's going to carry the message for you is a totally interesting iteration of engagement that I think is novel, that we haven't seen much of.*

***Role Models***

Many facilitators very consciously recruit and train scientists to, even unsaid, stand as potential role models for others: That the value of the engagement is not centrally what content is shared in what way, but WHO shares it.

This is especially true for audience members from demographics that are typically underrepresented. Whether it’s stereotype, geography, socioeconomic opportunity, cultural attitudes towards science, or simply whether there’s a tradition of those in one’s neighborhood pursuing “science”, many who are curious about science may never think of themselves as potential scientists.

Knowing how much engagement affects the audience, especially youth, opinions and ideas of who scientists are is a driving interest of the facilitators:

*F7*

*I'd love to see what kids think about scientists before and then what they think about after. I don't know how you'd quantify that and statistically compare it, but I would just love to see how we've affected the kids' concept of scientists. Maybe they could click words they associate with scientists out of a list of 50 adjectives and then see what we get more of or less of later. I would hope we would get more friendly, female, not old white dudes or something. I'd hope, we try to make scientists seem less cold and calculating. That scientists are just regular people with interests and not evil people in the movies.*

*F8
I don't think the kids really have any idea what it is like to do science by listening to someone talk about doing science. They might find the content engaging and interesting. Oh, maybe I could do that if it's some scientist that looks like them, and maybe they can see themselves doing it. But it's not the same as doing science, as saying I can do this.*

A sample of quotes below speak to conscious engagement of women in STEM for especially girls and underrepresented groups for all to see and possibly. Facilitators here also remark that staging and training to highlight the identities of individual scientists makes for better engagement all around.

*F21*

*[Our program] is trying to change the space of science and engineering. And when you think about who is a scientist, who's allowed to be scientist, what does a scientist look like, that's not something that's necessarily traditionally been particularly inviting, particularly to young girls. And so we try to change that image by highlighting women and men, although granted [men] in smaller numbers because that's been less of an issue. We try to change that image by demonstrating women who have advanced degrees and careers in scientific fields but who may not have the traditional image that you picture.*

*…*

*We're a different platform than a lot of people have used in the past. We're trying to breakdown the stereotypes rather than a lot of people go to these events and fulfill the stereotypes in order to fit that mold of what you're thinking. But you're less likely to see us in a lab coat [more likely in the cheerleading uniform for a major sports team]*

*F15*

*We can't have the same old faces dominate the space if we want different results. It's not just about quality of experience, but presenting different viewpoints along with that. I think there's a pretty clear sense that if we just broadly ask people about scientists that they know, they will talk about Bill Nye and maybe Neil Tyson if we're lucky, but probably Bill Gates too, which doesn't make any sense.*

*…*

*I think it's probably easy to say hey, somebody like Bill Nye is probably not going to have the authenticity to go into an African-American community and talk about the science of Black Panther in the same way an African-American scientist would. That's a broad generalization, but I think you probably take my point on it.*

*F16*

*I think our audiences tend to be pretty white, depending on which part of the country they're in. We cope with this by very deliberately diversifying and making sure that our shows are inclusive. We think it's the best way to get a mixture of people in the room is to recruit different kinds of people to perform on stage.*

Apprenticeship and mentorship is a tradition in science so it is sensical that providing role models is a guiding principle for science engagement. Facilitators therefore see engagement as a means of culture building, both within science communication/engagement and a society that includes scientists in general.

*F22*

*We recruit role models … we vet them, and see what they're working on, and then from [our] database we reach out to them, and say there's this program in Indianapolis, and it's doing such and such, and we're looking for someone to come in, because right now we're working on a project where we actually want the role models to come in and do an activity and participate in a wrap up of the girls [that we have had] working on something and to come and participate in that wrap up activity. Like a science fair type thing, where [the girls] show their projects, and we want the role models in there to help celebrate the girls as well, and say this is really cool.
…
Most of [the scientists] want to give back. They want to inspire the next generation. …They want to inspire the next generation. They want to give back, or they had not positive experiences themselves, and want to make sure that this generation has more positive science and STEM experiences, or they had male mentors and many of them say; I want to say almost all of them say that they had amazing male mentors. They're very grateful, but they would have liked to have some female mentors.*

*F1
Part of the goal of the program is to provide these students with the social support that they may lack at their institutions because they come from underrepresented backgrounds. They're often the only one from their group or one of the few, so they really don't have that support network, or they feel isolated. The program really emphasizes that aspect of community. We weave that into the communication training that we are doing.*

*…
It's really based on my personal experiences. I grew up in Puerto Rico. I came to the U.S. When I came to the U.S., I discovered I was a minority. I did feel that great disconnect between where I grew up, the community that I wanted to serve, and the science that I was doing.*

*That's something that I'm really interested in and thinking more and more about how do I bring that into my trainings because with the particular audiences that I've been serving, that's kind of been a natural fit. Now, that I'm thinking about broader audiences and really sharing what I've been doing and what I've learned with the broader, for example, science communication training community, everybody has culture. Convincing people that when we're talking about culture, we're not just thinking about underserved or underrepresented communities. We're talking about everyone. How does that look in practice?*

**WHY DO INDIVIDUALS CHOOSE TO ENGAGE?**

***Why are audiences interested?***

“Ok, wow, so there are a lot of people who go to science venues and things. And there’s entire channels on TV for science. I’m a proud nerd these days - nerds are everywhere, reveling in our identities. There’s some pretty cool stuff out there and I want to see more.”

Again, a fake quote capturing the sentiment of some audience members. Facilitators spoke to the clear demand for science-content events with various types of publics. This demand alone tells facilitators it is vitally important to bring individual scientists and scientific experts in contact with the audience.

Sometimes those audiences vocally demand specific types of scientists. Other times the audience stumbles into a realization that they want more. All this can impact how audiences can come away with a changed sense for what science is, who does science, and what all that might mean in their world.

*F15
I think in really specific settings we're engaging with publics that haven't had a chance to engage with scientists meaningfully over their lifetime or over their period, so those places where just engaging with a scientist is novel itself, engaging with somebody with that identity, I think that's where it's really important for that direct engagement, because we're offering people an opportunity they haven't had.*

*F14*

*Most people are not exposed to science and critical thinking on a regular basis. They go to work, it's a 9:00 to 5:00 and they clock out. I see people starved for intellectual conversation, and when they can pick up nuggets, and have a conversation, "Hey, I learned ... " or, "I thought this was so cool." It's the building of critical thinking and being curious and being science curious adults. If you have someone that's really engaging and super passionate about the science, it starts that process. “*

*F9 (in a venue that also involves STEM experts)*

*An attorney who writes a lot about copyright law published a piece with me. He emailed me very excited that evening to say that his babysitter had asked him a lot of questions about it. She had read the piece and just wanted to talk him about it, and she had never expressed any interest in copyright law before. Those are the sorts of stories that, to me, indicate success, that someone who previously would have assumed that this was a topic that was too dense for them wants to engage.*

***Why might it be important the audience has its interest piqued?***

 *F4*

*I think for me, primary source is always of the greatest value. That's not to say anything's wrong with the media or third party in between. There's a role for it all, but again, I think primary source has the greatest value, especially at critical decision making moments, so having a scientist at the table when decisions are being made, when legislation is being drafted, when meetings, international meetings are being convened, I think it's just to the benefit. You have a stronger, more authoritative knowledge of the impact of decisions that are being made present.*

 *F17*

*When nanotechnology first started coming on the scene, I was in meetings where there was public protest and people freaking out and scientists not really understanding what's the problem. It's really nice for those groups to interact in I feel like a really diffused setting, like a museum, and experience a phenomenon or have a grounding or foundation for discussion that lets them share these perspectives. I think at the very basic, it lets scientists appreciate and be exposed to those public perceptions and opinions and values. I think that's really good.*

*F16*

*A lot of scientists right now are asking questions about why doesn't the public trust us? I take umbrage at this idea of a war on science. I really think that's a profound mischaracterization of what's happening, but I'm very keenly interested in leadership. Who do people follow, who do people look to for trust? How do people access expertise in times of need? I think that our warm, irreverent, fun, egalitarian approach helps to minimize some of those hierarchical [structures]; the power distances that we put in place.*

***But wait … what about people this programming does not reach, for whatever reason? Are they potentially interested? How do we find out? Is it even knowable?***

*F18
I'd like to know what they did when they went home. I'd like to know, was there any ... everybody went back, did they talk about it? Did they find a video to watch? Did they ... what's the follow up? Yeah. And we did not ... I don't remember anyway doing any follow-up.*

*F23
I would also be interested to see ... I don't know, it's like a dark matter problem. I would like to know who we're not reaching who would be interested, but of course, if I knew where to find them, we'd already have found them. So, I don't know, I have to work on that as well.*

***Why are scientists interested in doing this? Do they enjoy it?***

Many scientists stay in their labs or out in the field doing science things. But some, by the accounts of this respondents, a growing number and especially younger scientists (students, postdocs) are engaging with the public. What motivates these scientists to engage? Are there any indications they’ll keep doing this?

Facilitators think that engagement makes scientists better scientists and report anecdotal evidence that scientists realize this potential.

*F16*

*[We have information on] how using technical concepts from their engineering training, like thermodynamics and dynamic equilibrium, as metaphor space in which they play to create personal stories that they tell on our stage, helps with this self-authorship concept of professionalism and being a member of a community, and understanding that knowledge is contextual and contingent and something that you create rather than is done by experts and handed to you as a student.*

*F18
[T]hey develop, from our perspectives, some real communication skills. We know those skills are useful to them when they go and give a talk at a conference. The communication skills we focus on are for the public. They are basing what we learn from the learning sciences about how you communicate, how people learn. So talking to their neighbors, talking to or teaching a class. We know there's been that kind of impact with the scientists. So all those things are good things that come out of it.*

*F13*

*I think communicating with the public is beneficial to the scientists also for exposure and to let the public know that they are doing certain types of science, that they found certain things that are important, and that the public should continue to fund this research. So it's going to help get the scientists themselves exposures to their science, which is great because the more widely your science is exposed to not just the general public, but it also exposes it to the academic public as well, and that can potentially lead to collaborations, invitations to give talks and presentations at other universities or conferences. It can help snowball into what can potentially be just better for a scientist's career overall.*

Facilitators who are currently laboratory-based researchers think that getting and keeping non-scientists interested in science is the key to having science still happen in society.

*F21*

*I guess the first and foremost, from my perspective being in cancer research, you have to make people care about what you're doing. If they don't care about what you're doing it's hard to get support, it's hard to get funding. You need people to care about it. In order to care about it they need to understand it. And if you can't explain it simply it's going to be really hard to have people understand and care about what you're doing.*

*F7*

*In the past 10 years, there's been this growing distrust of science. And back 30 years ago, science was pretty respected in American culture. It seems to be getting worse and worse. There is all this misinformation going around on the internet. People will say, there's a cure for cancer but scientists are hiding it because pharma is giving them money, or whatever and like juice cleanses. Can we just, maybe if they trusted scientists, maybe this kind of nonsense wouldn't be as prevalent. We would trust vaccines for example. There are these big problems that we have that I think could be fixed. I don't think you could fix them directly. You can't just hit people over the head with facts, it doesn't work. You have to build from the ground in getting people to like you and trust you to get you on their side. Get them on your side. I figure this is a good way to start.*

Many facilitators are heartened by seeing scientists enjoy engagement as evidence alone that more will seek out engagement opportunities, thus furthering the impact of facilitation.

*F18*

*A lot of them, they want to give back to the community or society, however you want to look at it. They think it's really important for people to understand their science and what they're doing. It's important for people to understand science in general [and be] scientifically literate. I'd say most of them like interacting with the public. They feel this is an enjoyable and a good thing to do, they wouldn't have signed up otherwise*

*F19*

*This next generation [of research scientists] is quite impressive in that way. They're willing to do it, they're willing to get active.*

*F22*

*[Engagement is promoted] to PIs as a way to satisfy your [broader impacts], or your outreach goal that you wrote into your grant. Here are some ways to do that, but that's not what I've seen, and I would say also probably because I'm working with individuals, or professional organizations where … one of their goals is to connect their members to this kind of thing ... There's some corporations that actually have a volunteer requirement, like volunteer service requirement, and this helps them with that, but many of these individuals I think would do it anyway.*

***But wait – are there times when scientists shouldn’t engage with the public? Why not?***

We asked facilitators if there are occasions when scientists should not be directly involved with engagement. There were two clear clusters of responses.

Facilitators putting an individual scientist in touch with a potentially very general audience:

*F14*

*As long as they're prepped and they know their audience, I think it's advantageous to have scientists speak. The only time that I've really seen it gone wrong is when a scientist is condescending to the audience, and not speaking at their level.

F17*

*When the scientist is not equipped, when they're not trained and they don't appreciate the differences in that skillset compared to what they're using in the lab or in their career. There is something to prepare for, that you want to be ready to interact with the public. I have seen interactions that do more harm than good.*

*…*

*[If] they're not interested. It really shows. You can't hide those things when you're talking with the public.*

*F13*

*I think that science is a very intellectual pursuit, and some people are very in their heads and not as good at communicating what they do and why it's important as others. And some people, even though in their head they know what they're doing is important, it's very hard for them to get that message across for whatever reason. And I honestly think some people are better suited to the communication pursuits than others, and sometimes no amount of training is going to make that better!*

*F18*

*What would be really bad is if we mandated that every scientist … so that every broader impacts statement had to be go to a science center or to a classroom and talk about your science. That would be a disaster. NASA tried to do that back in the '90s and got a lot of push back and lot of people in my mind who … didn't want to go through any science communication training. They would just go out and do their usual thing, which was not appropriate. So you wouldn't want to mandate everybody does it.*

Into a room with policy/decision-makers:

*F4*

*[On whether there occasions when scientists should not be involved,] I mean, my gut was to say, "No." Right? Of course it makes sense that they should be in ... You should have expertise at the table rather than not, but you also have to have someone who's smart about it. Someone who has the skillset to be able to translate that science. … You want to build in someone the capacity to have those conversations and be able to understand how they need to shift their conversation and their knowledge so that someone else can take meaning away from it.*

*F5*

*With public officials and with the public, I think scientists have an inherent level of credibility that you want to capitalize on. And also, it's about science, they're the ones who are the experts. But you want to make sure it's somebody who has the capability to do it well. You don't want to pick a scientist at random. [You] want to make sure there's someone who is good at talking to lay people, has a sense of what they're after and what they need and how they'll process the information, feels comfortable, personable, doesn't approach government officials with contempt, knows how to explain things, isn't defensive. So you need them that has a good instinct for this kind of thing.*

A couple facilitators articulated the nuances at play and discussed what to do with scientists who might not be suitable for direct contact:

*F15*

 *It depends on the event, it depends on the structure, because my outcomes are almost always dependent on two metrics, which is usually audience based outcomes and ones for the scientists that are involved.*

*[One] I think in really specific settings we're engaging with publics that haven't had a chance to engage with scientists meaningfully over their lifetime or over their period, so those places where just engaging with a scientist is novel itself, engaging with somebody with that identity, I think that's where it's really important for that direct engagement, because we're offering people an opportunity they haven't had. That's a simple one. Two is when the focus of the event is more on the side of humanizing or relating a personal story or rounding out the identity of what a scientist is, it becomes very important to have the scientist directly involved in that piece.*

*On the flip side, this is a generalization, but stick with me. When the desired outcomes all revolve around entertainment or specific outcomes that are not necessarily ones we tied to the expertise of a scientist, it becomes really important for an intermediary to be involved.*

*F10*

*I think if the scientist is ultimately not up for on-camera presentations or is not an effective communicator overall, it's probably not the best fit for what we're doing. There are other roles that scientists who want to communicate can fill. They can be writers on our series. They can be experts on our series in terms of reviewing content. There's a lot of roles that they can play there.*

*F9*

*I also recognize that not everyone wants to do it, and that's fine. I don't think that people who genuinely don't see any value in it after having thought about it, they shouldn't have to do it. ... There are a lot of people who want to but just don't feel equipped. Those are the people I'd like to spend more time with.*

***Who are these facilitators?***

So, who are these facilitators that bring together scientists and publics? Are they scientists? Or are they exemplars of super curious publics? Are they an agent of scientists, or a self-assigned representative of the people? Or something in between?

In this study, 20 facilitators of various backgrounds; 14 have a (natural or applied research) science degree of some sort, i.e. 70% of those surveyed:

* 11 have advanced degrees in science (9 PhD, 2 MS) and a further 3 have a BS with two of those having an advanced degree in another discipline
	+ Dominant degree type is biological sciences (4 marine, 4 molecular/biochem/genetics, 2 neuro); plus 3 chemists and 1 astronomer
* Non-research-science degrees cover business administration, classics, education, English, history, law, library/information sciences, rhetoric, urban studies
	+ 5 advanced degrees including 1 PhD, 1 JD, 3 professional masters (MBA, MEd, MLIS), and 1 MS in urban studies

In this sample of 20 science facilitators, only 2 are still involved as researchers full time and another 2 have degrees in communication or education. Most have job titles that speak to “director” or “manager” of communications or outreach activities; some are founders and consultants of independent operations.

Hybrid paths between science and non-science are common: A journalist with an English degree who helps PhD scientists write for non-PhD audiences; a former environmental services entrepreneur who has run events from small science cafes to a city-wide science festival; a PhD neuroscientist hired by a museum wanting a PhD on staff to talk with PhD contributors; a postdoctoral fellow researching medical oncology who is also a professional cheerleader with a pro-sports team; a former school teacher now running a nationwide youth & STEM outreach organization; a PhD historian who selects faculty from a top ten research university to speak with elected officials; and a former marine biologist who now runs a theatre company that puts scientists on stage.

***What motivates these facilitators?***

*F1*

*Engaging in science communication and outreach was a way for me to bridge that [very] gap. It was also a way for me to really find my voice and really be okay with being an intersectional human being and bringing all of the identities and elements of myself and my culture into my science. For me, it's deeply personal, and I draw on those experiences a lot when I'm thinking about how I'm creating these programs and how I'm training these young scientists.*

*F3
I decided out of passion, right? So it was an emotional decision, not a rational one. What I found is the best way to talk to the public as a scientist is to do it in an emotional way. Not in a rational one.*

*F18*

*We're interpreters of science, not researchers, and certainly not necessarily up on current science. So if you want to be able to convey current science, then you need to figure out a way to do that.*

*…*

*I have this dream, many people would consider it a fantasy, that someday science would be as pervasive as sports. So after-school sports, intramural sports, or sorry, after-school science, intramural science. A little pickup science activity at the park and I have the assessment tool so we all have to rush home from Monday night science. I mean, I think ... And a lot of this is happening, is how do we make sure there is science happening in a whole different set of venues? And finding science festivals, which have really picked up. so that's another avenue.*

*F21
[To me, it’s] important to foster the next generation. In my field, I build on what I did yesterday. Every single day is trying to make progress from where I was the day before. And every single day's different. But that being the case, my days might change over the course of a week, but over the course of a decade this field changes dramatically. And you have to be confident that there will be talented, excited, passionate people coming after you. And in order to make those people want to join the field you've got to be able to communicate and be able to explain why it's exciting, what brought you into this field, why do you care, why should they care. I think it's just so important for the sake of progress and having advances in science, engineering and technology, that we need to have the next generation get excited. And a huge part of that is having people to identify with who are in these fields, and making the fields more accessible.*

**IS IT THE “RIGHT” SCICOMM?**

As the volume and desired quality of science outreach has expanded in recent years, a discipline known as the “science of science communication” has developed in (largely) academic circles. There is an accompanying body of literature for this emergent communications specialty. We asked the science engagement facilitators if they “stay up to date” on findings of and the conversations around science communication; a couple of the responses indicated interviewees also considered informal science education (i.e. beyond classroom learning) literature as well, but we did not explicitly ask about that discipline.

Responses ranged the gamut from keeping very up to date to consciously not following the literature:

*F16
No books that I know of, so I'm sure that [there’s] some I'd like to hear about them. [Several] citations, I don't have them off the top of my head, but a lot of them link back into the Besley and Dudo stuff.*

*F22*

*STEM broadly, I read a lot. I'm trying to think what would be ... I get a lot of feeds from NSF, and from Science magazine. I've actually been enjoying Dennis Schatz’s new connected science learning online journal [Connected Science Learning]. NSTA, I actually get readings from almost every professional STEM organization, ACM, NSTA, all the technology folks.*

*F10*

*Pointer is not science communication specific, but I find all of their materials to be really relevant, because it is all about just reporting accurate, non-factual content. I think that's relevant to science communicators and just journalists in general. I think the work that Undark is doing and the Knight Science Journalism Lab is amazing. Anything that Deborah Blum touches, in particular, is just really good for all the science communicators. … I really do enjoy the talks at AAAS annual meetings. I think those are great places to get best practices in the field. Just following a lot of science communicators on Twitter I find really to be a great way to share this sort of knowledge and disseminate it.*

*F11
I would love to tell you that I'm going and checking the journals, the relevant journals all the time. It's not often what I'm doing, usually I'm kind of like, various things come across my desk and I hear about a new paper and I'm like oh, yes, whether it's via Twitter or via a blog or a new story or a colleague.*

*F7*

*I feel like I should do more of the peer reviewed on science communication but I gotta keep up on [my research field’s] literature. I figure if something really big happens and my Twitter people talk about it, because I follow a lot of science communication people. And Museum Hack is a group of museum advocates and I follow them and I talk to people who work for them fairly often. So if something big happens, I'll know about it.*

 *F23*

*Yeah, I'm struggling to think of any, and that's actually something I'm trying to work on a lot this year, is finding a good literature source and staying really up on top of it. Most of what I've seen has kind of been more from discussions, from people who have been doing this for a long time. But I think definitely increasing the formal research into the area, having more work to base decisions on would be great. But, you found my professional weakness.*

*F18*

*I don't follow any research journals,* Science Communication*,* Public Understanding of Science*. I find it just into the weeds and a little hard to apply to science communication to the public.*

*F15*

*Not really. There is literature out there that I referenced in my work that I've consulted with. Mostly there's a site, I can't remember what it's called off the top of my head, but it's a journal of science communication. There's a public understanding of science journal that gets published in the UK, but honestly, all right, so I'm being super honest here. I don't see researchers having any sense of what the trends are with various publics out there unless there is scale with them. I think there is a big disconnect between researchers and practitioners, and quite frankly, when I talk to researchers, of which there's only a handful in those countries anyways, that they seem less aware of what's happening in the field than the practitioners are, and the research questions that they're asking don't seem to dovetail with what is happening in practice.*

*Now, that's not saying the researchers are totally off base. They're asking interesting questions, but … I'm not clear that where the practitioners, the ones that are doing a lot of science communication, are connected at all with where the research is. Now, I'm talking about this in the context of live events, mainly, and not at all for writing. That's not my area of expertise on the research and literature, on scientific writing.*

Taken in aggregate, the vast majority of facilitators do not follow or keep up to date on the research literature in the science of science communication although they are aware of its existence. A small minority (two facilitators) explicitly mentioned the informal science education literature; the discipline was conceptually referred to by more but as noted we did not ask to that discipline specifically, unlike “science communication”. Twitter is by far the most popular means of keeping up to date on #scicomm.

**HOW SUFFICIENT ARE THE FUNDS?**

As in other measures reported in herein, the sufficiency of funding ranges widely for facilitators. Some report ample funding to get done what they wish, or at least a foreseeable path to more sufficient funds. Others note they have to choose what aspects to support, often choosing to forgo extensive, or any, metrics analysis if funding is limited. Still others report very limited funds and pine on what they might do with more, but sally forth with what they have. Finally some facilitators did not report financial concerns, even when prompted with a question as to “obstacles” that might prohibit their ideal event/process.

For example, the programs surveyed range from

*F18
Over the years we've had [federal and philanthropic funding] and we're now have 62 sites that are doing this around the country and in Canada.*

and

*F22
We've been funded [federally] for about 15 years [and we have foundation/corporate support]. Right now the programs that we serve reach about 20 million [people].*

to

*F23
We're not dependent on any federal money, so whatever happens with whims of administrations, we're okay. But there’s still a pretty involved review process. ... So it's still important to get that data and go a little slowly and get governance support.*

and

*F3
We are not a business operation. We are not quarterly profit orientated. It's not about money. It's about knowledge and understanding the world.*

to

*F7*

*We don't have any funding. One guy donated 500 bucks to us and that's all we've got.*

The quotes below indicate what facilitators have found possible within this range.

***What doors are opened by funding?***

*F21*

*[Our metrics from other events can inform] when we do have a large scale project like some of the collaborations we've done with [federal and philanthropic funding] how many people [we can] reach through the events that we do and the projects that we facilitate.*

*F16*

*We have an evaluation program set up, it's grant funded through work we are doing with [a philanthropic foundation].*

*F5*

*We have a significant number of [openings] that go unfilled each year, which is why recruitment is such a large effort for us, but the funding of these fellows definitely has a role in this formula, also, so it's a balance we work to strike. We are working to fund as many placements as we possibly can and give the fellowship experience to as many scientists as we can.*

***What are you limited from doing?***

F22
*I was at a meeting a few weeks ago where we were talking about longitudinal data, and if I had a dollar for every time I got asked if I had longitudinal data, I could fund a project around longitudinal data.*

*F17*

*A lot of these projects don't come with a lot of funding. The evaluation was very minimal, at best. We sometimes did some surveys that helped us understand the results of our mediation, our activities, our experiences. A lot of times, those were with the media assets or standalone assets, so we could get a lot of people going through them quickly. Unless it was an established program or there was a lot of funding behind it, very rarely did we look into those metrics.*

*F10*

*If the series is affiliated with an institution like [a scientific society], then there is more training in that space. On [our] side, no we just don't have the resources to give more training along those lines beyond giving science communications talks.*

*F11*

*[Our activity choices are] a matter of lining up the funding to be able to do it. That's frankly the biggest challenge for us, or I should say limitation in us; we would do this a lot more often because the demand is there, but the money isn't always there.*

|  |
| --- |
| **Appendix 2: THEMES BY VENUE OR AUDIENCE CONTEXT** |

**CIVIC GROUPS**

This sector concerns putting scientists in front of publics with a civic service in mind.

F1 has an advanced degree in the biological sciences and empowers younger scientists to engage with underrepresented groups;

F3 has an advanced degree in the biological sciences and works for a conservation organization that co-runs a scientist speaker program with a local civic group.

Note that F3’s program style reads like a large attendance science café and the target audience has a broad age range, but centered on adult. However, a co-funder of the program is the Rotary Club, which has a clear civic-facing mandate; also the other adult-facing programs described below target 21+ crowds and often charge admission. Therefore it is the support of a noted civic-facing funder that has this program in this section.

**What’s on the marquee and who’s checking it out?**

***Who is the audience?***

In the case of the outreach program run by F1, the audience depends on what the program participants choose. For F3’s program, the main event discussed here is a scientist speaker series held in a high school auditorium.

*F1
[The students’ outreach activities] is anything from doing an event, going to a school. We've had students in the past go do a visit to a school and do demonstrations. We've had students organize March for Science events. We've had students write for the newspaper or do podcasts, a variety of activities within that outreach and engagement umbrella.
…
There was a good number of the students that were in Puerto Rico and that were affected by the hurricane that hit the island in September. We had several clinical psychology students, for example. They went to schools or shelters to talk to kids about mindfulness and how to deal with the trauma of the hurricane. We had some public health students do an infectious disease workshop for healthcare providers. We have a student, his research is with mental health, deaf community, so he did a symposium that featured not just talks and discipline-specific talks, but also sketches and other things, like combined art into the event. As I said, somebody organized the March for Science. We had several people do school visits. We had several people write blog posts. The range of things that they do is really, really diverse.*

*F3*

*This lecture series is an after-school type program for the high school kids where they can come at the end of the day. It's a 7:00 at night, from 7-9:00., because it would have to be Wednesday, and get some of the population that might otherwise sit on the couch or go play bingo in one of these retirement communities we have here.*

***What value does the audience get? The scientists?***

For F1, this again depends on what audiences the program participants choose; they do have the chance to interact with scientists who might never otherwise engage with them. As noted above in the “global themes” section, the ability for the participant scientists to provide role models to the audiences they interface provides much value for them.

*F1
I think there are incredible benefits, particularly because I work a lot with students and young scientists from underrepresented backgrounds, I think there is great value from a psychosocial standpoint that these students feel like they're more valuable or there's more value of what they're doing to their communities. Engaging in this kind of activity mitigates feelings of isolation, that feeling that their multiple identities are disconnected.*

*I also believe that, by providing, particularly with scientists that are from these underrepresented backgrounds, providing them with those skills, they're better positioned to succeed in whatever career they decide to pursue after their PhDs. There's an element of they can lift their communities with them as they climb.*

For the speaker series,

*F3*

*[The audience has] a chance to meet real life scientists and make first connections, maybe get an invitation to their lab to visit and things like that. Then obviously there are teachers and adults, parents of the kids so that's a part of the adult segment. Then, it is sponsored by a local Rotary Club. So then we tap into this, well, they are usually pretty old people … we are trying to sort of attract away from the bingo nights.
…
If you are at Harvard or Berkeley, if you live in those places, you go to Harvard and Berkeley, there are lecture series all the time, in these big universities. But where the desert is, is in all the other places that are not university cities or towns. That's why I made it, because there is nothing here close to us.*

**Scientists on display/stage**

***Who are the scientists and how do you find them?***

The program managed by F1 has a formal application process that ultimately selects 40 annual candidates. Like any fellowship-style program there are various marketing efforts including web-based and social media postings to reach candidates. All the participants are graduate students or postdocs pursuing NIH-funded research, given the source of funding.

For the public speaker series, the host remarks his experience in a radio science show gives him a sense as to the type of scientist who would work with the regular audience.

*F3*

*For 13 years I did a live [radio] show about science … there was ample opportunity for me to meet all these different people because I got them on the air to talk about their work and then you build these relationships and then you count on it.
…
[So] recruitment is my job. It is always easier if you are a scientist yourself, I think. Because you sort of know, well first of all you can understand what they're doing more easily.*

***How do you train/prep them?***

Again, the program headed by F1 is a yearlong effort that has various trainings to ready the participants for their outreach work. Conversely for the speaker series, F3 gives minimal staging direction then lets the program flow free-form, wanting the audience to interface with a scientist as they (both) come.

*F1
The program is mostly virtual, but the students get together once a year in person … where we do two in-person workshops, the science communication workshop and the outreach workshop.
…
For the last two years, we've had a facilitator who is a theater actor. He's, again, an expert in improvisation, so he has a whole curriculum where he uses improv for communication training, but also for community building. … There's a high emphasis on building trust and building community because that really helps. Throughout the rest of the year, the students are doing all of these things together, but they're not together in person.
…*

*Increasingly our focus is in giving them the tools that they need to effectively complete the outreach activity and not as much as here are things where you can kind of plug and play and do things. We emphasize that the students really think about their skills, their values, their career goals, their own personal experiences and how they influence what kind of outreach they want to do, what kind of community they want to engage.*

*F3*

*I leave it completely up to the, whatever happens, the atmosphere in the room. All I do is try to set the atmosphere so things might happen … I don't introduce them like it's a formal event. So my introduction of my speakers is one minute, name, affiliation and maybe one or two highlights of their career and then I always ask them to tell our audience their personal life story. The first five minutes, just tell us how you got to this place of being a scientist. How did you start? Did you start with a chemical set at home as a kid? And you went to school and you always loved chemistry? Or maybe you wanted to be a football player and then you became a neuroscientist, you know? These stories are much more authentic and relatable then me reading off a few pages of their resume.*

**How’s it going?**

***What metrics do you collect and what do you think they’re telling you?***

The young scientist program of F1 attempts to quantify the reach of the outreach programming and collects various measures as to participants’ sense of their communication skills. For the speaker series, F3 bases all measurement off the recurrent attendance and anecdotal feedback.

 *F1
 [In 2017], we had, I think, 30 projects, and one of the things that we asked them to do is to really think about their audience and how many people they're gonna impact, why they're doing what they're doing. Last year's projects, I think they impacted about 5,400 people in total. The projects from 2016 impacted about the same amount of people.*

*…
We do a pre- and post-evaluation, looking at how their attitudes change after they've gone through the whole year of the program. But then in particular with the workshops that we do in communication and outreach, we also do pre and post to see how their knowledge changed, how their attitudes towards doing public engagement is changing. Do they feel like it's gonna be more valuable to their career? Do they feel like they're better prepared to do it? Yeah, we do evaluate that.*

*F3*

*I'm assuming I'm successful because people are coming back. I'm assuming I'm successful because we have created a new generation of scientists and I'm assuming I'm successful, or the program is successful, based on the feedback I am getting. People are saying, "Now I understand this better." Or, "No I still don't believe in climate change." Then, that's it. I don't think that as a scientist, I don't think we have to worry so much about measurable outcomes in other categories than these ones. We are not a business operation. We are not quarterly profit orientated. It's not about money. It's about knowledge and understanding the world. That can happen in many different ways and it can happen emotionally.*

***Where do you see this going?***

For the younger scientist outreach program, lessons are being learned as to the cultural impact of scicomm and integrating scientists in culturally relevant programming. Future work could look for synergy there. Regarding the speaker series there is interest in networking with other such groups and scaling larger.

*F1
How to incorporate this idea of cultural relevance into my trainings and really getting students or trainees to think about how culture influences the way that people value and perceive and understand science, but also how they themselves as communicators are sharing science.*

*F3
If you do it on a national platform like live stream, you could then have a very interesting lecture series going on in all corners of the United States and beyond and people can tune in. You could create actually quite a nice database of topics to talk about that are available to let's say school districts all over the country for the science teachers. It's also available to people who write about science in magazines and journals. And it's available to other scientists, for all we know, who might be interested to listen to somebody else.*

**DECISION MAKERS**

Three respondents interface scientists with professional policy makers (e.g. federal agency staff) and in some cases elected officials (e.g. federal legislative branch office).

F4 has an advanced professional degree and works at a scientific society that places scientists into policy fellowships;

F5 has an advanced degree in the humanities and works in the DC-based government relations office of a large research university;

F6 has an academic degree in the physical sciences and an advanced degree in the social sciences and works in a science museum that convenes citizens in policy discussion groups.

None of these three facilitators have academic degrees in research science.

**What’s on the marquee and who’s checking it out?**

***Who is the audience?***

Elected officials (or their staff representatives, aka “staffers”) are not generally science experts, and in that sense are an audience for engagement. They are different from other public audiences in that they create the rules under which society functions.

*F4:
The purpose of the program is to bring scientific expertise to the table and have conversations about science at the point of need in policymaking.*

F4 and F5 bring scientists in direct contact with elected/governmental officials: F4 by embedding them for many months as term staffers; F5 by bringing researchers into meetings in the government offices or facilitating a visit/tour by elected/government officials on the campus.

The program co-run by F6 acts as a conduit of information between scientists (commonly organized, represented, and supported by agencies), publics, and the decision makers: scientists inform the content and discussion rubric undertaken by citizens, and the scientists may be in the room but their contact with the citizens is carefully controlled by the facilitators so that citizens are free to discuss amongst themselves; the choices and feedback made by citizens are then delivered to the decision makers, typically as part of a report presented by the participating agency, for consideration. The program in this sense combines scientists engaging with the public so as to seed a “town hall” discussion that then flows back to the government.

 *F6*

*When you’ve got a complex idea and it brings up societal questions that an institution may not necessarily have asked its visitors to think about, how do you do that in a way that is inclusive, that is accessible, but also is useful for the scientific community. That is the tricky part – how do you triangulate the question for consideration? … How do you land on something that creates usable outcomes and interesting outcomes, for the scientific community, for the public, for the policy community and also feels right for an institution to be a convener of that?*

***What value does the audience get? The scientists?***

In balancing various value systems and, needs and wants, facilitators bring experts into (more) direct contact with the publics and decision makers. This permits the staffers and/or elected officials the opportunity to gain insight and perspective from those most steeped in the details of a particular topic that might inform policy. Decision makers and staff can discuss with a scientist, and the scientist-informed deliberation of publics (in the case of F6’s program), and get a better sense of the worldview that informs the data collection and interpretation and ask questions for more immediate response. Scientists gain an acute exposure to the complex world of policy framing and deciding: seeing that a massive infrastructure of aides gather various sources to relay back to those officials that perceived as the sole “policy makers”.

This sharing of worlds between scientists, citizens, and policy/decision makers undergirds both science for policy (i.e. data used to inform policy framings and/or assess its success/failure) and policy for science (e.g. what research to prioritize, how to regulate collection and distribution of data). This coming together thus provides mechanisms for policy to consider science and an opportunity for co-appreciation/understanding by scientists, citizens, and decision makers alike. Arguably, given the increasing presence of science in societal decisions, such facilitations are important.

*F4:
One side of it is to bring in scientific knowledge, scientific minds, and have them utilize, bring their knowledge, to actually help make better federal policy making, but the other side of it is to bring the knowledge of federal policy making back to the science realm*

*…*

*I wouldn't say [alumni pursuing policy careers afterwards is] predominant. I'd say it's definitely a natural outcome because I think they step in because it is an area of interest of theirs, but as I said, we definitely see, in post-fellowship career data, we see people transitioning back to the sectors they came from, so there is a reasonable number of people that stay in science policy, which I think is a great thing*

*F5:
Again the people we’re trying to influence, we want them to sometimes know particular things about science. We want them to think more favorably about science and engineering … it’s not just about the [academic] institution, it’s about the substance of the discussions.*

*F6
[This presents] different ways for people to get involved, based on their age, their civic engagement, their position, and where in life they are positioned to do work. The adult participant in the forum you could argue is maybe over towards the more civic participation side rather than the learning participation side.*

**Scientists on display/stage**

***Who are the scientists and how do you find them?***

For F4, the program has strict requirements and a competitive process by which scientists are selected – interviewed for a fellowship placement in an office where other staffs went through a job hiring process. Specifically, applicants must have fully completed their terminal advanced degree by the time of application or have a proscribed number of years with professional certification. Like many career recruitment programs, candidates are found through various marketing modes and an extensive use of alumni word-of-mouth.

For F5, the pool of candidates is programmatically those faculty and students of the academic institution in question. As the government relations staff have acute understanding and relatively constant contact with officials, they tend have an archetypal sense of scientist candidate and possibly a particular name. Depending on the official in question, a given scientist’s experience in speaking with non-scientists will weigh heavily into consideration of candidates.

*F5:
The office has a sense of who's good at this, or we'll meet people and talk to them
…*

*want to make sure there's someone who is good at talking to lay people, has a sense of what they're after and what they need and how they'll process the information, feels comfortable, personable, doesn't approach government officials with contempt, knows how to explain things, isn't defensive. So you need them that has a good instinct for this kind of thing.*

***How do you train/prep them?***

F4 has a formal process, again given the scientists are fellowships for job placement.

*F4:
There's an orientation that's approximately eight days. We sort of see it as a science policy communications 101, where they spend those eight days altogether as a cohort learning about sort of an overarch, an overview of science policy, looking at the science communication issues. Just preparing them for their sort of immersion experience that is their fellowship … Then throughout the year they are offered two to three opportunities a month, ongoing sort of workshops and seminars*

F5 has a sliding scale of preparation based on variables of time and their office’s perception/knowledge of the scientist’s readiness:

*F5:
I wouldn't necessarily say training, although, I mean, the more we're talking, the more I'm thinking of things we've done. So with graduate students and post-docs and people who are more junior, sometimes there's sort of a brief training involved. So the main selection is just sort of by topic, right, so who's the expert on the particular issues we've got?*

*…*

*we've had government officials up to campus and same kind of thing, did a briefing in advance on what kinds of things to expect, what kinds of things to avoid. And then was at the presentations and were able to sort of help shape things by asking questions as part of the presentations.*

**How’s it going?**

***What metrics do you collect and what do you think they’re telling you?***

Given the complex nature of policy making, in addition to some ethical and even legal restrictions on polling government officials, the impact of a given facilitation is very difficult to quantify. Therefore, any metrics that exist tend to measure the health of ongoing recruitment and past participants’ reported or anecdotal impressions.

*F4:
One of the things that I think I've been really amazed at in my time with the program is the level of engagement that alumni continue to have with it, and we don't have a very strong alumni engagement program yet, but every year our applications are vetted. The first round of applications are vetted by alumni reviewers, and we need hundreds of them*

 …

*[Metrics on the policy side is] the more difficult one, and it's not just for us. I think it's a difficult piece for programmatic assessment, period, and we are not unlike a lot of other programs similar to ours. Our fellows are engaged in several offices. They're engaged in several offices that sometimes have security clearances that they have to have, to even be there, so our opportunity and possibility for actually gauging fellows' impact from the offices side get very dodgy in those situations.*

 *F5:
You don't want to draw too close a connection between meeting A and action B, that's usually delusional. So yeah, you're looking at the way officials talk about issues publicly and privately, you're looking at spending decisions, you're looking at legislation, you're looking at policies that are undertaken. Whatever is in the purview of the people you're trying to influence.*

***Where do you see this going?***

As with most programs, an immediate desire to conduct a program review in the near future and continually on set terms. F4 reports that demand for fellows is growing quickly and thus the program desires recruitment in pace. F5 remarks that it would be beneficial to have a growing cohort of candidates who better understand how the policy world works; this could improve the quality of the engagement and perhaps improve the programmatic efficiency in terms of preparing scientists.

F5:

The more they understand the overall situation they're getting into, the more demystified it is, the more open they are, the more it seems legitimate on the other side. That's an important part of preparing people and we do that. Again, there's more of that that's actually done when it's grad students. But partly of the time, and there are plenty of organizations around D.C. that do this larger training, but that's I think the thing that [will create] more incentives for scientists to communicate [with policy makers].

**FORMAL EDUCATORS**

Facilitators below interface scientists with formal classrooms, thus targeting students and their teachers. Some of the other respondents, notably in the youth-facing informal science venues have facilitated scientists going into classrooms (F21 and F22), but none of their quotes are presented below.

F7 is completing an advanced degree in the biological sciences and co-manages a program to video conference scientists into classrooms;

F8 has an advanced degree in the physical sciences and integrates computers-based curricula within a large K-12 school district presently experimenting with citizen science classroom work.

***Who is the audience?***

School-aged children in a classroom environment or school-day activity (e.g. field trip).

*F7 (any age that a teacher requests)*

*The point of [our program] is to have communication between students and scientists. Not to have the students feel like they're being talked at. We really want to facilitate personal interaction and having the kids feel like they're actually being heard and not told about something.*

F7 also notes they’ve just started to include small groups of adults based around libraries.

*F8 (middle school, i.e. grades 6-8)*

*we have like Skype with the scientists or things like that, but those are kind of one-[off] things*

*…*

*I think we still have some where the scientist comes in and does career day.*

*…*

*I think the [citizen science project\*] naturalist is going to the school because it's easier to transport one naturalist than 30 kids. But then the idea is for the students to actually go to the park as many times as they can within the timeframe.*

\*note that it is unclear whether the “naturalist” in question is a research scientist

***What value does the audience get? The scientists?***

Students get to ask questions of a working scientist and consider what they hear about in addition to their science classwork. Scientists have the opportunity to interact with the source of the next generation of scientists, perhaps motivated by “broader impact” needs in their research funding structures.

 *F7*

*We match [the scientist and the classrooms] based on location, availability, the type of scientist the teacher requests and how the scientist identifies themselves as scientist. And then we allow the teachers to request either a female scientist or a minority scientist and different types of minorities including socioeconomic and then based on what the two request we match them up. The scientist can say they want to [participate in] anywhere between one and five sessions.*

*…*

*It's a nice program because you can do a [session] while you're in your lab in between incubation times or whatever.
…
If you need something for your broader impact section, you might participate. If you know that there's some kind of check mark box you have to fill for outreach, this will certainly do it and it's really easy to do compared to making a pub trivia night or lot of other outreach things, which may involve you actually having to leave your lab. I haven't had a lot of that sort of negative feedback yet about bad scientists.*

**Scientists on display/stage**

***Who are the scientists and how do you find them?***

*F7*

*I advertise heavily on Twitter and a little bit on Instagram. On Facebook a lot, especially for the teachers. … We do advertise. We don't have an advertising budget but it's just mostly word of mouth.*

It was not clear where or how the scientists brought into F8’s classrooms came from; allusions to those associated with citizen science projects but that was less clear, especially at the early stage of this pilot program.

***How do you train/prep them?***

Both facilitators are very busy with their other primary tasks and report no time to train the scientists. In both cases, they recommend that teachers prepare their students for the visit, but how much is done and to what standard is wholly unclear.

*F7*

*I don't have time to develop a lot of curriculum for getting [the scientists] prepared. This is kind of a way to practice your jargon-free speech in the wild, like as you go, just figuring out as you go. The worst that can happen is you have one bad session and kids have no idea what's going on. The risk isn't that high. So I link to Alan Alda's science communication group in New York. They have some online things you can play with to practice. There is also this online tool, it's like a text editor online called the Up-Goer Five.
…
Ideally, the teacher will have had something simple ahead of time. The kids will have read it or watched it. The kids will have prepared questions ahead of time and then the session happens and the scientist says hi, gives a two-minute explanation of what they do, just like, "Hey, I'm [“Susan”]. I'm [in my 20s] and I like [to study this] and I also paint in my spare time." Something to humanize them. And then just launch into questions from there.*

**How’s it going?**

***What metrics do you collect and what do you think they’re telling you?***

The nature of F7’s program means a database is maintained on how many scientists and classrooms sign up. However, the program is run by two volunteers with a very limited budget, so beyond advertising and matching scientists to classrooms there is little time to do more. Since F8 is still in the pilot phases so there were no metrics to report beyond that 6 of 41 schools are participating with an estimated 800 students involved.

As for feedback and other information on the program itself and what it seems to indicate,

*F7
That's tough. We can't ask the kids directly without having IRB approval. … We can ask the teachers how they felt, but we need IRB for that as well, if we wanna publish … that's a Ph.D. project in and of itself and I'm just trying to get my [own] research done. The thought of having to do that, was like, no thank you.
…
We ask the teachers at the end for an informal Google forms survey and that's really the only metric we have. We ask them would you do it again? Would you recommend it to another teacher? We ask them what would you do to improve the program? And we really thoroughly went through those suggestions last semester and made huge improvements in the program. Some of which have back-fired as we're learning.
…
We asked the scientists what they wanted, and the scientists said, "I really want to know what the kids are, generally speaking, covering that year in school." We were like that's a reasonable thing to request of course. We'll just ask the teachers what they're covering and we'll include that in the match email. And then scientists thought that meant that they had to be an expert in what the kids were covering that year, even if the teacher really just wanted them to talk about their own stuff. … It's been a learning process.*

*F8*

*It's hard. We're always looking at engagement and that's a really hard metric to get at, right? How do we know what we helped a kid, so I ask because ... and I think it's why anecdotal for the teachers, we interview and I'm not in the classroom with them, so it's not if, if a teacher shares with me or not.*

***Where do you see this going?***

Both facilitators report they are excited at the momentum thus far and look forward to continuing to build the potential. While F7 is completing her graduate studies, time is limited to expand even if she wanted to; F8 will have a better sense of successes once the program expands to more classrooms in the next academic cycle.

**MEDIA**

Three of the facilitators interviewed help scientists author or host media engagements, all in digital formats; two facilitators act as what is referred to below as “media agents” – networking scientists to journalists, incorporating with some amount of training, both in digital and traditional media formats.

F9 has an academic degree in the humanities and is an editor at a digital-only news and culture magazine that hosts sci/tech experts in a special op-ed section;

F10 has an academic degree in the biological sciences and an advanced professional degree and is programming director for a set of online video channels within a larger media service;

F11 has an advanced degree in the biological sciences and acts as a media agent and trainer for scientists and journalists interested in science topics;

F13 has an advanced degree in the biological sciences and hosts both a weekly livestream/podcast science news program and also offers video production services for scientists.

Note F1 also acts as a media agent predominantly for Spanish-language publications.

**What’s on the marquee and who’s checking it out?**

***Who is the audience?***

Readers, watchers, and listeners of science content in both digital and traditional media and social media; some of the facilitators who work with publications spoke to circulation/viewers and subscriber counts for a sense of reach, but the motivations for a given consumer are not covered below, if known beyond occasional surveys.

*F9 (digital magazine)
We reach about 2 to 3 million readers per month, so it's a broad audience. It's very similar demographically to [the publication’s] larger audience. It tends to be a readership that is fairly educated but non-expert, fairly affluent, liberal leaning, and concentrated on the coasts of the [U.S.]*

*F10 (YouTube)
We are approximately 70% male viewers, 30% female viewers ... We want to close that gap and make it more equal between the genders, but ... that's actually better than a lot of science content on the internet in general.*

*…
Each individual show has a slightly different demographics in terms of gender splits and the age range, but it is all around that ballpark.*

*F11 (media training)*

*The publics can be very different, and this is one of the things that we really stress in our training
…
Sometimes we're really focused on helping people understand audience and what are the various mechanisms that can most effectively reach that audience. Sometimes we focus on framing and messaging, sometimes we focus on very skills-based things like using video or writing blogs, or other types of writing like op-eds. Sometimes we focus on, like for academics especially, working with your press office in an effective way. We've also done training that's focused on working with members of the press in an effective way or ways*

*F13 (livestream/podcast science news and interviews)
It's a really broad swath of people actually. We have people who are scientists, who listen or watch. It's kind of a way for them to keep up on different areas of science because we cover science very broadly. But then I also have people who work in warehouses and drive trucks. I've got stay at home moms, stay at home dads who listen.
…
I kind of like to think of our audience as like the Comedy Central demographic. It's educated or at least if not formally educated, people who are interested in educating themselves but also like humor to be a part of what they're learning.
…
[Note on process] It's an initial live broadcast online, and so people can watch on YouTube Live. They can also watch through our website. They can watch on Facebook in real time as it's happening, and so there are comments all over the place. People make comments on Facebook. People make comments on the YouTube Live chat, and then we have our own private chat that our primary audience is involved in.*

***What value does the audience get? The scientists?***The central engagement of scientists in media give an authenticity to the content, especially with viewers/readers so able to access concepts online (e.g. Wikipedia for just the information). For those facilitators helping scientists interact directly with audiences: the media content itself serves the online version of what in-person facilitators do as described in the other sectors of this report:

*F1
[Our organization has a] collaboration with media outlets in Puerto Rico and also in the United States. My role has been finding scientists who want to tell stories, like popular science stories for a so-called general public and then guiding them through the process of writing for the newspaper in a way that is accessible for non-experts, but in a way that it's also culturally relevant for the main audiences, which are mostly Puerto Rican or Spanish-speaking.*

*F9 (digital magazine)
[Our STEM policy section is to] help explain emerging technologies to a general interest audience. A large component [for me] is editing scientists, as well as policy makers and attorneys and other sort of specialized figures ... helping experts translate their work [for] someone who is curious and smart but might not have taken chemistry or physics since high school.
…
 I think that scientists often don't think of writing an opinion piece is an option for them. Maybe they'll see an opinion piece in the New York Times and think, oh, I could do that, but I don't see the pathway to make that kind of thing happen … I often suggest to people when you talk to your family and friends about the topic, what gets them excited? That's often a good gateway to think about what would be useful.*

*F10 (YouTube)
People don't want a general talking head host. They want somebody who really knows what they are talking about … online video requires that hosts engage with viewers on an informal level and respond to their comments. Only somebody who is a subject matter expert could knowledgeably respond to more technical questions. That's an important factor.
…
It is really great seeing things like, "Oh, this makes me want to be a chemist." Or "Oh, I never thought of insert scientific topic here. I never thought of it that way." Those comments are the ones that really show that we are having a more meaningful impact.
…
I will also say too teachers use our content all the time.*

 *F13 (livestream science news)
The audience is able to react to the interviews, react to the information that they hear in text form and ask questions and respond and make comments about the interview as it's going on. And then there is a little bit of interaction between the hosts and the scientists because we're usually reading the chatroom, and the person being interviewed is not necessarily doing that.
…
We pick some of the comments and questions to read out loud and to tell the scientist about, but then the scientist is able to react and respond.*

The scientists themselves find their career work often enhanced by having developed communications skills for these specific pieces. Sometimes the exposure alone generates new benefits.

F9
I've found people get opportunities through writing. A cybersecurity researcher wrote a piece about cybersecurity insurance for me and then was given a data set by an insurance company that she wouldn't have had access to. I've had people tell me that [during] the editing process, I may have had a question that they couldn't quite answer, so then they wrote a grant proposal that kind of was based on that original discussion. So it can help bring them new opportunities to communicate with the public and help further their own research, too.

F10
On a relatively popular new media program, I think the impact that those science communicators can have can be massive. I think publishing research is not the end all be all of what makes a good scientist.

F13
I get an overall feeling from the [scientists] that we interview that they are really excited to talk about what they do, and our show offers people an opportunity to talk at length and not have to worry so much about having a soundbite ready. [They] are excited by the prospect of having an intelligent conversation but that's still lighthearted and can be fun.
…
It's going to help get the scientists themselves exposures to their science, which … also exposes it to the academic public as well, and that can potentially lead to collaborations, invitations to give talks and presentations at other universities or conferences. It can help snowball into what can potentially be just better for a scientist's career overall.

**Scientists on display/stage**

***Who are the scientists and how do you find them?***

The content producers engage with networks of scientists that provide individual scientists for article writing and/or interviewing. While many of these engagements are in-person contact, the size of the networks rely heavily on social media as a source of scientific talent. How the scientists themselves enter these networks is varied:

*F1
[Our organization is] a large community of global scientists. We have people in about 50 countries and about 8,500 members. I've been kind of the connection between that community and editors at media outlets.*

*F9*

*I get a lot of recommendations from people saying, "My friend wrote this thing for you two years ago and suggested I email you." That sort of word of mouth has become really important to my recruiting methods
…
A lot of what I do is speaking to groups of scientists [at universities] and fielding pitches from scientists who are interested in writing. Reaching out to scientists who might be interested in writing, if I have an idea for them.*

*F11
So we started doing these programs really focused on scientists, and when I say that I mean from graduate students, post-docs, faculty, research staff, even some communication staff in the state [we’re based in]. So then we started building these ideas and realized, well obviously this need is colossal and we know how to do this now, so we're going to start doing this any place we can.
…*

*Seven or eight years ago … science communication training was really just starting to blossom … there was interest and people started contacting us from all over the country. So we would do programs at science conferences for example, or smaller [research] groups [that reached out saying] we need this training, will you do it for us?*

*F13*

*If there's an interesting paper that's come out that we just want, it's like, "Oh my gosh. I have to talk to this scientist" Then I'll reach out to that scientist via email and ask if they would be interested in an interview. Other times, it's interactions that I'm having on Twitter. I follow a lot of scientists on Twitter, and if somebody makes an interesting comment or says, "Oh, I've published this paper," I'll say, "Hey, you want to come on the show and talk about it?"*

In the specific case of the YouTube producer these networks provide scientists at minimum for technical reviews of content in development, possible on-camera interviews (depending on the channel style), and ultimately the source for individual channel host(s). For the latter potential:

F10 (YouTube)
[We’ve always] preferred to use subject matter experts as hosts. What that means is that we have number of scientists turned hosts hosting our series.
…

[One source of candidates is] recommendations through the network, or it is just finding somebody who is doing really exciting work in science communication on social media already. That can mean existing DIY video experiments on their own or it can be other social platforms ... [Sometimes via] casting groups that can find talented ... scientists that have on-camera talents.

…

[We want] scientists who've given lots of talks. Scientists who have a very active social media presence. [For example] my predecessor [identified a candidate 6-7 years ago because he had] fostered a really great, enthusiastic community about science on Tumblr. … Now, it's the most popular show we have on the network.

***How do you train/prep them?***

These responses are highly tailored to the medium/context in question:

*F9 (digital magazine)*

 *[Working with the writer] I'm going to push them to make their arguments more accessible. I will do some stuff that could be called dumbing down. I like to think of it more as reframing it so it's applicable to, like, a freshman 101 class instead of a graduate seminar. [Then] they at least can push back if they see I introduced a mistake into their piece … and we can negotiate a better way to phrase it. I think that this gives them more ownership and more control over their ideas while also helping them communicate in a way they don't typically.*

*F10 (YouTube)*

*That happens on the producer level, because each show has its own team involved … [When I was a single channel producer] I trained the team to become better science communicators in terms of editing their scripts, in terms of improving their on-camera performance, and now I'm doing a similar role across the network with our science-focused series.*

*F13 (livestream science news and video production)*

*In my video production work … I do have a handout that I give to people ahead of the interviews that we do to help them have a starting point for things to think about, and it goes over basics of video interview skills, which includes including the question in your answer so that you're not just giving a yes/no answer and you're making a complete statement that can be edited properly.*

*F11 (media agent/trainer)
Often we partner with professional journalists who will come in and will either … present about something in particular and/or then interact with the participants in a way that's helping those participants learn in real-time. … Customization [of standard components] is essential for us based on the group that we're working with. Once we have identified their goals for the program then we figure out who are the people we want to bring in to help them best achieve those goals to get the kind of learning that they need and then interaction.*

**How’s it going?**

***What metrics do you collect and what do you think they’re telling you?***

The producers report various tracking data based on traditional media metrics, which indicates extensive reach for some of these pieces.

*F9
I'm usually pretty happy if a piece by an academic gets about 10,000 page views. That's usually pretty good for a non-professional writer. … We also look to see how much a piece has influenced the discussion … Have other sites that we sort of see as competitors noticed it and want to interact with it in their own editorial?*

*F10*

*[We get] between 10-15 million views on our science content each month.
…
Views is an obvious easy metric, but it's not the only one … Online video is great, because you can get really granular data, per show, per episode, per region. What we look for is lots of viewer retention where people are sticking around the whole time. We like to see to engagement. [We take] likes and dislikes … into account. I think as far as science communication efficacy is concerned, I think the comments might be the most interesting place. That's like more of a … qualitative metric, because unless you're doing sentiment analysis of comments, it's harder to get specific target metrics there.*

*F13*

*I can look at podcast download numbers. I can look at YouTube comments, views on YouTube, Facebook ... and even the comments that are left on the YouTube and Facebook pages, on those video posts, to see what people are saying and how they're responding.
…
[For the livestream] if there's a lot of conversation in the chatroom while it's going, I know that the scientist is at least piquing people's interests, is getting them to think, is getting them to engage and respond. [Comments are] not a metric that is easily measurable, but it is kind of a gauge of interaction and engagement [for both live and recorded content].*

As reported in other sections, assessing the impact of training is a challenge as where the scientist takes what they have learned forward may not be known to the trainer.

*F11
Gauging success with training programs is really, really hard, and we have worked a long time to try to develop instruments that are as useful as possible. [We don’t] have the capacity to do content analysis long-term follow-up kind of stuff. [We ask participants] before the training and immediately after the training … about confidence … their likelihood of doing certain things. … We’re looking for behavior change and attitudinal change, knowledge change, and skills change, but we're asking it on a self-advocacy basis, and so it's limited.
…
We use these data to change how we approach our training programs. And we get really good feedback from our training programs, but you don't know, you can't know what kind of impact you're truly having if you're not doing longitudinal studies. So I think this is the dilemma that pretty much everybody faces.*

***Where do you see this going?***

The media producers speak to using viewing metrics and social media to better understand the impact and how the content could be improved to engage audiences more. Since social media platforms are constantly evolving there is ongoing experimentation and best practices are often a moving target.

*F9
[T]wo PhD students [wrote] about carbon capture and storage recently [and] they emailed me afterward to tell me that [a U.S. Senator] had tweeted about it … but I hadn't noticed that it had been tweeted. A better way to collect the social media discussion happening around the piece, it would be really useful to me to sort of gauge a cross-section of who's talking about it. Is it only people who are already in this field, or is it a bigger group of people?*

*F10
[F]iguring out if there were some metrics that could indicate more sentiment analysis on specific topic areas. We do have a climate science series coming out soon. That would be really interesting if we could somehow measure public sentiment about climate science and whether our show is helping to move the needle.*

*F13
[Given YouTube and Twitter polling features] I've been thinking of including a question prior to the interviews, in the videos themselves ... So, the people are watching the videos, and they can answer a poll question as to their understanding of a topic prior to an interview. And then I can ask them either the same question or a similar question at the end of the interview. And of course, it may or may not be the same people responding to the poll, but it may give information as to change in mental state, change in understanding, and whether or not any actual education took place.*

**INFORMAL SCIENCE VENUES: Adult-Facing**

This sector usually has scientists speaking to 21+ audiences (one respondent indicated average age is 21-45) either in museums after hours or otherwise private cafes/bars. Two of the facilitators here have also run programming that targets families, but those experiences are not represented below.

F14 has an academic degree in the humanities and is presently in charge of adult programming at a large science museum; also runs scientists-on-stage events in 21+ venues;

F15 has an academic degree in the physical sciences and has run multiple adult-facing Science Café style events in addition to a city-wide science festival;

F16 has an advanced degree in the biological sciences and works at a company that runs scientists-on-stage events in 21+ venues, and also podcasts.

**What’s on the marquee and who’s checking it out?**

***Who is the audience?***Science curious adults who enjoy “intelligent nightlife” as articulated by F15 – interested in urban events with as much opportunity for socializing as content interest. Attracted to events in both traditional venues of science engagement (e.g. museums) as well as venues that are otherwise un-associated with such programming (e.g. nightclubs). The term “infotainment” has been used by some but that term is far from universally accepted: some find it pejorative by suggesting that the event and its organizers reject many of the altruistic motivations of other informal science education venues. Responses from these facilitators suggest they share the altruistic motivations have a zeal for alternative, perhaps ironic, scicomm events.

As to how this audience type affects the content offered:

*F14
I work mostly with adults, and one of the things that I tell scientists over and over, I was like, "What do you laugh about at the bar with friends when you talk about your work?" It was like, "I want you to make a talk out of that." It was like, "But I'm not putting in my data points," and I was like, "I don't care. I just want it to spark curiosity." When you spark curiosity, and you get that kind of equal setting with the audience, they totally engage, but if they feel like they're being talked down to, it's a very bad experience.*

*F15
Most of my work is really focused on creating environments where scientists can engage with audiences in more authentic ways that lead to a variety of outcomes based on the goals of the events and the publics involved.*

*F16*

*Our venues are 100 to 215 seats per show. They sell out, so we normally have an audience size of whatever the capacity of the room is. We do trend a bit youngish I would say. In the mid-20s to mid-30s is I would say a bulk of our audience, but we do get senior citizens and older people. We don't have any children because of where we perform. I think our audiences tend to be pretty white, depending on which part of the country they're in.*

*…
We also sometimes will deliberately do shows out in rural areas at the behest of sponsors and in different parts of cities to try and get over this white affluent hipster-type audience. That is our, I think our natural base.*

***What value does the audience get? The scientists?***

This audience delights in programming styles that seemingly upend traditional science programming. Facilitators spoke to “fun” being as much a desired outcome as any other, including “learning”, “engagement”, or “dialogue”.

*F14
They really deliver on magical moments and how you end at Disney. Those are the things that people are gonna talk about and word-of-mouth is some of the best marketing that you can do. If people are talking about magical moments, when they talk about [these events, e.g.], "Oh my God, I followed this girl, who is blowing bubbles throughout the museum to go to a ball pit explosion." They're gonna talk about that in a really positive manner. They're gonna forget the lines that they had to stand in.*

*F15*

*The public involved was really identified by the location where we held the event. I specifically held this event at a café in kind of a neighborhood that was going through a gentrification process. There was a mix of people that lived in this neighborhood that would just be at this café, because that's what happened, and because the neighborhood selected, it was this wildly diverse crowd. You would get these high end tech workers to construction workers to people that were science enthused. There wasn't one public there, there was three or four publics there, but most loudly defined by people that lived there and subscribed to the location that it was at.*

**Scientists on display/stage**

***Who are the scientists and how do you find them?***

Scientists drawn to these events are often the same (younger) demographic as the attendees, and otherwise audience members themselves. Thus, presenters are also motivated by the event being “fun”. The facilitators seem to rely on themselves and their networks to identify speaker candidates, along with audience members’ suggestions for future speakers. Social media is a pervasive tool for these events, providing another source of speaker candidates.

With potential speakers making up part of the audience these events are a very different sort of public compared to other engagements presented in this landscape.

*F14
I network a lot, and I go to a lot of different events, and see how they're doing it, or if there's people that I find interesting.
…
I'll vet them. I definitely will look at their background and see, but it's always better to come through an introduction. [If a colleagues suggests] “This is a great speaker. You should check them out." Then I'll absolutely check them out, versus someone just sending a cold email.*

***How do you train/prep them?***

Facilitators make it clear to participating scientists that the mode is far from the staid lecture approach to many public talks. All aspects of the venue’s environment, to speaking style, to staging are tuned to maximize the engagement as casual conversation, or theatric spectacle, or intimate dialogue, depending on the program goals (sometimes changing from set to set). All training is designed to break an academic modes and ready speakers for a disruptive event.

*F14
[Prepping the scientist speaker involves] setting up a meeting, getting to know them, setting up what the stage is like, what the audience is like, what expectations are, and then really going down, and, "Okay, tell me about your talk." And then I'll give them pointers of, "Really should avoid that." At times, depending on how nervous the speaker is, and how much time they've had on stage, I'll either sit them down in my office, or I'll take them out for coffee, or do it over the phone, where I will go through their talk and slides with them, then give them feedback.
…
[For my museum-hosted event] I always do kind of a show flow meeting ahead of time. I talk about what the stage is like, what to expect, how the audience is, kind of what grade level to talk at, because I feel like scientists a lot of the times talk over people's heads. And then setting out that it's way better to do maybe a sentence at most on a slide.*

 *F15*

*I basically very rarely let the scientists use any sort of PowerPoint. I stripped away their tools of communication so they just mostly had to use their voice. I think that had two effects. One is it makes the scientist a little bit more naked in terms of how they have to communicate, but it also did not make the stakes very high. It wasn't like a microphone and a stage and lighting where they felt like they were performing. It was really just them sitting at a bar stool at the end of a table.*

*F16*

*On our stage, stories about failures and vulnerabilities and struggles are gold in a way that most of the time we try and hide that. For the rest of the time, the primary requirement I have is that a storyteller's actually strongly motivated and enthusiastic and willing to take the notes from our production team. It doesn't matter how great the science is if they're recalcitrant and try and give a presentation on our stage, it's not going to work. The recruitment is very much about us laying down expectations of what they need to give us and then also what they get in return.
…
[We go] through an editing process where we, more than anything else, we strip out a lot of the exposition, the expository stuff or the now it's going to be my sciency part of this talk. No, no, no. The science, all of it needs to either advance plot or advance character. That's our initial process there.*

**How’s it going?**

***What metrics do you collect and what do you think they’re telling you?***

The facilitators of these events put data in a high regard, especially as often revenue streams necessitate tracking of ticket sales and marketing budgets. Ironically however, the collection of evaluations can disrupt the flow of an event that prides itself as being disruptive with respect to traditional programming that often collects evaluations.

*F14
Evaluations really help. We don't do evaluations at [the events in bars], but we certainly do [at the museum-hosted events], of how people see things.*

*F16*

*We have less robust data about the live domains because we actually have a pretty aggressive stance where we don't want to interrupt the emotional experience by doing heavy-handed evaluation after the shows.
…
I have an interest in doing more, but we have to be very careful about how we do this and my team is adamant. We are a theater company. We're creating theater that happens to be about real science stories. We put that first and I really appreciate my artistic director for defending the sanctity of that experience rather than just opening everything up for study and dissection.*

Despite a dearth of data, these facilitators are so experimentally minded that they think deeply about what the metrics might mean.

*F15
When I started that café a decade ago, there wasn't much stuff that was away from campuses. There was maybe three or four things that was a regular event, or away from places where science occurred. It was a little wild west-y back then. The difference between now and then is I think twofold, is one, there's scale differences, like a lot of the stuff I do is at much bigger scale, but also moreover now, there's, back then there was a handful of stuff, away from campuses. Now there's dozens on a weekly basis, so there's about 40 science events a week here in the Bay Area, and I know that because I built the calendar that catalogs all of them. About 20 of them are away from campuses and stuff. There's just a lot more stuff now versus back then.*

Which primes thoughts on what future metrics might be intriguing:

*F15
This idea of intelligent nightlife, that when you go out you're just not going to a bar to grab a couple drinks, there's things you can go out to that are much more interesting and fulfilling, and I think that's broadly across the spectrum of adults with disposable income now, and we've seen a huge boom with science entering that space, whether it's evening nights for adults at museum, and the quality of those really dramatically rising, or the proliferation of “Nerd Nites” around the country. What I haven't seen is an economic analysis of those things, like how much money they're generating and how many scientists are participating. I think it's just no one has studied them.
…*[Another] place that no one has studied is I think there's a huge surge of scientists participating in those events, but we don't know anything about their motivations or their experiences or the benefit that they're delivering by directly engaging in that motif. We have a lot of anec-data that says oh, they're having a great experience, they're coming back, they're inviting their friends, they're coming just as a social experience just after participating in them, there's all of that kind of stuff, but we don't have real answers to those questions in the same way we do with other events, especially ones that have been geared towards families.

*F16*

*We built our evaluation program on the impact on the storytellers, the scientists based on theory of planned behavior because our read of the literature is that most short interventions create relatively little measurable change in skills. Also, how you measure skills for something like live storytelling is still I think up for debate about what are the dimensions that actually matter. What does being good look like? We are looking for attitudes and perceived social norms. What they think their colleagues think. We're looking towards perceived self-efficacy.
…
I'm thinking about social legitimacy in science and who does it belong to, and do people like me do this? That's one of those things that we are really keenly interested in.*

***Where do you see this going?***

*F14
There's so many adults who are not exposed to intellectual and critical thinking conversations and topics. I'd like to see less competition, more collaboration with the people who do it. [Washington] DC, one big example, it's way more competitive than it should be. Philly and San Francisco, I've seen way more collaboration, but this idea that there's more than enough people who are interested, and as long as you make it fun and engaging for the audience, it's just competition and other events should be welcome.
…
[Also] social media is getting so crowded and that people are not trusting that as a source, they're looking for other ways to connect with audiences. I'm really interested to see in the future, where I think libraries, museums, science outreach is going to be seen as more a community ... what's the word? A community asset in the future that it has been in the past.*

*F16*

*Like any theater company, any arts company, we are constantly striving to master our art form.*

*…*

*Figuring out how we help amateurs do that week after week after week, and how we teach it, and then also how we teach our [speakers] to elicit and to create those spaces in which that kind of sharing and artistic and creative exploration can happen.*

**INFORMAL SCIENCE VENUES: MUSEUMS, ZOOS, and AQUARIA**

Three facilitators interface scientists with the public through various types of engagement within a museum/zoo/aquaria (MZA) floor; all are staff of a museum:

F17 has an advanced degree in the biological sciences and is a museum engagement specialist, speaking to working at a science museum situated next to a major research university;

F18 has an advanced degree in the physical sciences and is engagement staff at a science museum in a major U.S. city;

F19 has an advanced professional degree and is a senior executive at an aquarium.

**What’s on the marquee and who’s checking it out?**

***Who is the audience?***

Within typical a museum visitor, different exhibits and programming can target segments (e.g. youth, adults, members, tourists). Some institutions have considerable traditional and social media presences and thus present exhibit content in different ways.

*F19
We have business audiences, we have public policy maker audiences, we have the general public and the media. Media's not an audience but the general public who digests the media and then we also have kids and teachers, and then we also have ... So everyone's a different audience, and the same information is used, and then we have onsite audiences, which are the general public but a smaller section of it. We do segment audience much more than probably at any other job I've had.*

***What value does the audience get? The scientists?***

F19 largely speaks to several types of engagement programs and media content involving staff research scientists. F17 has much experience building exhibits and activities with individual scientists’ research inspiring content. F18 focuses on a program that puts research scientists onto the floor of the museum for direct interaction on their research with visitors.

*F17
The vast majority of them wanted to make their grant competitive with an outreach section. This is part of the broader impacts requirements of NSF [the National Science Foundation]. It would scale. Sometimes it would be a single PI [principal investigator] that had a research project. We went through many of these [at my institution] where they were writing a first core grant.*

*F18
It's an informal science education. It's a free choice. You go in, you spend a little bit of time, you spend a lot of time, little bit of time. … I think the other thing was a real excitement about talking to a real scientist.*

**Scientists on display/stage**

***Who are the scientists and how do you find them?***

F17 and F18 recruit through established networks of research scientists generally affiliated with academic institutions that traditionally collaborate with the MZA in question. F19 mostly draws from staff research scientists but has also involved outside scientists who collaborate with the institution’s researchers.

*F17*

*[W]e use the word recruitment when we are bringing them into an existing program and they have rarely any funding. If we want to work with a group of volunteer scientists, we have a festival or an outreach event or a week long activity, something at the museum. We would bring them in. That recruiting was often we would call up on people we know were interested in outreach efforts, people that have demonstrated their interests in the past, like we've written a career grant with them, or met them. They've come to the museum, they have come to us. That was rarely a cold call. We did that sometimes.*

*F18*

*We were doing some joint activities with [polar research scientists at a crosstown university] and they wanted to get information out to the public about the work they were doing … [T]hey actually had an open house at their lab, moved all these tables out into the hallway, sent out invitations, and they had 82 people show up … We said we get 2000 at the museum*

*F19*

*When you work for an aquarium you kind of go in knowing it's about, you'll have lot of different opportunities than you would have in an academic institution*

***How do you train/prep them?***

F17 and F18 facilitate in-house training as part of the engagement program. The methods developed by F17’s institution have in some part become course offerings at the affiliated university; the approach developed by F18 has been adopted at other MZAs. F19 uses both in-house staff, especially where media content is concerned, but has also brought in outside scicomm trainers.

*F17*

*A real good one that I liked was, and science museums have done this in the past, we worked with [undergrad and/or grad students], and ran them through almost a bootcamp of outreach primer … Helped them create an activity on their own that they could use to reach the public.
…*

*[The] next phase is we worked with their students to create discrete activities [on] interpreting their own research. Often, it was concepts that were fundamental to their research.*

*…*

*The museum ran [that course] on campus as a registered class number. It was a rare thing.*

*…
[It] boiled down to really key things about don't try to explain all your research. Be patient, you want to hear their questions. There's a lot of good tips that we rely on that came out of that work that we now all use over and over.*

*F18*

*[We use a] three-part professional development we do for scientists to deal with how people learn, effective questioning strategies, how to [stay] away from jargon, telling a personal story, bringing yourself out. … In the last workshop, they actually pilot their interactive activity with some of our high school explainers. So, I'd say they trial test it. They can then go back and modify it, and then they actually come out on the floor. And of course, part of the time, they actually go out and … see the current [scientists] presenting so they get some idea of what it's like.*

*F19*

*We also have done trainings and so we've had [outside companies] do some trainings here … So, they are more opportunistic doing sort of exercises to get them to be able to summarize their work simply, because it is challenging to get it down to a quick art.*

**How’s it going?**

***What metrics do you collect and what do you think they’re telling you?***

All three facilitators note their institutions take ample measures of visitor numbers and demographics. When it comes to the state of data for the facilitated engagement programs:

*F17*

*I'll be honest with you. Not much. A lot of these projects don't come with a lot of funding. The evaluation was very minimal, at best. We sometimes did some surveys that helped us understand the results of our mediation, our activities, our experiences. A lot of times, those were with the media assets or standalone assets, so we could get a lot of people going through them quickly. Unless it was an established program or there was a lot of funding behind it, very rarely did we look into those metrics. When we did, they were often around visitor satisfaction*

*F18*

*We did observations. We also did surveys but we did observations of families going through and looked at what they did and then also interviewed them as they left the [activity] space. And then we had surveys that went back to the scientists and we actually surveyed, because the other area we wanted to have impact on was the informal science educator. What impact was there on the members of our institution and the other science centers who are involved?*

*F19
[Our research administration has] tried to figure out how we measure scientific productivity and how me measure impact of that productivity in people's decision making. … [W]e've been increasing our output, we're being strategic about that, but we're also trying to figure out how we judge the metrics of how it resonates throughout the social sphere, and that's an exciting area. So, we are being very purposeful about that, because it's not just … when you drop the publication, that's only the beginning it's not the end and a lot of scientists, that checks their box in their career development. But … how does it resonate through the whole system and also [as content for] popular press.*

 ***Where do you see this going?***

In the short term all three facilitators expressed a desire to acquire more data to investigate how visitors take the science engagement activity around with them: learning outcomes, agency of science in their own lives, interest in more such content. F19 noted a desire to involve more citizen science activities to perhaps enhance the informal educational effects.

*F17*

*A lot of what I'm interested in and a lot of people are interested in these days is based from the learning science and informal spaces or informal environments, the NRC [National Research Council] report and the six strands of learning, that not only encompass content knowledge but also encompass socio emotional learning interests, efficacy, or self-relevance, self-efficacy. There's a lot of things that are wrapped in identity and their experience with whatever you're doing with them, that go beyond learning.*

*F18*

*I'd like to know what they did when they went home. I'd like to know, was there any ... everybody went back, did they talk about it? Did they find a video to watch?*

*R19
Education is really focused on how do you teach it in the classroom or help supplement your learning in and informal setting, but they've often been so separate. We do our science and then they do their education. That's very common. It's hard to have a discipline around education pedagogy, right? Everyone's got to stay on task, so how do you actually bring cool science to kids in a way that's manageable. So, citizen science is an area we're exploring a little bit more and how do you bring the next generation in.*

**INFORMAL SCIENCE VENUES: YOUTH-FACING**

Three respondents interface scientists with youths (K-12 age, perhaps younger) and tacitly their parents in a variety of informal science venues:

F21 has an advanced degree in the biological sciences and is also a cheerleader who networks with other STEM student/professionals who are also cheerleaders;

F22 has an advanced education degree who founded and manages a national database of youth-facing STEM activities and focuses on matching women STEM professionals with girls;

F23 has an advanced degree in the biological sciences and works at a scientific society managing their flagship public engagement programming.

**What’s on the marquee and who’s checking it out?**

***Who is the audience?***

Youth and their parents/guardians predominantly in various informal science venues; some of the programming targets young girls. All three mention programming that pairs with classrooms. F21 explicitly mentioned citizen science activities as a means of engagement. Only F23 specified that the target audience age group is 6-15.

*F21:*

*Most of what we do is to try to get young people, particularly young girls involved in science projects. We like to do this in two ways. First, by hands-on facilitating, what we call, citizen science projects that require no intense training or expertise, and very little if any material, but allow people to participate in large scale projects that really have large impact.*

*…*

*[For science festivals we] try to bring a citizen science project with us that people can either do on the spot or pick up a small kit with directions that they can do at home. And it depends on what we're trying to get across, but sometimes we'll do things like have a collegiate stunt team come with us, and we'll explain some of the physics principles behind stunting and try to connect that way. Other times the venue can be much smaller. We go to Girl Scout troops, or we go to classrooms [and for example talk on] how I became a mathematician, or here's how I became an engineer. [Oh and also I happen to be a] cheerleader.*

 *F22:*

*The front facing part of the database is for families and parents [where participants can look] for an activity in their zip code; and then there's also what we call the partner, the practitioner portal which is another sort of matching database where program people can look for partners for say facilities, or again speakers, or funding. I would say all of those have a goal of making sure that we have a wide range of stakeholders that are supporting programs that are serving youth in STEM, many of the programs that serve girls also serve boys, and in making sure that the public is connected to scientific endeavors.*

 *F23:*

*[Our outreach programs] involve scientists working with volunteers who are typically more junior scientists or students, and doing hands-on activities with members of the public.*

 ***What value does the audience get? The scientists?***

Role models is the goal especially for F21 and F22; see section on that aggregate theme above.

**Scientists on display/stage**

***Who are the scientists and how do you find them?***

F21 represents an organization comprised of the scientists themselves: professional and/or collegiate cheerleaders who are also STEM students or professionals, recruiting from annual rosters of cheerleaders along with word of mouth.

*F21*

*[We] try to fulfill all the different walks of the career options within science from hard sciences, life sciences, physical sciences, mathematicians, engineers; We have a fair number of coders.
…
[Our recruits] are driven and have excellent time management skills, which is how they manage to be professional cheerleaders and dancers while also pursuing these careers and degrees in science fields. And so a lot of them have already done some outreach activities. Many of them have either started their own organizations or been doing community outreach for a while. And even if they haven't, a lot of them, it's been something that's been on their mind that they've been wishing to be engaged in and definitely have felt personally the need for.*

F22 recruits from various groups populated by professional scientists.

*F22*

*I would say that many of the scientists that we work with are more in corporations. Maybe some faculty members in universities, but it's much more about connecting programs to scientists that are working directly in the field.*

F23 relies on its national, and increasingly international, network of society members.

*F23
We encourage, if people don't know how to start, recruiting from our student chapters. They're typically our most engaged groups. Graduate students as well. [Members] who come to our [domestic] training institutes for our [international] festivals.*

***How do you train/prep them?***

F21 focuses on how to present as a team and run activities/citizen science lead-ins.

*F21*

*I typically get on the phone with any new recruits who are going to do an event for us, and we'll talk about the key phrases that we use, the way that we generally try to spin things, and what's expected. We also have a code of conduct with every new Science Cheerleader signs, which gives an overview of what the organization represents, what we try to focus on. And then, again, just pairing newer girls with very seasoned veterans who can give them a feel for the events, and we train each other along the way.*

F22 runs formal training for the new scientists via 4.5 hours of online segments and conversation. The focus is science communication best practices as a role model.

*F22
We call it role model and site visit training, but as you know most of what we're doing is teaching them how to communicate what they're doing to the girls, or to the educators, because we have found that often these amazing female scientists, they're amazing ... And it's not boring work, but [without the training] they're boring, or they don't talk about the things that would help them connect with the public, and especially young girls.*

The domestic program for F23 has run for a number of decades and delegates training choices to local sections based on experience. Expanding into overseas venues has introduced training to ensure brand quality and generate local uptake:

*F23
They're train the trainer events, they're regional events outside the country, so that way we can train volunteers to basically go from, I want to do an outreach program, [to] I want to [run] festivals like this, from the idea to execution. So it's all the things, like how do I get 100 kids in a room and make sure everything's safe, and do I have to get insurance, to the communication skills, which is a lot more fun to practice, of course.
…*

*We say, think about what you're explaining at five levels. Little kid, medium sized kid, adult who really could care less about science, adult who is interested but doesn't really have experience, and then how you talk to another scientist, whether in your discipline or outside of it.*

**How’s it going?**

***What metrics do you collect and what do you think they’re telling you?***

All three programs maintain databases of recruited scientists and accomplished events. The facilitators did not get into the details, but they are used to gauge success and future plans. F22 and F23 focus on generating interest in science and less measuring whether learning occurs.

*F21
The number of people that we've engaged and worked with, the number of events that we're able to handle per year. … And then when we go to these festivals and things, we get signup sheets and all of those people want to be contacted and kept up with what we're doing. When are we coming back to their area? What projects can we do? So when we do have a large scale project like some of the collaborations … how many people can we reach through the events that we do and the projects that we facilitate?*

*…
On the one hand we do have an idea of how many people we're engaging each year, and those numbers are increasing and we love to see that. And then the other part of it is also anecdotally. And some of that is the most motivating when you have say, a classroom where you go in and do a project with them and they stay involved or stay in touch, or you hear from them later on that they've been really excited about this project.*

*F22
Our metrics are going to be around audience satisfaction … [B]ecause of this role model visit, or this interaction with a scientist, are the girls more likely, so we ask them questions, are you more likely to consider STEM, are you more interested in STEM fields? Really for the role models when we do a follow up ... Did the training prepare you? Was the program leader helpful?
…
We're not as focused on the content that the scientists talks about, and we're not ... I don't want to say we don't care, but we don't collect any information about, did the scientist feel like they were able to communicate their content, because that's a secondary thing to us. It's more about the overall experience.*

*F23*

*Whenever we do successfully get results back from our events, they're overwhelming positive. Everybody's like, they said they learned something new, most people would come back.*

*…
We do not particularly care about learning outcomes … but having people leave with positive associations of [science]. And we also ask for comments, of course, and a lot of times we will get the, I thought [this topic] was boring and now I think it's fun, or maybe I'll be a [scientist]. So we do keep track of that a little bit. Not as quantitatively as maybe we could.*

***Where do you see this going?***

In the short term, all three facilitators want to continue running events with as many willing scientists as possible. F21 and F23 remark on a desire to build up sustainable capacity is various geographies; F22 has the opposite problem of needing to incorporate volunteers who linger in the databases longer than desired, waiting for events.

*F23
Anything we can do to help prevent volunteer burnout would be great. … some people will say, "I am the only person I know of [around here] who cares about this." So of course you have that person and then something happens in their life and they can't do the program one year and it ends. And that just seems like such a waste.*

*…*

*[How can] you start that kind of culture. How do you get enough of a critical mass that you have a community that cares and a volunteer pool that's going to stay for a while? That's one of the big bugaboos, I guess, in the field.*

F21’s driving focus is to leverage citizen science opportunities as much as possible.

 *F21
So we're always trying to help engage people in science, and one of the best ways to do that is to find something that they're interested in. If you're interested in flowers, you love gardens and flowers, well then maybe you're interested in a project about how bees pollinate flowers and particular ways that bees communicate or diseases that bees carry. So using citizen science through SciStarter we can connect people to things that they're interested in.*

F22 and F23 both wish to adjust the style and perhaps quantity of their training.

*F22
I would love to do more in person trainings with scientists ... It would be heaven to have six hours [33% more time], have a lot of scientists in a room together, and do this sort of training, because I think it would be helpful personally. It would be personally rewarding, and one of the things that we do with all of our adult events is we always start with a panel of girls, and that's to ground them in, here's what ... or boys and girls depending on the event, but here's what young people are saying, here's what it's like today for young people, which for scientists, and also sometimes for educators can be really helpful.*

*F23
The idea of doing direct volunteer training is ... How can I put this? There are already people who are fantastic at it. So if you're at one of [our] events that's been going on for 20 years, they already know how to do it. But having some kind of training either online, or something we could do at a national meeting, I think would be very helpful.*

In the long term/blue sky ideals, F22 yearns for data to measure long term impact:

*F22
We really want to have longitudinal data. We have data that says that when educators are supported, and they receive role model visits, and training they're better able to serve the young people in their program, primarily girls, and girls are more interested in STEM because [of this program] ... We have lots of stories, and we have lots of reflective data, but we don't have data that says because these 5,000 girls heard from a scientist, they've now become chemists or something. We don't have that. ... There's some more recent studies around the value of role model visits, and the value of girls connecting with or talking with scientists that that helps them consider going into STEM, because a lot of the past data was primarily girls who's fathers were scientists. Many of those girls are now scientists. The impact of fathers is really huge, but we don't really have that sort of data. We need that data.*

*…*

*I was at a meeting a few weeks ago where we were talking about longitudinal data, and if I had a dollar for every time I got asked if I had longitudinal data, I could fund a project around longitudinal data.*

|  |
| --- |
| **Appendix 3: SCIENCE ENGAGEMENT EVENT EXAMPLES** |

The below list gives a thorough, but hardly exhaustive, listing of the sort of science engagement events considered in this report. All of the below are US-based programs, although a few of the aggregate websites include programming in other countries under that same brand/mode. Any events/programs under a given aggregator are shown to provide examples with a bit of geographic distribution, but are not necessarily chosen to suggest they are the most noteworthy of the grouping. The same sector categories are retained from above, but just as some of the facilitators interviewed have presences in multiple categories, some of the programs below could be grouped differently.

In the interests of space, annotations are not included - interested readers are highly encouraged to click through to all the programs that intrigue attention.

**CIVIC GROUPS**

AGU Thriving Earth Exchange
<https://thrivingearthexchange.org>

Drexel University Dornsife Center for Neighborhood Partnerships

<http://drexel.edu/dornsifecenter/programs/creating-knowledge/>

University of California San Francisco Community Engagement and Health Policy

<https://ctsi.ucsf.edu/about-us/programs/community-engagement-health-policy>

CienciaPR / Yale Ciencia Academy
<https://www.cienciapr.org/en/yale-ciencia-academy-career-development>

***Rotary Club***

Chestnut Hill, PA

<http://chestnuthillrotary.org/2018/02/28/club-meeting-february-28-2018-modern-science-part-2/>

Huntington Beach, CA
<http://www.huntingtonbeachrotary.org/service-projects/>

Jupiter, FL
<https://taras.org/campaigns/meet-the-scientist-lecture-series/>

Stockton, CA
<https://www.sjcoescience.org/dinner-with-a-scientist-for-the-scientist.html>

***Kiwanis Club***

Columbus, IN
<https://portalbuzzuserfiles.s3.amazonaws.com/ou-15312/userfiles/files/science%2Bsaturday%2B2_21_2015.pdf>

Jefferson County, VA
<http://www.journal-news.net/news/local-news/2017/11/new-kiwanis-club-adopts-north-jefferson/>

**DECISION MAKERS**

American Association for the Advancement of Science (AAAS) Science & Technology Policy Fellowships
<https://www.aaas.org/program/science-technology-policy-fellowships>

(note the many scientific societies co-involved
<https://www.aaas.org/page/stpf/partner-societies-st-policy-fellowships>)

COMPASS
<https://www.compassscicomm.org>

Expert & Citizen Assessment of Science & Technology (ECAST)

<https://ecastnetwork.org>

Leopold Leadership Program

<https://leopoldleadership.stanford.edu>

March for Science
<https://www.marchforscience.com>

The National Academies: Christine Mirzayan Science and Technology Policy Graduate Fellowship Program
<http://sites.nationalacademies.org/pga/policyfellows/>

Lenfest Ocean Program
<http://www.lenfestocean.org/en/about-us>

Union of Concerned Scientists
<https://www.ucsusa.org/action/science_network/science-network-workshop-series.html#.WtkvHS_MwWo>

**FORMAL EDUCATORS**

National Science Teachers Association
<http://www.nsta.org/publications/calendar/>

Skype a Scientist
<https://www.skypeascientist.com>

 ***Scientific Societies***

American Chemical Society (ACS) / American Association of Chemistry Teachers Science Coaches
<https://www.acs.org/content/acs/en/education/outreach/science-coaches.html>

ASM International
<https://www.asmfoundation.org/who-we-impact/teachers/k-12-education/>

***Universities***

Center for Education Integrating Science, Mathematics & Computing (CEISMC)
<https://www.ceismc.gatech.edu>

Wonders of Our World
<https://ecos.osu.edu/other-organizations/wonders-our-world>

**MEDIA**

***(Digital) Magazines***

*The Conversation*
<https://theconversation.com/us/technology>

*Future Tense*
<http://www.slate.com/articles/technology/future_tense.html>

*Issues in Science & Technology*

<http://issues.org>

*Scientific American – blogs* [many written by research scientists]

<https://blogs.scientificamerican.com>

*Sciart Magazine*

<https://www.sciartmagazine.com>

 ***Radio / Podcasts***

*ScienceFriday*
<https://www.sciencefriday.com>

*RadioLab*

<http://www.radiolab.org>

*This Week in Science (TWIS)*
<http://www.twis.org>

***Media Training***

ComSciCon
<https://comscicon.com>

The Metcalf Institute
<http://metcalfinstitute.org>

***Media Agents for Scientists***

ACS Experts
[www.acs.org/experts](http://www.acs.org/experts)

Weather and Climate Service Providers - American Meteorology Society

<https://wcdirectory.ametsoc.org>

National Science & Technology News Service
<https://nstns.org>

Science & Entertainment Exchange (of The National Academy of Sciences [NAS])
<http://scienceandentertainmentexchange.org>

SciLine (AAAS)
<https://www.sciline.org>
 ***Video (& TV)***

Broader Impacts Productions
<http://www.broaderimpacts.tv>

*CrashCourse*

<https://www.youtube.com/user/crashcourse>

iBiology
<https://www.ibiology.org>

PBS Digital Studios

<https://www.youtube.com/user/pbsdigitalstudios>

PBS SciGirls

<https://pbskids.org/scigirls/home>

*SciShow*

<https://www.scishow.com/channels>

*Secret Life of Scientists*

<http://www.pbs.org/wgbh/nova/blogs/secretlife/>

**INFORMAL SCIENCE**

***Citizen Science & Science Clubs***

*Discover* magazine Citizen Science Salon
<http://blogs.discovermagazine.com/citizen-science-salon/#.WtkydS_MwWo>

Maker Faire
<https://makerfaire.com>

SciStarter
<https://scistarter.com>

*Astronomy*
<http://www.skyandtelescope.com/astronomy-clubs-organizations/>

Space Place (NASA)
<https://spaceplace.nasa.gov/astronomy-clubs/en/>

*Biology*

Baltimore UnderGround Science Space
<http://www.bugssonline.org>

Cornell Ornithology Lab

<http://www.birds.cornell.edu/Page.aspx?pid=1478>

DIY Biology
<https://diybio.org>

*Geology*

The Vug
<http://www.the-vug.com/educate-and-inform/rock-and-gem-clubs/>

***Science & Art Salons***

District Art Science Evening Rendezvous (DASER / NAS)

<http://www.cpnas.org/events/upcoming-events.html>

Leonardo
<https://www.leonardo.info>

SciArt Center

<https://www.sciartcenter.org>

TEDx
https://www.ted.com/about/programs-initiatives/tedx-program

***Science Cafés (style workshops)***

<http://www.sciencecafes.org>

BEACON

<https://www3.beacon-center.org/education-outreach/public-engagement-workshops/>

DC Science Café
<https://dcswa.org/dc-science-cafe/>

Science Café at Discovery
[https://discovery.wisc.edu/programs/science-café](https://discovery.wisc.edu/programs/science-caf%C3%A9)

Sip of Science
<https://biodesign.asu.edu/sip-of-science>

***Science Festivals***

Science Festival Alliance (part of MIT Museum)
<https://sciencefestivals.org>

Bay Area Science Festival
<http://www.bayareascience.org>

Cambridge Science Festival
<https://www.cambridgesciencefestival.org>

USA Science & Engineering Festival
<https://usasciencefestival.org>

World Science Festival
[https://www.worldsciencefestival.com](https://www.worldsciencefestival.com/)

**INFORMAL SCIENCE – ADULT-FOCUS**

Astronomy on Tap
<https://astronomyontap.org>

Guerilla Science
<http://guerillascience.org/projects/>

LabX (NAS)
<http://labx.org>

Museum Hack
<https://museumhack.com>

Nerd Nite
<https://nerdnite.com>

Science, Neat
<http://www.scienceneat.org>

StoryCollider
<https://www.storycollider.org>

You’re The Expert
<https://theexpertshow.com>

***Museums “After Dark”***

Social Science – Perot Museum of Nature and Science
<https://www.perotmuseum.org/programs-and-events/adults-only/social-science/index.html>

Science in the Dark (Frost Science [Miami], but not held at museum)
<https://www.frostscience.org/blog/science-dark-1-hotel-south-beach/>

Science After Hours – The Franklin Institute
<https://www.fi.edu/special-events/science-after-hours-21-plus>

NightLife – California Academy of Sciences
<https://www.calacademy.org/nightlife>

**INFORMAL SCIENCE – MUSEUMS, ZOOS, AND AQUARIA**

Association of Science - Technology Centers
<http://www.astc.org>

Brainscoop – The Field Museum
<https://www.youtube.com/user/thebrainscoop/about>

The Franklin Institute - Science Stories
<https://www.fi.edu/science-stories>

The Lawrence Hall of Science – STEM outreach

<https://www.lawrencehallofscience.org/do_science_now/partnering_for_broader_impact>

The Smithsonian Institution – citizen science
<https://www.si.edu/volunteer/citizenscience>

National Informal Science Education Network (NISENet)
<http://nisenet.org>

Nano Days – multiple institutions
<http://nisenet.org/nanodays>

Portal to the Public (Pacific Science Center)
<https://popnet.pacificsciencecenter.org>

Association of Zoos & Aquariums
<https://www.aza.org/citizen-science>

Monterey Bay Aquarium

(meet a scientist)
<https://www.montereybayaquarium.org/education/teen-career-resources/education-specialist-ii>

Seafood Watch
<http://www.seafoodwatch.org/about-us/our-standards>

San Diego Zoo – citizen science
<http://zoonooz.sandiegozoo.org/2017/06/19/wildwatch-kenya-help-wanted/>

Shedd Aquarium – citizen science
<https://www.sheddaquarium.org/Conservation--Research/Citizen-Science/>

Association of Children’s Museums

<https://www.childrensmuseums.org>

**INFORMAL SCIENCE – YOUTH**

ACS National Chemistry Week
<https://www.acs.org/content/acs/en/education/outreach/ncw.html>

Afterschool Alliance
<http://www.afterschoolalliance.org/STEM-curriculum.cfm>

STEM Scouts (Boy Scouts)

<https://stemscouts.org>

The Connectory
<https://theconnectory.org>

AAAS Family Science Days
<https://www.aaas.org/page/family-science-days>

GeekGirlCon
<https://geekgirlcon.com>

Girl Scouts
<https://www.girlscouts.org/en/about-girl-scouts/girl-scouts-and-stem.html>

How to Smile
<https://www.howtosmile.org>

National Society of Black Engineers - Summer Engineering Experience for Kids (SEEK)
<http://www.nsbe.org/seek.aspx>

Science Cheerleader
<https://www.sciencecheerleader.com>