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# *The Impact of Portal to the Public: Creating an Infrastructure for Engaging Scientists in Informal Science Education*

Summative Evaluation

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# Executive Summary

Portal to the Public (PoP) has been operated with considerable funding from the National Science Foundation since 2007 under the leadership of the Pacific Science Center (PSC). The program uses a particular model to train and support science-based professionals ("scientists") in outreach and engagement activities, based on the premise that scientists should engage directly and through materials-rich hands-on activities with family audiences, based on a basic understanding on how people learn, and how to engage audiences in discovery-based learning. Furthermore, the model assumes that scientists need ongoing logistical and pedagogical support by educators and peers, and easy access to audiences.

The model was first developed and tested at three institutions (PSC, Explora in Albuquerque, NM, and the North Museum in Lancaster, PA), and then expanded to five additional sites to test the robustness of the approach. With considerable funding from NSF, the initial model was expanded in 2011 into *Portal to the Public: Expanding the National Network* (PoPNet). PoPNet expanded the number of institutions involved to more than 50, and added a train-the-trainer and network element to its program structure in order to serve the large number of participating institutions and scientists. Considerable formative evaluation supported the expansion into a network and helped make programmatic adjustments that were essential in adapting to increasingly varied local conditions as institutions joined which did not necessarily represent science center and children's' museums, the original institution types for which the PoP model was created.

Now in its 5$^{th}$ year, the network has matured and is moving from a state of establishment and growth into one of sustaining efforts. This is the ideal time to take stock and reflect on the degree to which PoPNet fulfilled its goals and added value to participating institutions and scientists, and to distill the components of PoPNet that will be essential to preserve into the future. To that end, PSC contracted with the Oregon State University's Center for Research on Lifelong STEM Learning (STEM Research Center, SRC) to conduct a summative evaluation (impact study). The summative evaluation is based primarily on a retrospective quantitative survey conducted with staff representatives at participating institutions and with scientists affiliated with the program who could be contacted through these institutions. Sixty-six staff from 23 institutions and 264 scientists from 25 institutions completed the questionnaires.

The results of the study confirmed that PoPNet was able to achieve its major objectives. PoPNet created an emerging network of participating institutions. PoPNet also created institutional value based on connection to scientific research via scientists and their institutions. The benefits extended to the institutions' audiences who where able to engage first-hand with scientists and with current research in accessible and enjoyable ways. [Positive impacts on audiences was established in previous evaluation and research studies]. The PoP model overall seems robust not only to various locations, but also to different institution types: staff could adjust elements of the model to fit specific local needs. Participating scientists in the sample were mostly in their early career, and reported to benefit tremendously from their involvement in PoPNet. They reported gains in their science communication and science engagement abilities and skills, which extended into their regular professional context. Most importantly, they conducted significant levels of science engagement activities in ways that adhere to evidence-based practices in informal science education and science communication. Overall, PoPNet was successful, and has served as a crucial institutional infrastructure to support a closer connection between science and society.

# Key Findings

**I. Intended Impacts: To what extent are the intended impacts (outcomes) achieved with participating informal science education (ISE) staff and scientists?**

*Ia. Does the PoP network itself add value to the participating institutions?*

We used a very basic definition for a network in order to determine whether a network structure developed and added value to the sites: We considered a network to exist if there was evidence that staff at sites exchanged information/communicated directly with one another, rather than relying entirely on a hub and spoke model focused on the Pacific Science Center as the central organizer of the community. Using this basic definition, we found clear evidence for an existing network and determined that the emerging network itself through its communicative function added value to for many of the participating institutions. If no network had been created, all or almost all communication would have been with the lead institution, Pacific Science Center (PSC). That is, PSC would have served as the sole connector, controlling information flow to all participating institutions. Instead, exchanges were distributed acrossmany PoPNet members from different institutions communicating with each other. In this emerging network, several veteran institutions (i.e., early PoP recruits), and PSC as the lead institution played prominent roles, serving as mentors and consultants to others. Additional institutions had a secondary role relative to these core institutions, suggesting a possible network structure with links through an inner and outer circle. Most institutions appreciated the possibility to connect with others in the network directly, and only a small minority of members suggested they did not need to make connections with others in PoPNet.

Most connections between PoPNet members were made after the institutions joined PoPNet, suggesting that membership in the network helped create and foster the connections, rather than simply benefited from pre-existing ones. These connections resulted in important benefits to institution staff (described below). Despite these cited benefits, the frequency of communication among members was relatively low. Sporadic contact indicates that members in the network did not (need to) make much use of the potential for network affordances and points to the need for potentially stronger future stewardship of the network itself.

*Ib. To what degree did PoPNet contribute to changes at the participating institutions?*

A majority of institutions in PoPNet both initially and currently employ key elements of the PoP program. These center on planning, training and support. Elements not directly tied to implementation, such as evaluation and inclusion of other institutional departments, were less common. As the PoPNet project matured, there was an apparent decrease in the frequency of use of some key PoP elements. This decrease may indicate a decline in overall activity across institutions over time, but also a shift in which of the project elements emerge as important, essential, helpful or doable.

As expected, most respondents reported that their institutions made some changes to the PoP scientist-training model. These included shifts in who participates in the PoP training and outreach, revisions to the training through increased practice and communication, revisions of public engagement activities, and alternation of administrative elements (including formalizing university relationships). These revisions to the PoP implementation were supported by exchanges between PoPNet members at different institutions. Many exchanges simply provided information that PoP members thought they might use to enhance their work with scientists, but others resulted in actual changes to the

implementation itself. In some cases, members had evidence of improvements based on these modifications, and a subset indicated their exchanges with other PoPNet members led them to sweeping revisions of their overall practices. Also common were dialogues and exchanges that were not specifically about PoP, which indicate that a network structure enabled communication between ISE institutions for general professional benefits.

*Ic. To what degree did PoPNet contribute to changes for participating scientists?*

Participating scientists who responded to the survey were deeply impacted by PoP. They reported levels and types of science engagement that would not be achievable without their participation in the program; they increased their pedagogical and communication ability and skills; they transferred those ability and skills into their work environment (and subsequently were more motivated to do their regular work – often laboratory-based research); and they further increased their appreciation for continued improvement and growth. Most of them indicated that they would continue conducting outreach and engagement activities in the future. In some cases, participation in PoPNet might have contributed to, or even motivated changes in career trajectories. While certainly a self-selected group of mostly early-career scientists, we nonetheless have ample evidence that the program itself was contributing to the growth of scientists in these various outcome areas. Program elements that were considered of particular value were initial PoP training workshops, one-on-one support in developing outreach and engagement activities, logistical support and access to audiences, and creating local communities of like-minded scientists who share in the passion for outreach. A few existing program elements were considered less valuable, such as online updates or refresher workshops, though given the diversity of voices within the participating scientist community, each element of PoP was valued highly by some.

**II. Extended Impacts: As the Portal to the Public Network expands (in breadth and duration since its inception), how have the project's impacts extended or grown?**

*IIa. What is the degree to which ISE staff has achieved sustained, integrated implementation at their institution, and what value has the Network provided in supporting local efforts?*

We found evidence that each institution plans to continue PoP for the foreseeable future and that their top-level administration is supportive of continued PoP implementation, which is key to any sustainability efforts. The most productive way that PoPNet supports these implementations is through in-person and one-on-one gatherings with PoPNet leads or mentors, which were highly or moderately useful for all staff members involved in the PoPNet program. Perhaps least useful were online exchanges via webinars and group discussions, suggesting it may be necessary to refine online training and communication within PoPNet.

PoPNet sites reported that involving scientists in outreach is integral to their institutional mission and practice, and that this integration occurred as a result of staff members' involvement in PoPNet. The network's role was cited as providing the opportunity to collaborate with network members to get guidance, support, and mentorship and to deepen relationships with university partners. Also important was access to the PoP framework and resources, which provided the necessary focus, foundation and creditability. This stands in contrast to the relatively low frequency of inter-institutional communication and moderate value of this communication (i.e., other elements had stronger perceived value). . With limited resources, it could be argued that sustaining a network with more horizontal communication between members may not be as essential at this stage. However, given the ongoing commitment to

PoP implementation and the important benefits gained in spite of the limited communication, a network offers a valuable distributed support system that can help guide new initiatives and provide community-based insight for program refinement and sustainability. Whether the network function ought to be strengthened, however, or whether a loose network with mostly self-directed initiative for horizontal communication may suffice is an open question. Expansion and deepening of the network will certainly require stronger curation. Additionally, any curation of communication between PoPNet members may be perceived as most valuable if it focused on major issues of concern directly, that is, curation may have to assume programmatic elements

*IIb. What are extended (long-term) impacts of PoP participation of volunteer scientists and institutional staff, including their ongoing commitment to outreach, attitudes about outreach, and the degree to which knowledge, skills, and attitudes developed through PoP have impacted their work, outreach, or careers?*

The PoPNet program had extended impacts by helping to advance institutional goals; this occurred in three distinct ways. First was helping respondents' institutions form and sustain key collaborative partnerships. Second was connecting the public to current research (particularly within the community or museum), thus providing opportunities for expanding the public's STEM literacy and interest. Third were the multiple opportunities for professional development for both institution staff and scientists. Scientists gained communication skills, ensuring their research-based outreach activities were accessible and understandable; staff developed new content expertise and experimented with new ideas. For some institutions, there was also an increase in the multi-departmental use of PoP to improve the visitor experience, as well as a deepening of relationships with corporate partners, both of which provide evidence of program growth.

While most PoP institutions were already working with scientists, PoPNet helped implement strategic desires to strengthen work with research scientists and other science-based professionals. There is evidence that PoPNet improved, deepened or expanded the work that institutions meant to do or already did with scientists. In that sense, PoPNet truly provided value added to institutions that required a mechanism for fulfilling their mission and goals.

*IIc. To what degree was the PoP model resilient to different locations? What kind of local adaptations or modifications have been developed? To what degree was the model adopted/adapted for different contexts?*

We found no distinct differences between PoP institutions based on their size and only limited differences based their type. We defined science centers and children's museums as initial typical PoP institutions, and contrasted their collective experience against all others, which included natural history museums, zoos, aquariums and university-based outreach. Staff from institutions that belonged to the "other" category typically had slightly lower presence of key PoP elements and did not list as many changes to their implementation. They also demonstrated less appreciation for the booster workshop and informal meet-ups but had greater interest in the PoPNet Annual Meeting and more frequently mentioned professional development as an important PoPNet benefit. These moderate differences are easily explained by the later entry of the "other" institutions into the PoPNet program. Thus, these findings suggest that broader recruitment of PoP institutional partners does not necessarily require unique engagement mechanisms. However, the findings do highlight the distinct needs of novice versus veteran partners, which can be supported through existing PoPNet resources and a more curated network (e.g., structured and focused training and follow-up interactions for recent recruits versus more

informal support addressing changes and sustainability for veteran partners).

# INTRODUCTION

The *Portal to the Public: Expanding the National Network* (PoPNet) project is an NSF-funded effort (NSF AISL #1224129) to disseminate the empirically-validated Portal to the Public guiding framework (PoP, NSF AISL #0639021) broadly across the informal science education (ISE) field within North America. The PoP model trains researchers to share their research with the general public at ISE institutions (Selvakumar & Storksdieck, 2013).

The expansion of the PoP program has been underway since 2012. It incorporated more than twenty new ISE sites into the growing network, provided training and mentorship to ISE professionals on the use and adaptation of the PoP implementation manual and toolkits, and developed an enhanced network website that currently serves as a communication and innovation hub.

The Oregon State University Center for Research on Lifelong STEM Learning conducted the summative evaluation for the PoPNet project. The Center seeks to improve understanding of how all people STEM throughout their lifespan and across formal and informal settings.

This document provides the summative evaluation of PoPNet program. It consists of an executive summary, key findings, results from surveys with staff at PoP institutions and with their participating scientists, and appendices with methods, instruments, and data.

The questions for this summative evaluation are as follows:

*I.* *Intended Impacts*: To what extent are the intended impacts (outcomes) achieved with participating ISE staff and scientists?
   a. Does the PoP network itself add value to the participating institutions?
   b. To what degree did PoPNet contribute to changes at the participating institutions?
   c. To what degree did PoPNet contribute to changes for participating scientists?

*II.* *Extended Impacts*: As the Portal to the Public Network expands (in breadth and duration since its inception), how have the project's impacts extended or grown?
   a. What is the degree to which ISE staff have achieved sustained, integrated implementation at their institution, and what value has the network provided in supporting local efforts?
   b. What are extended (long-term) impact of PoP participation of volunteer scientists and institutional staff, including their ongoing commitment to outreach, attitudes about outreach, and the degree to which knowledge, skills, and attitudes developed through PoP have impacted their work, outreach, or careers?
   c. To what degree was the PoP model resilient to different locations? What kind of local adaptations or modifications have been developed? To what degree was the model adopted/adapted for different contexts*?*

# RESULTS – Staff Survey

## *I. Key PoP model elements implemented with some refinements*

Sixty-six staff members from 23 institutions (one respondent did not provide their institution name) completed the entire questionnaire; this provided a reasonable representative sample of PoPNet staff participants (Table 1). Many institutions were represented by more than one staff member; those with four or more respondents were Explora, Oregon Museum of Science and Industry, Pacific Science Center, New England Aquarium, and University of Wisconsin Madison. These institutions were categorized by type (science centers and children's museums vs other types of institutions) and size (more or fewer than 50 full-time staff members). Responding staff members varied in their longevity with the program, from its inception (2007) to the current year (2016, Table 1). As the PoP program initially targeted science centers and children's museums, it is not surprising that quite a few respondents from these types of institutions joined before or during 2013. "Other" types of institutions were only recently recruited, and thus all these respondents' entry year was 2013 or later. There was no apparent difference in size with regard to year of joining; nor was there an apparent relationship between size and type.

**Table 1. Institutions represented in the staff questionnaire**

| Institutions | Institution type† | Institution size†† | Number of respondents | Earliest year respondents joined PoP |
|---|---|---|---|---|
| Adventure Science Center | SC-CM | Small | 3 | 2009 |
| Carnegie Science Center | SC-CM | Large | 2 | 2014 |
| Children's Museum of Houston | SC-CM | Large | 3 | 2015 |
| Explora | SC-CM | Small | 10 | 2007 |
| Florida Museum of Natural History | Other | Large | 3 | 2013 |
| Mayborn Museum Complex at Baylor University | Other | Small | 3 | 2016 |
| Frost Museum of Science | SC-CM | Small | 2 | 2013 |
| Natural History Museum of Utah | Other | Large | 2 | 2013 |
| New England Aquarium | Other | Large | 4 | 2015 |
| Oregon Museum of Science and Industry | SC-CM | Large | 6 | 2012 |
| Pacific Science Center | SC-CM | Large | 4 | 2007 |
| Powerhouse Science Center | SC-CM | Small | 2 | 2012 |
| Reiman Gardens | Other | Small | 3 | 2015 |
| Rochester Museum & Science Center | SC-CM | Large | 1 | 2012 |
| Sci-Port | SC-CM | Small | 1 | 2014 |
| Science Central | SC-CM | Small | 2 | 2014 |
| Sciencenter | SC-CM | Small | 2 | 2014 |
| Smithsonian Institution National Museum of Natural History | Other | Large | 1 | 2014 |
| The Discovery Museums | SC-CM | Small | 2 | 2013 |
| The Franklin Institute | SC-CM | Large | 1 | 2015 |
| UNAVCO | Other | Small | 1 | 2016 |
| University of Wisconsin-Madison | Other | Large | 5 | 2013 |
| WYSTEM | Other | Small | 1 | 2016 |

†"SC-CM" is science centers and children's museums, and "other" is other institution types
††"Large" is institutions > 50 full-time staff, and "small" is institutions < 50 full-time staff

**Many of these respondents are or were deeply involved in the PoP program** at their institution (Table 2). Their activities ranged from implementation (e.g., training scientists) to program leadership, and the majority of respondents were involved in three or more of the listed activities (with, on average, 4 out of 6).

**Table 2. Percentage of respondents involved in different PoP roles at their institution (N=65).**

| PoP implementation responsibilities | Percentage of PoP staff respondents |
|---|---|
| Trained PoP scientists at their institution | 80% |
| Provided leadership with regard to PoP at their institution | 75% |
| Made operational decisions about PoP at their institution | 68% |
| Recruited scientists to participate in PoP at their institution | 66% |
| Built and sustained relationships with scientists for PoP | 66% |
| Mentored PoP scientists after initial training | 52% |

**Three-quarters of respondents indicated that their institutions initially and currently employ key PoP implementation elements**; these center on planning, training and support (top eight rows in Table 3). Elements not directly tied to implementation, such as evaluation and inclusion of other institutional departments, or formal agreements with science or research institutions, were less common (bottom six rows in Table 3). When examining responses by institution type, **more respondents of science centers and children's museums consistently listed the presence of key PoP model elements compared to respondents from other types of institutions** (both initially and currently, bolded blue in Table 3). This may be because, as noted earlier, science centers and children's museums have been involved in the PoP effort longer than other institutions. There is not a clear distinction between responses from staff at large and small institutions in terms of initial presence of key elements; however respondents from smaller institutions seem to believe that more of the key elements are still present at their institution.

**Table 3. Percentage of respondents who reported initial and current presence of various PoP model elements at their institution. Respondents' institution type and size are denoted by color, and bolded text indicated larger value for each.**

| PoP model elements | All Respondents (N=66)<br>*Respondents by Type†*: SC-CM v Other† (N=23 v 42)<br>*Respondent by Size††*: Large v Small (N=32 v 33) | | |
|---|---|---|---|
| | Initial presence | Current presence | Not sure |
| Institution supported scientists in the creation of a hands-on activity based on their expertise | 88%<br>**90%** v 83%<br>84% v **91%** | 77%<br>**79%** v 74%<br>72% v **82%** | 0%<br>0% v 0%<br>0% v 0% |
| Institution handled all logistics and promotion of public engagement events in which these scientists participate | 86%<br>**88%** v 83%<br>**88%** v 85% | 74%<br>**76%** v 70%<br>69% v **79%** | 5%<br>5% v 4%<br>3% v 6% |
| Institution was guided by a conceptual plan that outlined resources, goals, and strategies for your PoP efforts | 86%<br>**88%** v 83%<br>**88%** v 85% | 65%<br>**67%** v 65%<br>59% v **73%** | 5%<br>5% v 4%<br>3% v 6% |
| Institution provided group training of scientists using the PoP professional development elements | 83%<br>**83%** v **83%**<br>**84%** v 82% | 74%<br>**76%** v 70%<br>69% v **79%** | 3%<br>2% v 4%<br>3% v 3% |
| Institution provided ongoing as-needed communication with these scientists beyond the training period | 80%<br>**86%** v 70%<br>78% v **82%** | 73%<br>**76%** v 70%<br>69% v **76%** | 6%<br>5% v 9%<br>9% v 3% |
| Institution provided individualized support or mentorship to these scientists | 79%<br>**79%** v 78%<br>78% v **79%** | 74%<br>**79%** v 65%<br>66% v **82%** | 3%<br>2% v 4%<br>6% v 0% |
| Institution leveraged contacts of staff, board members, and/or donors to recruit scientists | 74%<br>**76%** v 70%<br>69% v **79%** | 62%<br>**62%** v 61%<br>56% v **67%** | 6%<br>10% v 0%<br>9% v 3% |
| Institution sought to build a sense of community among participating scientists | 74%<br>71% v **78%**<br>72% v **76%** | 73%<br>71% v **74%**<br>**75%** v 70% | 3%<br>2% v 4%<br>6% v 0% |
| Institution recognized and showed appreciation for PoP scientists | 68%<br>**70%** v 67%<br>**69%** v 67% | 65%<br>61% v **67%**<br>63% v **67%** | 3%<br>4% v 2%<br>3% v 3% |
| Evaluation used to improve PoP activities at the site | 61%<br>**70%** v 55%<br>**69%** v 52% | 59%<br>**61%** v 57%<br>56% v **61%** | 15%<br>17% v 14%<br>9% v 21% |
| Evaluation used to document impact of the respondent's PoP activities | 47%<br>**52%** v 43%<br>**59%** v 33% | 44%<br>39% v **45%**<br>**47%** v 39% | 21%<br>22% v 21%<br>13% v 30% |
| Multiple departments and/or leaders at the institution used PoP as a tool to improve the visitor experience | 41%<br>30% v **45%**<br>38% v **42%** | 52%<br>30% v **62%**<br>**53%** v 48% | 14%<br>22% v 10%<br>6% v 21% |
| Institution used PoP as a method to deepen relationships with corporate partners | 20%<br>0% v **31%**<br>13% v **27%** | 23%<br>4% v **33%**<br>**25%** v 21% | 24%<br>17% v 26%<br>13% v 33% |
| Institution established a formal agreement with a science research institution. | 18%<br>13% v **19%**<br>**19%** v 15% | 18%<br>9% v **24%**<br>**28%** v 9% | 29%<br>26% v 31%<br>22% v 36% |

†"SC-CM" denotes respondents from science centers and children's museums, and "other" is respondents from other institution types

††"Large" denotes respondents from institutions with more than 50 full-time staff, and "small" is respondents from institutions with fewer than 50 full-time staff

**Regardless of type or size, there is a relatively small decrease in the use of most PoP elements** when comparing initial to current implementation (Table 3), suggesting a possible small decline in the intensity of PoP implementation across institutions, and a stronger focus on fewer elements that seem essential at individual sites. Interestingly, respondents indicated a higher rate now for using PoP as a tool to improve the visitor experience, driven mostly by participating institutions that did not fall under the science or children's museum categories. Furthermore, **at least one respondent from each institution stated that they plan to continue PoP for the foreseeable future**; they also reported that their top leadership (e.g., CEO, president) has knowledge of their PoP effort. One exception is the New England Aquarium, where two of four respondents confirmed that reorganization and staffing changes has forced them to put their PoP efforts on hold.

**Many respondents (65%) reported that their institutions made some changes to the PoP scientist-training model** (Table 4, also see Appendix 3 List 1). Respondents from both types of institutions (science center and children's museums vs. "other") mentioned shifts in who participates in their PoP implementation, as well as revisions of their PoP training. Perhaps because they are veteran PoP members, science center and children's museum respondents also mentioned changes in public outreach activities and alteration of administrative elements (including formalizing university relationship). Some staff from these types of institution noted changes were necessary to re-start their project (after a brief hiatus) or sustain their ongoing project. A small percentage (19%) of respondents from both types noted that their institution made no changes (or that their program is dormant or that they are unsure). There were no differences between big and small institutions with regard to these changes.

**Table 4: Emergent themes associated with significant changes of the PoP model at respondents' institutions.**

| Change Themes | Components |
|---|---|
| Shifting who is involved | ▪ Narrowing<br>  ▪ Temporarily focused more on alumni scientist (due to limited funds)<br>  ▪ Focused on in-house scientists<br>▪ Expanding<br>  • Adding more or all of staff (includes training other staff and volunteers on the project)<br>  • Involving youth (e.g., through joint teen-mentor workshops)<br>  • Involving alumni scientist in delivering training |
| Revising scientist training through increased practice and increased communication | • Expanded/revised training<br>  • Added new activities<br>  • Focused more on communication than activity development<br>  • Provided more individualized support—less formal and tailored to each scientist<br>  • Provided shorter, more intense training for those with limited availability<br>  • Added more opportunities to practice (including on the museum floor)<br>  • Involved scientists in training<br>• Added workshops<br>  • Prototype workshop or 2-4 hour "build sessions" when staff helped participants on their activities<br>  • Follow-up workshop on working with very young and old audiences, as well as teen audiences<br>  • Training to give TED-like talks<br>• Maintained dialogue with past scientists<br>• Made use of existing museum activities<br>• Experimented with interactions through social media<br>• Added mentorship program<br>• Added social events |

| | |
|---|---|
| Revising public engagement activities | • Revised expectation for scientists<br>• Expanded requirement for engagement for scientists<br>• Expanded venues for public engagement including outside museum (e.g., shopping mall) |
| Making administrative changes | ▪ Formalized and/or deepened university relationship (including focus on graduate students)<br>▪ Added fee structure (which universities pay)<br>▪ Added appreciation event/opportunities<br>▪ Tried to recruit corporate STEM professionals<br>▪ Hosted training at university<br>▪ Increased communication between in-house PoP staff<br>▪ Improved and/or expanded |

### *II. Enhanced outreach through science partnerships, public linked to research, and training*

PoP model impacts are illustrated in Tables 5a-c (below). These tables present mean ratings for participation in and usefulness of various PoPNet components. The rating scales range from "no or low participation" (1) to "high participation" (5) and from "not useful" (1) to "very useful" (5). Strong endorsements (>4.0) are bolded; moderate endorsement is considered to be 3.0-4.0, while low endorsement is less than 3.0. NA indicated "not applicable."

**In-person and one-on-one gatherings with PoPNet leads or mentors were highly or moderately useful for all staff members involved in the PoPNet program** (Table 5a). In particular, the in-person trainings (both initial and refresher) stand out in terms of the level of participation and usefulness to implement the PoP program. While a large percentage of respondents were not involved in the refresher workshop, those who did participate considered this component of the training very useful. Even though participation in direct communication with PoPNet leadership was only moderate, it was rated as highly useful by those who had these dialogues.

**Table 5a: Staff respondents' mean rating and percentage not applicable (NA) for participation and usefulness of various PoPNet components for all institutions (N=66). Bolded values are above 4.0 (range 1-5).**

| | Participation | | Usefulness | |
|---|---|---|---|---|
| | Mean | N/A | Mean | N/A |
| Initial in-person training (Dissemination Workshop) | **4.7** | 34% | **4.8** | 33% |
| Refresher in-person training ("Booster Shot Workshop") | **4.4** | 73% | **4.6** | 72% |
| One-on-one online/phone communication with PoPNet leadership (Pacific Science Center) | 3.2 | 35% | **4.2** | 40% |
| One-on-one online/phone communication with your PoPNet mentor | 3.4 | 39% | 3.8 | 39% |
| PoPNet Annual Meeting at (Association of Science and Technology Centers conferences) | 3.3 | 53% | 3.8 | 58% |
| Informal in-person meetups (e.g., Association of Zoos and Aquariums, 2015) | 2.1 | 84% | 3.6 | 92% |
| Online webinars, online group discussions, PoPNet listserv | 2.6 | 24% | 3.2 | 31% |
| One-on-one online/phone communication with staff from other PoPNet institutions but not your mentor) | 2.2 | 47% | 3.3 | 57% |

Similar trends are apparent when breaking out institution type and size (Figures 5b and 5c) with some exceptions. Despite similar participation levels, mean usefulness of the refresher training was lower for

"other" institution respondents compared to those from science centers and children's museums. Additionally, "other" institution respondents seem to benefit more from the PoPNet Annual Meeting, while science center and children's museum respondents benefited more from informal in-person meet-ups at conferences. **Because "other" institutions are fairly recent recruits, their staff may not yet be ready for a "booster shot" training but may require the structure and focus of the more formal gathering provided at the Annual Meeting**. For similar reasons, smaller institution respondents may benefit more from the Annual Meeting compared to larger institution respondents, who seem to find greater usefulness in one-on-one communications with their PoPNet mentor. Perhaps least useful were the online exchanges via webinars and group discussions, as well as one-on-one communication with other members of the network, especially for large institutions. Some respondents from smaller institutions and both institutions did still find these elements valuable (i.e., mean usefulness >3.0). Additionally, there is contrary evidence suggesting communication with PoPNet peers was benefical (see Tables 9 and 10). Regardless, these results suggest it **may be necessary to refine online training and to expand support for networking with other members.**

**Table 5b. Respondents' mean rating and percentage not applicable (NA) for participation and usefulness of various PoPNet components for science centers and children's museum (SC-CM, N=23) and other institutions (Other, N=42). Bolded values are greater than 4.0 (range of 1-5).**

| | Participation | | | | Usefulness | | | |
|---|---|---|---|---|---|---|---|---|
| | Mean | | N/A | | Mean | | N/A | |
| | SC-CM | Other | SC-CM | Other | SC-CM | Other | SC-CM | Other |
| Initial in-person training (Dissemination Workshop) | **4.6** | **4.8** | 40% | 26% | **5.0** | **4.5** | 38% | 27% |
| Refresher in-person training ("Booster Shot Workshop") | **4.4** | **4.3** | 64% | 86% | **4.8** | 3.7 | 63% | 86% |
| One-on-one online/phone communication with PoPNet leadership (Pacific Science Center) | 3.5 | 2.7 | 36% | 30% | **4.4** | **4.14** | 41% | 36% |
| One-on-one online/phone communication with your PoPNet mentor | 3.2 | 3.8 | 46% | 26% | 3.6 | 3.9 | 46% | 27% |
| PoPNet Annual Meeting at (Association of Science and Technology Centers conferences) | 3.2 | 3.6 | 46% | 61% | 3.7 | **4.0** | 50% | 71% |
| Informal in-person meetups (e.g., Association of Zoos and Aquariums, 2015) | 2.0 | 2.3 | 85% | 83% | **4.0** | 3.0 | 92% | 91% |
| Online webinars, online group discussions, PoPNet listserv | 2.8 | 2.3 | 26% | 23% | 3.3 | 2.9 | 33% | 27% |
| One-on-one online/phone communication with staff from other PoPNet institutions but not your mentor) | 2.3 | 2.1 | 44% | 52% | 3.3 | 3.4 | 50% | 67% |

**5c. Respondents' mean rating and percentage not applicable (NA) for participation and usefulness of various PoPNet components for institutions >50 full-time staff (Large, N=32) and institution <50 full-time staff (Small, N=33). Bolded values are greater than 4.0 (range of 1-5).**

| | Participation | | | | Usefulness | | | |
|---|---|---|---|---|---|---|---|---|
| | Mean | | N/A | | Mean | | N/A | |
| | Large | Small | Large | Small | Large | Small | Large | Small |
| Initial in-person training (Dissemination Workshop) | **4.6** | **4.7** | 33% | 36% | **4.5** | **5.0** | 38% | 30% |
| Refresher in-person training ("Booster Shot Workshop") | **4.1** | **4.6** | 73% | 71% | **4.1** | **5.0** | 73% | 70% |
| One-on-one online/phone communication with PoPNet leadership (Pacific Science Center) | 3.1 | 3.2 | 36% | 32% | **4.1** | **4.4** | 40% | 39% |
| One-on-one online/phone communication with your PoPNet mentor | 3.7 | 3.2 | 42% | 36% | **4.0** | 3.5 | 40% | 38% |
| PoPNet Annual Meeting at (Association of Science and Technology Centers conferences) | 3.7 | 2.9 | 52% | 52% | 3.5 | **4.2** | 50% | 66% |
| Informal in-person meetups (e.g., Association of Zoos and Aquariums, 2015) | 2.4 | 1.8 | 84% | 84% | 3.7 | 3.5 | 90% | 93% |
| Online webinars, online group discussions, PoPNet listserv | 2.2 | 2.9 | 33% | 16% | 2.7 | 3.5 | 40% | 23% |
| One-on-one online/phone communication with staff from other PoPNet institutions but not your mentor) | 2.1 | 2.4 | 52% | 42% | 2.8 | 3.8 | 57% | 55% |

As described by respondents, there were three key ways of the PoPNet program advanced institutional goals (Table 6 and Appendix 3 List 2). First was helping respondents' institutions **form and sustain key collaborative partnerships**. This had the benefit of promoting a sense of community with scientists, other PoPNet staff, other institution staff, and other critical community partners (including founding donors, board members, parent institution, higher education institutions, corporations). One respondent noted that,

> "PoP has allowed us to engage with the broader scientist community in a new way to create a collegial environment of experts. We are viewed in a new light being able to support their endeavors and needs through meeting our own with public experience."

Second was **connecting the public to current research** (particularly within the community or museum), thus expanding the public's STEM literacy and interest (including increasing adult and youth education opportunities and making connection to scientific career paths). Implementation of PoP at home institutions led to involvement of scientists in exhibits and visitor services, which had the added benefit of demonstrating that scientists are "regular" members of the community. As one respondent reported,

> "We now have a rich (and growing) pool of scientists willing to share their work and expertise with the museums, beyond their initial involvement through the PoP program, which has meant an increase in the number of "expert" lead programs we are able to offer."

In later item, another respondent emphasized the important of dialogue emphasized by the PoP program, stating,

> "Portal is the one example I can cite that emphasizes (and not as much as it should) that communication begins with the ears. It begins with listening. It rejects the "it's all about me" mindset of the horrible 'elevator pitch.' Conversations at an Exploration Station allow visitors/learners to chat with researchers, to hit the ball back and forth over the net, to see a researcher in casual setting far from the lectern or camera."

Third were **multiple opportunities for professional development** for both institution staff and scientists. Scientists gained communication skills, ensuring their research-based outreach activities were accessible and understandable; staff developed new content expertise and experimented with new ideas. Additional benefits included expanding volunteer pool, helping scientists meet broader impacts requirements (become the "place to go" for this), and supporting institutions' strategies goals. For some, this work shifted the identity of the institution as a hub for science communication. Respondents emphasized **these benefits were possible because the PoPNet program provided: (a) focus/structure for collaboration with scientists and (b) access to PoPNet training, resources and evaluation methods, as well as ideas/approaches used by other PoPNet institutions** (see Appendix 3, List 2).

Respondents from many institutions mentioned all of these benefits. Both large and small institution respondents, as well as science center and children's museum respondents, listed partnerships and public-researcher connections more frequently than scientist and staff professional development. Only respondents from "other" types of institutions (not science centers or children's museums) mentioned professional development as frequently as the other benefits; **perhaps as newer PoP members, the training continues to play a more prominent role in terms of impacts at the institutional level**.

**Table 6: Emergent themes associated with advancement of broader institutional goals due to PoP implementation at respondents' institutions.**

| Advancement Themes | Components |
|---|---|
| Partnerships | • Formed/maintained real, more robust, longer-lasting partnerships with local scientific community<br>• Helped better connect with other critical partners (including founding donors, Board members, parent institution, other departments)<br>• Established relationships with other PoPNet staff (which helped make connections to local scientists)<br>• Learned from peers including other PoPNet institutions<br>• Created collegial environment of scientists, as well as promoted greater sense of community among staff |
| Public connected to real/current research | • Involved scientists in exhibits and visitor services (including making this core to the institution)<br>• Helped make local scientists and their ideas accessible and understandable<br>• Demonstrated scientists are part of the community<br>• Kept visitor experience fresh, and ignited visitors' curiosity and lifelong discovery of science'<br>• Expanded public's (Including youth) awareness, view, and knowledge of science concepts, scientific research and scientific career paths<br>• Helped public see themselves as scientists<br>• Promoted culture of STEM literacy |

| Advancement Themes | Components |
|---|---|
| Staff and scientists development | • Developed new content expertise among staff<br>• Helped educators create/refine programs<br>• Provided staff time to experience and learn from peers<br>• Enhanced scientists knowledge/skills (including internal scientists and graduate students)<br>• Improved communication strategies for all |
| Broader benefits | • Helped scientists met their 'broader impacts' requirement in more meaningful ways<br>• Expanded volunteer pool (with scientists)<br>• Supported strategic and education goals (including aligning with 21st century needs)<br>• Now viewed as supporting scientists, as a regional science hub, and as national leader in science communication |

These benefits are echoed in an additional questionnaire item. While most institutions were already working with scientists, almost two-thirds of respondents indicated that **PoP improved this programming or more deeply embedded the scientist engagement model in their institution's education programming** (Table 7). There was not much difference in these benefits based on institution type and size, although more "other" institution respondents reported PoP primarily helped them better position their existing efforts; this group consisted of respondents from three large natural history museums, one large aquarium, two universities, and a botanical garden, all of which might be expected to have significant relationships with local and residential scientists.

**Table 7: Percentage of respondents agreeing with the following impact items**

| | All respondents (N=62) | By Type: SC-CM (N=39) v Other (N=22) | By Size: Large (N=30) v Small (N=31) |
|---|---|---|---|
| Already working with scientists, and the PoP program helped position this type of outreach more sustainably and deeply in their institution | 42% | 35% v 55% | 21% v 21% |
| Already working with scientists, and PoP helped them do it better | 29% | 28% v 32% | 15% v 15% |
| The PoP program provided the idea to work with scientists | 13% | 18% v 5% | 7% v 7% |
| Already had this idea, but the PoP program helped them implemented this idea. | 10% | 10% v 5% | 5% v 2% |
| None of the above | 7% | 8% v 5% | 3% v 3% |

**Almost all of respondents fully or partially agreed that involving scientists in outreach is an integral part of their institutions** (Table 8). While six respondents reported that this was true prior to PoP, the rest suggested this occurred as a result of their PoP involvement. For example, they describe involving scientists in outreach as now "a pillar of our engagement strategy" and "becom[ing] an even larger goal than we ever imagined." (see Appendix 3, List 3). Those who only partially agreed or did not agree stated they are just getting started or are working to re-ignite or expand their efforts and will continue to seek buy-in and traction. The small percentage of respondents felt that the statement overall was not true (5%) represents the bias in our sample—that is, all of these institutions had opted to be part of PoPNet and the staff was willing to complete a questionnaire.

**Table 8: Percentage responding to the following statement: "Involving scientists in outreach is now an integral part of your institution." (N=61)**

| | Percentage of all respondents (N=61) | By Type: SC-CM (N=39) v Other (N=21) | By Size: Large (N=29) v Small (N=31) |
|---|---|---|---|
| Yes, this is true. | 57% | 54% v 62% | 33% v 23% |
| Yes, this is partially true. | 34% | 41% v 24% | 10% v 25% |
| No, this is not true. | 5% | 5% v 5% | 3% v 2% |
| I'm not sure. | 3% | 0% v 10% | 2% v 2% |

## *III. Evidence of burgeoning network supporting PoP implementation*

The PoPNet program sought to develop a network among institutions implementing the PoP model, and **there is evidence of this burgeoning community**. Twenty-six institutions were mentioned five or more times as a source to address questions, share strategies, and provide guidance (Table 9). Most of these connections were made since joining PoPNet. Of these, five appear to be core to the network (10 or more mentions). Not surprisingly, this includes the Pacific Science Center, which played an important connecting role. The four others are veteran members who are well positioned to provide advice and guidance to others. These two sets of institutions (core and secondary) suggest a possible network structure with an inner and outer circle of linkages.

**Table 9: Number and means of respondents of who communicated with other PoPNet institutions about PoP or public engagement by scientists (e.g., ask questions, share strategies, get guidance). Respondents selected from a list of all 52 institutions in PoPNet.**

| Institution | Number of respondents who communicated with this institution | Number of respondents who communicated with this institution since joining PoPNet | Mean frequency of this communication* (range: 1-5) | Mean benefit of this communication† (range: 1-5) |
|---|---|---|---|---|
| Pacific Science Center | 36 | 24 | 3.2 | 4.6 |
| Explora! | 19 | 13 | 2.8 | 4.1 |
| OMSI | 18 | 14 | 2.5 | 4.3 |
| Science Center of Iowa | 12 | 9 | 2.3 | 3.2 |
| Adventure Science Center | 11 | 7 | 1.9 | 3.4 |
| The Franklin Institute | 10 | 9 | 1.9 | 3.3 |
| Natural History Museum of Utah | 9 | 7 | 3.4 | 4.4 |
| Bradbury Science Museum | 8 | 5 | 3.2 | 3.8 |
| Rochester Museum & Science Center | 7 | 6 | 2.2 | 3.0 |
| Museum of Life and Science (North Carolina) | 7 | 6 | 3.2 | 3.0 |
| Da Vinci Science Center | 7 | 5 | 1.2 | 3.3 |
| CU Science Discovery | 7 | 5 | 3.0 | 3.3 |
| Sciencenter | 7 | 6 | 2.7 | 3.7 |
| Discovery Center Museum (Illinois) | 6 | 5 | 2.0 | 3.0 |
| Detroit Zoological Society | 6 | 5 | 1.8 | 2.7 |
| Smithsonian Institution National Museum of Natural History | 6 | 4 | 2.4 | 3.6 |
| Powerhouse Science Center | 6 | 5 | 2.2 | 2.8 |

| Institution | Number of respondents who communicated with this institution | Number of respondents who communicated with this institution since joining PoPNet | Mean frequency of this communication* (range: 1-5) | Mean benefit of this communication† (range: 1-5) |
|---|---|---|---|---|
| Children's Museum of Houston | 6 | 2 | 3.5 | 4.5 |
| Carnegie Science Center | 6 | 4 | 1.5 | 2.5 |
| COSI | 6 | 4 | 2.3 | 2.5 |
| California Academy of Sciences | 6 | 4 | 2.5 | 3.3 |
| Turtle Bay Exploration Park | 5 | 5 | 1.4 | 2.8 |
| North Museum | 5 | 4 | 3.0 | 3.7 |
| New England Aquarium | 5 | 3 | 1.5 | 3.3 |
| National Zoological Park, Smithsonian Institution | 5 | 3 | 1.5 | 2.3 |
| NC Museum of Natural Sciences | 5 | 4 | 2.8 | 3.8 |

*1 (only once) to 5 (very frequently)
†1 (not beneficial) to 5 (highly beneficial)

Frequency of communication was low to moderate (3.5 or less in Table 9); this aligns the finding that one-on-one interactions had low participation (bottom row, Tables 5a, b, c). Despite this, many respondents reported benefits from communication with other PoPNet institutions; nine institutions were cited as providing moderate to high benefit (greater than 3.5). While the most common benefit was knowledge or information not necessarily related to PoP, 152 exchanges between PoPNet members resulted in knowledge that might be used to enhance PoP implementation (potential value) or was applied to change PoP implementation (applied value, Table 10). For a small number of exchanges, there was evidence of improvements based on these modifications (15), and even resulting changes in practices overall (19). These findings provide evidence of the value of the network but highlight the need for additional curation to extend its uses among members.

**Table 10: Total number of times a suggested benefit was gained by the respondent through communication with another PoPNet institution. Note that 59 respondents answered this item for the 52 institutions.**

| Suggested benefit | Total |
|---|---|
| I gained knowledge or information from staff at this institution (not necessarily related to PoP implementation). | 116 |
| I gained knowledge from staff at this institution, which I think I can use to change our PoP implementation. I haven't used this knowledge yet. | 80 |
| I have applied knowledge that I gained from staff at this institutions, which I have used to change our PoP implementation. | 72 |
| I have applied knowledge that I gained from staff at this institutions, which I have used to change our PoP implementation. And, I have evidence that it improved our PoP implementation. | 15 |
| Interaction with staff at this institution has prompted me to re-examine the definition of success at our institution and thus to change our practices overall. | 19 |

Only 10 respondents stated they did not connect with others in the network. This was primarily because this was not part of the respondent's role or because of limited time/resources. **Just three suggested they did not need to make these connections** (see Appendix 3, List 6).

When asked about the *network's role* in making scientist-public engagement integral to their institution, **one of the common themes was the opportunity to collaborate with network members to get guidance, support, and mentorship and to deepen relationships with university partners** (Table 11 and

Appendix 3 List 4). As one respondent noted, “It's great to hear what other museums are doing, get advice, troubleshooting suggestions and encouragement!”

Additional themes were **access to the PoP framework and resources**, which provided the necessary focus and foundation. PoPNet helped make scientist involvement an integral part of the programming, adding credibility (within the institution and beyond) and expanding marketing potential. In some cases, this opened up funds through broader impacts and fees for training. As captured by one respondent,

> “participating in PoPNet gave us the tools and the confidence to involve scientists in outreach to the point that we now consider scientists as integral as evaluation: in other words, instead of making a special program for scientists, we plan to involve scientists in virtually every major project.”

**Table 11: Emergent themes associated with advancement of broader institutional goals due to PoP implementation at respondents’ institutions.**

| Network Themes | Components |
|---|---|
| Collaboration with other network members | • Got updates, advice, troubleshooting suggestions, ideas from other members<br>• Got support and encouragement, as well as push to offer public engagement<br>• Mentor was particularly helpful<br>• Connections to other relevant networks (e.g., Teen Science Café Network) |
| Framework | • Developed internal language, which led to in-house support<br>• Gave focus, be more systematic, foundation to build on<br>• Established “named” training program, provided credibility<br>• Made scientists integral to programming |
| Network resources | • Provided well thought out strategies, curriculum, mentor provided conceptual basis<br>• Enhanced confidence<br>• Trained scientists more effectively<br>• Established ongoing interest |
| Partnership with universities | • Worked with university on broader impacts<br>• Worked with university on outreach beyond PoP |
| Funding | • Through broader impacts<br>• Through training |

When asked at the end of the questionnaire to reflect on the value of PoPNet for their home institution, respondents repeated a variety of aspects mentioned by them already (Appendix 3 List 5):

- Collaborations with scientists and science research institutions
- Professional development for scientists, and opportunity to improve their resume/CV
- Added value to the visitor experience
- Reinforcement of reputation of science museums as places for authentic science encounters
- Opportunity for staff growth
- Reputation for approach to involving scientists in outreach through the national network

Respondents also mentioned **challenges with sustaining PoP at their institution** (i.e., creating a sustainable financial models). One respondent (from a university) added the notion of increasing the value of PoP by expanding its scope from a focus on hands-on activities delivered by scientists at a museum setting to a broader community partnership or collaboration, including training that would help create local partnerships. As one respondent noted,

> “PoP has helped us to grow our relationships with local universities and has brought more scientists to the museum than ever before. I truly believe that it has assisted us in

achieving our goal to "be the place to go for science" in our community. I personally feel that my involvement with PoP has helped me to grow at my institution."

**PoPNet could be instrumental in providing inter-institution guidance on PoP expansion and sustainability, while also supporting new recruits in starting or re-starting their own efforts.**

# RESULTS – Scientist Survey

## *I. Sample description of participating scientists*

Of the 299 scientists who started the survey, 264 shared demographic information with us. Sample sizes for each question varied in part because of the dynamic nature of online sampling (forking), but also because respondents were encouraged to skip questions if desired.

**Our sample was slightly skewed towards women (58%), and is dominated by emerging professionals such as graduate students and postdocs (71%).** Just 20% were mid-career professionals, and 9% senior professionals in their field. In fact, of those who identified as working at academic institutions (n=218), half were graduate students, followed by faculty (31%) and post-docs (16%). Given the professional background of respondents/participants, only about 2 in 5 have no teaching, training or outreach responsibilities in their current position.

Our **sample was dominated by participants from research universities** who constituted two thirds of the sample, followed by government entities, teaching universities, non-profits and industry, all with less than 10% representation (see Table 13)

**Table 13: Institutions of participating scientists (N=264)**

| | Percentage of PoP scientist respondents |
|---|---|
| Research University | 68% |
| Government | 7% |
| Teaching University | 6% |
| Non-Profit/NGO | 5% |
| Industry | 4% |
| Medical Field | 2% |
| Self employed | 2% |
| Liberal Arts College | 1% |
| Other | 5% |

Respondents hailed from 25 of the 52 listed institutions; all but two institutions were represented by more than one scientist. We do not know the overall response rate, given that we had to rely on local PoP coordinators to distribute the invitation and link to the survey. **Two institutions stood out as homes for respondents, for reasons that have to do with the nature and history of the program: Pacific Science Center in Seattle (WA) and the Oregon Museum of Science and Industry (OMSI) in Portland (OR).** The former represents the PI institution and original founder of PoP, the latter hosts an active PoP-like program called Meet the Scientist, developed and directed by the first project manager of PoP.

**Table 14: Percentage of scientist respondents involved PoP program from various participating institutions (N=278)**

| | Percentage of PoP scientist respondents |
|---|---|
| Pacific Science Center | 15.5% |
| Oregon Museum of Science and Industry | 14.4% |
| Powerhouse Science Center | 7.5% |
| Natural History Museum of Utah | 6.8% |
| Rochester Museum & Science Center | 6.5% |
| Frost Museum of Science | 6.1% |
| The Discovery Museums | 5.8% |
| Adventure Science Center | 5.4% |
| Explora! | 4.7% |
| Science Central | 4.3% |
| Sci-Port | 3.2% |
| University of Wisconsin- Madison | 2.9% |
| Carnegie Science Center | 2.5% |
| Detroit Zoological Society | 2.2% |
| Florida Museum of Natural History | 2.2% |
| Children's Museum of Houston | 2.2% |
| Reiman Gardens | 1.8% |
| Smithsonian Institution National Museum of Natural History | 1.8% |
| Mayborn Museum Complex at Baylor University | 1.4% |
| Sciencenter | 1.4% |
| Sunset Zoo | 1.4% |
| Science Center of Iowa | 1.4% |
| UNAVCO | 1.1% |
| California Academy of Sciences | 0.4% |
| Hatfield Marine Science Center at Oregon State University | 0.4% |

**No mention:**

1. Bradbury Science Museum
2. COSI
3. CU Science Discovery
4. Da Vinci Science Center
5. Discovery Center Museum (Illinois)
6. Discovery Center of Springfield (Missouri)
7. Explorit Science Center
8. Great Lakes Science Center
9. Headwaters Science Center
10. Koshland Science Museum of the NAS
11. Museum of Life and Science (North Carolina)
12. Museum of Science and Industry (Illinois)
13. National Zoological Park, Smithsonian Institution
14. NC Museum of Natural Sciences
15. New England Aquarium
16. North Museum
17. Phipps Conservatory and Botanical Gardens
18. St. Louis Science Center
19. Synthetic Biology Engineering Research Center
20. TELUS World of Science
21. The Franklin Institute
22. The Thinkery (formerly Austin Children's Museum)
23. Turtle Bay Exploration Park
24. UNC Morehead Planetarium and Science Center
25. University of Michigan Museum of Natural History
26. Woodland Park Zoo
27. WYSTEM

***PoP Scientists like to inform and inspire.*** Scientists rated a range of reasons for taking part in public engagement (Table 15). By far the **most important reason, aligned with national data, is to increase public knowledge and excitement about science**. This is the base or foundation on which almost all other goals or objectives for scientist outreach rests. In that sense, scientists in our sample, and hence scientists active in PoPNet, do not fundamentally differ from their colleagues. Interestingly, a sense of duty for giving back to the community seems to play an important role as well, out-rating impact on teaching or research, or personal enjoyment or gratification. On the other hand, reasons connected with professional advancement, such as tenure and promotion, obtaining research funding or fulfilling

expectations by colleagues rated relatively low, suggesting that PoP scientists engage in outreach primarily for altruistic reasons.

When we asked a similar question about prioritizing objectives for outreach on a scale from 1 to 7, our sample deviated somewhat from a recent national sample of AAAS members (Table 16). In our equivalently sized sample the highest priority was assigned to "getting people excited about science" (6.61), an item that scored a whole rating point higher than in the AAAS sample (Dudo & Besley, 2016). In fact, **our sample generally prioritized items higher than the AAAS sample, suggesting a heightened awareness of various positive objectives for conducting outreach that developed in scientists who participated in PoP.**

**Table 15: What drives scientists personally to do outreach? Scientist respondents' mean ratings for various reasons for taking part in public engagement activities ("very low importance" (1) to "average importance" (4) to "very high importance" (7), N=287-290)**

| | Mean |
|---|---|
| Increase public knowledge and excitement about science | 6.6 |
| Fulfill a sense of duty (e.g., give back to my community) | 6.0 |
| Improve the impact of my teaching | 5.6 |
| Personal enjoyment | 5.4 |
| Improve the impact of research | 5.4 |
| Intellectual gratification | 5.2 |
| Improve professional networks | 4.7 |
| Involve the public in my research | 4.6 |
| Increase the odds of obtaining research funding | 3.7 |
| Fulfill expectations of my institution, my funder, and/or my field/discipline | 3.2 |
| Fulfill criterion for promotion, tenure or general job performance assessment | 2.9 |

**Table 16: What are scientists' objectives when conducting outreach? Scientist respondents' mean rating for various possible objectives for engagement with the public ("very low importance" (1) to "average importance" (4) to "very high importance" (7), N=285-286)**

| | Mean |
|---|---|
| Getting people excited about science | 6.6 |
| Describing scientific findings in ways that make them relevant to people | 6.3 |
| Ensuring that our culture values sciences | 6.2 |
| Getting people to appreciate the role of science in their daily lives | 6.2 |
| Encouraging more children and young adults to pursue science as a career | 6.2 |
| Ensuring that people are informed about scientific issues | 6.2 |
| Encouraging girls and minorities to pursue science as a career | 6.1 |
| Correcting scientific misinformation | 5.8 |
| Helping people use science to make better decisions | 5.8 |
| Demonstrating that science advances society's wellbeing | 5.8 |
| Demonstrating that scientists share the values of their community | 5.6 |
| Ensuring that scientists' findings are part of the public debate | 5.4 |
| Hearing what others think about scientific issues | 5.2 |

## *II. Impact of PoPNet on scientists*

**Participating scientists were highly satisfied with their experience in PoPNet**. We employed the equivalent of a Net Promoter Score for PoPNet, a common and highly valid composite measure for satisfaction that is used in marketing to determine whether customers are likely to purchase a product again, and more so, whether they would actively promote a product within their social circles. Based on a ten-point scale, scores above 8 are generally seen as indicating high satisfaction associated with active promotion. The PoPNet program received an equivalent of a 9.3 score on a ten-point scale (4 or greater in Table 17), indicating not only an extremely high level of satisfaction, but also an extremely high level of assigned value.

**Table 17: Scientist respondents' mean rating scores for items associated with their satisfaction with the PoP program, rated from -5 to +5 (N=263-264)**

| | Mean Score (-5 to +5) |
|---|---|
| Satisfaction with overall experience in the PoP program | 4.0 |
| Willingness to participate in the PoP program again | 4.4 |
| Likelihood of recommending PoP program to colleagues | 4.4 |

**PoPNet encourages excellence in outreach.** Scientist who participated in PoPNet exhibited an **unusually high percentage of participation in outreach overall compared with national samples**. More importantly, a rate of 93% for their self-declared outreach based on hands-on activities with manipulatives is extraordinary (Table 18). While expected within the model of PoP (since PoP trains science-based professionals to use manipulatives and then supports them in developing those for their outreach efforts), there **is no known other context within which outreach by scientists achieves these levels of hands-on interactions with audiences.** Therefore, this outcome can be attributed entirely to PoP itself, and serves to indicate that **the program achieves its goal of not only teaching scientists new forms of engagement, but that it also incentivizes and empowers them to actually conduct hands-on and engaging outreach.** Activities conducted by respondents are not limited to hands-on manipulatives. Lectures with considerable audience interaction (60%) and demonstrations (59%) are popular, as are tours (51%). More than a fifth of scientists stated that they have been engaged in citizen science type projects.

**Table 18: Percentage of scientists who conducted or took part in the following public engagement activities at museums or any other venues (N=299)**

| | Percentage of PoP scientist respondents |
|---|---|
| Hands-on activity in which audience directly manipulates objects | 93% |
| Lecture or discussion with considerable audience Q&A or other audience interaction | 60% |
| Demonstration in which audience observes but does not directly manipulate objectives | 59% |
| Tour (e.g., lab tour, nature walk, or a planetarium presentation) | 51% |
| Collaborating on science research with the public (e.g., citizen science) | 21% |
| Other | 3% |

When preparing public engagement activities, scientists need to balance a variety of "tensions" between their and the audience agenda, sharing their thoughts and knowledge versus hearing ideas from the audience, pressing ideas versus engaging in dialogue, engaging deeply with few people versus engaging more superficially with many, or (and relatedly) covering a lot of content with less depths versus

focusing on a few ideas and digging deeper (see Table 19). Generally speaking, PoP scientists try to strike a balance between what they consider their audience' agenda and their own; they prefer a smaller audience with which they can go deeper in terms of content and experience; and while they show a slight preference for sharing their ideas through interactive dialogue, they tend to strike a balance in their choice of content and delivery that aligns well with their desire to address theirs and the audience's agenda. While we cannot verify how these design preferences play out in practice, they nonetheless indicate **that PoP scientists are thoughtful and deliberate about their overarching approach towards public engagement.**

**Table 19: Percentage of scientist respondents' answers on how they would balance competing aspects of pedagogy when preparing for public engagement (N=259, highlighted is the most frequent answer)**

| Item | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | M | Item |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Audience Agenda | 2 | 6 | 14 | 15 | 11 | 12 | **31** | 8 | 1 | 0 | 5.9 | My Agenda |
| Shallow* Extensive | 1 | 1 | 3 | 6 | 10 | 18 | 23 | **23** | 9 | 7 | 6.8 | Deep Limited |
| Large** | 1 | 1 | 3 | 4 | 5 | 12 | 20 | **30** | 18 | 6 | 7.3 | Small |
| Sharing yours† | 2 | 4 | 7 | **23** | 15 | 22 | 15 | 8 | 3 | 1 | 5.4 | Hearing others |
| Engaging in dialogue†† | 5 | 11 | 20 | **24** | 11 | 8 | 15 | 5 | 1 | 1 | 4.5 | Presenting ideas |

*Shallow audience engagement but extensive content covered (1) to Deep audience engagement, but limited content covered (10) (N=261).
**Large audience but no one-on-one interaction (1) to Small audience and extensive one-on-one interaction (10) (N= 232, Mean = 7.3).
†Sharing your perspective (1) to Hearing other's perspectives (10) (N=201, Mean = 5.4). ††Engaging in dialogue (1) to Presenting ideas (10) (N=217, Mean = 4.5)

**Scientists report that they conduct more and better outreach through PoP.** Since their initial training in PoP, participating scientists report conducting on average 6 events at the partnering institution and 5.5 events elsewhere, **for a total of 11.5 events per scientists**. More than half of respondents state that they conduct public engagement activities at a higher rate now than before PoP, and only 7% at a lower rate (which would be expected simply from changes in scientists' professional contexts that discourage outreach and engagement activities) (Table 20). Encouragingly, almost all of the **scientists stated that the quality of their public engagement improved since their initial PoP training**, and none felt it worsened. **From the scientists' perspective, PoP is a phenomenal success.** Similarly, **half of the respondents plan to increase the frequency of their public engagement activities in the future**, and almost all of the remainder indicated that they would maintain current levels of engagement. Just 2% plan to decrease it. These results are astonishing given that most participating scientists are emerging professionals who should expect that time for outreach activities might decrease as their careers advance.

**Table 20: Percentage of scientist respondents in terms of their frequency of, quality of and future plans for public engagement (N=268-274)**

| | Percentage of PoP scientist respondents |
|---|---|
| *Frequency of public engagement activities after PoP training* | |
| Higher | 53% |
| Same | 40% |
| Lower | 7% |
| *Quality of public engagement activities after PoP training* | |
| Improved | 90% |
| Remained the same | 10% |
| Worsened | 0% |
| *Plans for future public engagement activities* | |
| Increase | 52% |
| Maintain at current level | 46% |
| Decrease | 2% |

**PoP Training contributed to advanced pedagogical skills of participating scientists.** Participating scientists confirmed the value of core pedagogical skills for conducting effective public engagement activities (Table 21), and rated themselves high on all of them at this point in time (scores between 4.1 and 4.5 on a 5-point scale). We did not ask them to speculate how much their abilities and skills changed over their time with PoP; instead, we asked them to rate the degree to which they felt PoP training might have impacted these abilities and skills on a 5-point scale between "no impact" and high impact". With an average rating of 4.4, **participating scientists confirmed the value of training for their current level of pedagogical abilities and skills.**

**Table 21: Scientist respondents' mean rating and standard deviation (SD) for their pedagogical abilities and skills. The first column represents their agreement with the statement, rated on a 5-point scale from strongly disagree to strongly agree, and the second column rated the degree to which PoP training might have impacted these abilities and skills, rated on a 5-point scale from no impact to high impact.**

| | Agreement (n=271) | | Impact of PoP Training (n=267) | |
|---|---|---|---|---|
| | Mean | SD | Mean | SD |
| Understanding of how people learn enables me to do effective public outreach | 4.5 | 0.6 | 4.4 | 0.7 |
| I can effectively explain my work or area of study to non-experts | 4.4 | 0.8 | 4.3 | 0.8 |
| I can effectively adjust my communication for learners of different ages or experience levels | 4.3 | 0.8 | 4.5 | 0.7 |
| I can effectively use dialogue-based interactions with the public to explore science concepts | 4.2 | 0.8 | 4.4 | 0.7 |
| I have a good understanding of the nature of learning in informal environments | 4.1 | 0.7 | 4.4 | 0.7 |

Despite these generally high self-reported rating on pedagogy, when asked to rate from "definitely no" (=1) to "definitely yes" (=10) whether they planned to improve their engagement practices in the future through reflection on current practice or participation in ongoing training, 43% chose the highest score (10), and 83% scored 8 and higher. With an average score of 8.7, **respondents clearly indicated an appreciation for continued learning and improvement in the area of outreach and engagement**.

The impact of PoP training was not limited to interpretive abilities and skills during outreach and engagement activities. Participating scientists report that the training changed their ability to position their academic research (3.8 on 5-point scale), helped in communicating their work to colleagues and decision makers (3.5 and 3.4, respectively), and helped their university mentoring and teaching (3.3 and 3.2, respectively) (Table 22). While moderate in degree, responses nonetheless indicate that **the benefits of participating in PoP extend to other aspect of a scientists' professional work.** Scientists do not report, though, that participation in PoP training improved their research – an average score of 2.3 on a 5-point scale should probably be considered negligible.

However, **some attributed rather significant changes in their career trajectory**. One respondent, for instance, wrote that *"during my training in PoP I was working as a postdoctoral fellow at a university with an interest in science communication and public engagement. I am now working full-time at a museum-science center. This is largely due to my training."* We don't know whether this person participated in PoP because of an existing desire to change careers, or whether PoP created the impetus for this career change. The distinction is somewhat irrelevant, though, since PoP clearly provided a platform through which the respondent was able to nurture a new career identity.

There were 94 more testimonials that illustrated ways in which PoP training, and more broadly participation in PoP, influenced the scientists (see Appendix 4, List 7). They verify the ratings in Table 22 through explanations of the mechanisms that improved grant writing, teaching, communicating research, or advising and mentoring. While not true for all participating scientists, PoP clearly created transferrable abilities and skills beyond the focused objectives of the project.

**Table 22: Scientist respondents' mean rating for the degree to which various professional practices have changed due their PoP training ("no change" (1) to "large change" (5). (N=262-264)**

| | Mean | Percentage n/a |
|---|---|---|
| Placing your research in a broader context | 3.8 | 3% |
| Communicating your work to colleagues | 3.5 | 2% |
| Communicating your work to decision makers | 3.4 | 16% |
| Mentoring and advising students | 3.3 | 15% |
| University teaching | 3.2 | 35% |
| Mentoring and advising staff | 2.7 | 48% |
| Staff training | 2.7 | 48% |
| Conducting research | 2.3 | 10% |
| Conducting administrative, management or other key job duties | 2.3 | 28% |

We asked respondents to share an example or personal story that illustrates how participating in PoPNet might have influenced them. The 103 resulting statements and vignettes can be found in Appendix 4, List 8. They ranged from short descriptions of impact to deep insights and reflections. Short statements about personal growth around communication were plentiful, similar to the three statements below:

> "I can communicate at all levels more effectively, from coworkers, to friends and strangers."
>
> "Participating in this public engagement makes me learn how to simplify my explanation to broader group of audiences. It also encourages me to see my value in sharing and giving to others."

> "I have a new appreciation of the first few sentences of a conversation. The invitation to participate. The sharing of something about myself, and the vice versa. The exchange of names. This is a skill that I will use for much more than just science outreach."

There were also many stories around motivation, about ways in which outreach helps with research:

> "It has helped my feel part of my community. This, for me, was the biggest impact, and a very important one. As a researcher, I often feel very isolated in the lab, and that my work will only have an impact in the long run. By adding outreach to my work, I can also know I am making an impact in the short term as well."

But there were also a variety of responses that described memorable encounters which made the respondent think deeply about their work or the relationship between science and the public, as the two following examples illustrate:

> "A little girl at a fruit & veggie botany dissection ran up to me to get a carrot because she was so excited about the science of plants. Her parents said she had never been so enthusiastic about anything before and they were planning to get her some botany books afterwards. As I continue to progress through my PhD program, I find a lot of my colleagues have given up on the general public - they feel as though people are just too stupid to understand science or logic. But having regular exposure to the public, I can attest that people *want* to learn and grow - they are just confronted by a Wild West of misinformation to navigate with very little training on how to discern the quality of information sources. I don't think I would see the roots of our systemic education failings without the PoP program tools, and without understanding the problem, you can never solve it."

> "Often times I feel burnt out when I get into the nitty-gritty of my research. Preparing for these public engagements reenergizes my love for what I'm doing. At one public engagement I showed off a game I hadn't worked [on] in months. That engagement was one of the most successful I've ever had. Three families said they were so glad they came to Sci-Port that day, two kids told their parents they wanted to download Unity (a free game making engine) when they got home, almost everyone said they learned something new about sound waves (the focus of the game), and there was a group of kids that stayed for an hour asking me questions about math and game design, and gave me suggestions that I have used to improve the game."

Finally, some responses indicated that participation in PoPNet may have contributed significantly to career enhancement or even career changes, away from conducting scientific research and towards science engagement and interpretation as a profession:

> "I am now a faculty member in Colorado, and am on a committee to help design a biology exhibit at a math and science center on campus. The training I received at the Natural History Museum has helped prepare me for this project."

"My increased participation in PES led me to apply for a fellowship to work on science policy, focusing on providing an overview of PES in different disciplines."

"Prior to participating in the PoP program, I had not considered a career in science communication. Now, I am actively seeking job opportunities that value science communication skills and opportunities."

"Because of my involvement in this program and other public engagement opportunities I had, I am now working full-time at a museum-science center to develop content for programming and exhibits."

"… the PoP program inspired a career change. Moving away from an isolated applied research setting and toward a broader science communication role was an excellent fit for me."

## *III. What elements of the program were and will be most helpful to participating scientists?*

Asked which PoP components scientists felt helped them improve the quality of their public engagement activities, **workshops on communication and engagement, and one-on-one support, both provided by the PoP home institution**, rated above 4 on a 5-point scale on the degree of helpfulness (Table 23). These were followed by logistical support, easy access to audiences, being informed regularly about opportunities to conduct outreach, and being connected to colleagues who are also engaged in outreach. All of these scored between 3.7 and 3.9 on a 5-point helpfulness scale. Additional information on public engagement in general, provided before or after the workshop, rated the lowest with 3.5.

When asked to rate which elements allowed them to conduct public engagement activities at a higher frequency than otherwise, **providing easy access** to the public rated by far the highest, with a score of 4.3 (Table 23). The other ratings were basically similar to those for quality, indicating that access to audiences is considered one of the biggest obstacles for how often scientists can engage in outreach. By simply providing continued access, PoP institutions are providing a valuable service to the research community.

**Table 23: Scientist respondents' mean rating for the degree to which the PoP program helped improve their public engagement or allowed them to do it at higher frequency. The rating varies from "not helpful" (1) to "extremely helpful" (5).**

| | Improve (n=236) | Increase (n=140) |
|---|---|---|
| Workshop(s) on communication and public engagement provided by my PoP institution | 4.4 | 4.1 |
| One-on-one support to develop and implement my own public engagement activity provided by my PoP institution | 4.2 | 4.0 |
| Logistical support for public engagement event(s) provided by my PoP institution | 3.9 | 3.9 |
| Easy access to public audiences provided by my PoP institution via emails, newsletters, websites, conference calls, etc. | 3.8 | 4.3 |
| Ongoing communications about public engagement opportunities or strategies provided by my PoP institution | 3.7 | 3.8 |
| Cohort of other scientists interested in public engagement | 3.7 | 3.6 |
| Additional information on public engagement provided before or after the PoP workshops | 3.5 | 3.4 |

We asked scientists to reflect on programmatic elements they considered most helpful for continuing with their efforts in public engagement (Table 24). Most of the suggestions provided to them rated at or above a score of 4 on a 5-point helpfulness scale. **Providing additional venues rated the highest (4.3), followed by new workshops that would provide additional science communication skills (4.2).** Combined, these two ratings suggest that **many scientists might now be ready to expand beyond their current scope or direction, and are interested in trying new things**. Contrast those ratings with the 3.5 score for a refresher workshop: participants are willing to expand, rather than to revisit. Technical support of various kinds (including evaluation) and opportunities to engage in reflective discussions around best practices rated relatively high (4.0). The latter stands in contrast with a more passive mechanism for engaging around ideas for effective public engagement strategies: online reminders, which rated lowest of all the given options (3.3).

**Table 24: Scientist respondents' mean rating and standard deviation (SD) for factors that help continue to conduct public engagement activities. The rating varies from "not helpful" (1) to "extremely helpful" (5). (N=139-142)**

| | Mean |
|---|---|
| Additional venues for public engagement | 4.3 |
| New workshop(s) to build additional science communication skills | 4.2 |
| Getting online reminders of public engagement opportunities | 4.1 |
| Technical support for designing more outreach activities | 4.1 |
| Support for evaluating my performance (i.e., quality of my work and its impact) | 4.0 |
| Active discussions (with PoP scientists and professional educators) on best public-engagement practices | 4.0 |
| Refresher workshop | 3.5 |
| Getting online reminders of effective public engagement strategies | 3.3 |

We asked participating scientists to describe any components of the PoP program that they considered "extremely helpful" to improving their public engagement and that had not been offered as options in the rating questions. Of the 29 answers given, the following categories emerged: learning by and from doing/experimenting; feedback from educators or audiences after events; observing others who conduct outreach as examples; exchanging ideas with colleagues in cohorts and networking with them; being provided a safe environment in which to encounter audiences; and being supported by excellent, dedicated and motivating PoP staff.

We asked a similar question about additional program elements that were extremely helpful in increasing frequency of outreach or help continue conducting outreach at the current level. The following (additional) ideas emerged from the 29 answers given: providing opportunities to practice and

experiment; various forms of feedback from peers and educators; the quality of PoP staff; being part of a cohort or network of (local) colleagues (potentially through a virtual community), and recognition of PoP activities for employers (letters of appreciation) all were identified as additional factors that might increase outreach frequency of participating PoP scientists.

## *IV. Does career stage influence how participating scientists engage audiences and experience PoPNet?*

Most of the PoPNet scientists identified as early career or emerging professionals (71%). One might reasonably assume that motivation and opportunity for outreach and public engagement might differ considerably according to career stage. The general hypothesis is that doctoral students and postdocs are more inclined to do more and different type of outreach than senior professionals, and that mid-career professionals might be the most limited group in terms of outreach. The data suggest, though, that **overall career stage was not an important factor in this study**.

A cross-tabulation of scientist data by career stage, for instance, reveals **no major difference in motivation for outreach between the groups**, with one minor exception. Emerging professionals rated about a point higher than mid-career or senior professionals (3.9 vs. 3.0) "increasing the odds for obtaining research funding" as important reason for engaging in outreach. However, the item was rated low overall, and thus seems simply even less important to more senior scientists.

Overall, **seniority made little difference in the way participating scientists conducted outreach or were impacted by their participation in PoPNet**. Somewhat predictably, senior professionals were more likely to use lectures and demonstrations in their outreach than either early- or mid-career scientists (by about 20-30%). Nonetheless, all senior scientists engage in hands-on activities as well. They might simply encounter more opportunities for public speaking than less established (and hence less known) scientists. In terms of PoP program elements that are particularly helpful for conducting outreach, senior researchers were rating access to audiences higher than their colleagues, while early career scientists rated being in a cohort of like-minded scientists slightly higher than the others. The effects are small, though. Early career scientists were also slightly more willing to improve their outreach in the future (8.9 vs 8.4 vs 8.0), but again, the effect is somewhat negligible.

# Appendix 1: Methodology

*Overall Approach:* The evaluation questions were answered using primarily a written questionnaire with closed-ended rating questions and constructed answers questions. Some of the constructed answers were freestanding and addressed particular research questions; others were designed to elaborate on ratings.

*Survey Construction:* Two distinct questionnaires were developed: one for staff of participating PoPNet institutions, and one for scientists participating in PoP implementation at these institutions. Both were built on existing questionnaires used for formative evaluation of this project, and on national surveys of scientists about outreach (Besley, Dudo & Storksdieck, 2015; Dudo & Besley, 2016). Questionnaires items were chosen or developed *de novo* based on pre-determined concepts linked to the hypothesized outcomes of the project. The questionnaires were iterated with staff of the PI institution to guarantee appropriateness of items, both conceptually and with respect to terminology. Final draft versions of the questionnaires were pilot-tested with a small number of likely respondents, revised and reviewed in final version by the evaluation and the project team. The questionnaires were designed and implemented on Qualtrics.

*Sampling:* The program staff at the PI institution identified all local site coordinators and invited them to distribute a link to the online questionnaires, using standardized language (see Appendix 2). The request was shared with site coordinators around August 15, 2016. It was assumed that site coordinators would need up to two weeks to share the request with staff and scientists. They were asked to sens a reminder after two weeks, and a final note after three weeks post requesting participation. The total length of time during which the surveys were accessible was scheduled to be four weeks, but last responses for staff were recorded on September 20, 2016 and for scientists on October 19, 2016.

*Data Analysis:* Data were mostly analyzed using summary descriptive statistics, such as frequency distributions, means and standard deviations. We did not hypothesize from the sample to a larger population as the sample itself represented the population in question. Consequently, we did not conduct inferential statistics. Constructed answers were analyzed using iterative content analysis that extracted major trends from the data. We did not attempt to quantify most of the constructed answers since the nature of the questions was conceptual, and analysis was focused on identifying typical answers.

# Appendix 2: Sampling Procedures

**Email to the local PoPNet site coordinators:**

**Survey to help us document the potential impact of the Portal to the Public Network (PoPNet)**

Dear [Name],
We are ready to hear from the growing PoP community how our network of now 52 sites is doing, what value it provides, and how the network might have influenced you, your colleagues, institutions and participating scientists. And we would need your help with that!

We appreciate that some of you have been involved in the past and might currently not be as connected or active anymore; nonetheless, we would love to hear from you, your colleagues and your science-based professionals.

We have created two questionnaires that will help us understand the network's impact. One will capture feedback from you and your PoP colleagues at your institution. The second one will capture feedback from current and past science-based professionals who have been actively involved in your local PoP/outreach efforts. We would need your help in distributing the surveys to both.

We hope that you can identify those colleagues who are currently working on PoP at your institutions, or have been involved in the immediate past, and share the Staff Questionnaire Link with them, using the attached invitational text. Secondly, we hope you could share a link to the "scientist" questionnaire using the appropriate invitational text (attached) with all the current and past scientist participants for whom you have emails still.

And, of course, we would want you to fill out the staff questionnaire yourself.

The results from this survey will be essential to help us document how public funding from the National Science Foundation might have benefited science and society. We hope that you'd be able to distribute the questionnaires within the next few days, and we'd be most happy to answer any questions or concerns you might have.

Thank you so much for your help!
Eve or Anna

**Procedure for contacting your colleagues:**

1. Email Link with cover letter (copy/paste into your email from below text following **Staff invitation to complete the questionnaire**) to your colleagues; ideally you can email them individually. Invite the persons at your institutions who are working with you on PoP, or have done so in the past two years. If you have questions who should be invited, you can call Eve or Anna.
2. Make note of who you sent the email to and tally the number. The former allows you to sent a reminder in about 2 weeks, the latter allows us to estimate the response rate.

3. Let us know when you have emailed your colleagues, so that we can start "the clock" for responding (2 weeks). This will also allow us to sent you a text that you can use after two weeks to thank your colleagues for filing out the survey (if they did), and to remind those who did not yet had a chance to fill it out.
4. In about three weeks we will provide you with a thank you note to your colleagues for participating in the survey. The note will have a P.S. that the survey will be open for another day and then close.
5. Of course, don't forget to fill it out yourself ;o).

**Procedure for contacting your science-based professionals:**

1. Email Link with cover letter (copy/paste into your email from below text following **Scientist invitation to complete the questionnaire**) to all the science-based professionals who have participated in your program; ideally you can email them individually (depending on the numbers), but feel free to email in bulk.
2. We count as "participating science-based professionals" all who have been working with you under the Portal to the Public banner; at a minimum, they will all have gone through the initial PoP training. We appreciate that some may not have been very a ctive afterwards, but that is OK. And we also acknowledge that you may not have contact information for all of the ones who participated in the past. That is OK as well. No need to chase any of this. Email to those for who you have contact info. If you have questions who should be invited, you can call Eve or Anna.
3. Make note of who you sent the email to and tally the number. The former allows you to sent a reminder in about 2 weeks, the latter allows us to estimate the response rate. Note whose email bounces. If there is an alternative email, try that one instead and make a note of that.
4. Let us know when you have emailed the scientists or science-based professionals, so that we can start "the clock" for responding (2 weeks). This will also allow us to sent you a text that you can use after two weeks to thank the group for filing out the survey (if they did), and to remind those who did not yet had a chance to fill it out.
5. In about three weeks we will provide you with a thank you note to your "scientists" for participating in the survey. The note will have a P.S. that the survey will be open for another day and then close.
6. Of course, this one you don't have to complete yourself ;o).

**For email to staff: Staff invitation to complete the questionnaire**

Subject line: Please help with the evaluation of our [insert PoPNet or your name, should you have used a different one, here] program

Dear [Name of Colleague],
I am writing you today to ask for your help. We are doing a little study to document the potential impact of the Portal to the Public Network (PoPNet), a federally-funded outreach program that helps informal-science-education professionals, like you, who are supporting scientists in public engagement at your institution. We are asking for your feedback because you provided leadership, made operational decisions, and/or trained scientists as a part of PoPNet. While you may have been involved with PoP before 2011, this survey asks about your potential involvement during any time of the 5-year PoPNet program (2011-2016). The following online survey should take about 15 minutes to complete. Your participation and your answers will be confidential; the evaluators will not share them with others. Taking part in this survey is completely voluntary, but filling out the survey will be of tremendous help to us.

Thank you so much for your help!
[Your signature]

Here is the link to the survey:
http://oregonstate.qualtrics.com/SE/?SID=SV_23KGJwBK5RpUCPj

P.S.: If you have any questions or comments about this study, feel free to contact the Portal to the Public evaluators:

Martin Storksdieck
Oregon State University (OSU)
Storksdieck@oregonstate.edu
Phone: 541-737-8666

Cathlyn Stylinski
University of Maryland Center for Environmental Science
cstylinski@umces.edu
Phone: 301-689-7272

**Scientist invitation to complete the questionnaire**

Subject line: Please help with the evaluation of our [your name here] program

Dear [Name of "scientist" or – in case of bulk email, colleague],
I am writing you today to ask for your help. We are doing a little study to document the impact of Portal to the Public (PoP), a federally-funded outreach program that supports science-based professionals, like you, who are engaging the public with their work (i.e., public engagement). We are asking you for feedback because you worked with us to create public programming related to your research. The following online survey should take about 15 minutes to complete. Your participation, and your answers will be confidential. Taking part in this survey is completely voluntary, but filling out the survey will be of tremendous help to us.

Thank you so much for your help!
[Your signature]

Here is the link to the survey:
http://oregonstate.qualtrics.com/SE/?SID=SV_0IE8hGWJXaOAPaZ

P.S.: If you have any questions or comments about this study, feel free to contact the Portal to the Public evaluators:

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# Appendix 3: Staff Survey

**List 1: Referring to the list above, describe key significant changes that you have made to your implementation of the PoP Framework, including new key strategies that you have tried but which were not part of your initial implementation plan. If applicable, write, "I haven't made any changes." [N=52]**

1. At UW-Madison we have long used Exploration Stations as a way for researchers to develop their skills of chatting one-on-one, one-on-two, one-on-a-few with visitors of all ages. The Portal program gave cachet to those efforts and gave us the occasion to establish the Wisconsin Idea STEM Fellows Program to acknowledge the achievements of researchers who share their science through conversation, in contrast to those who do one-way mass media.
2. Experimented with communication strategies as applied to social media interactions as well
3. We haven't made many changes, except that, for funding reasons, we were working more with alumni than with new cohorts of scientists. Thus, we'd gotten away a little from the active community building and recognition. Our alumni scientists have basically become integrated into the Explora family and, thus, were treated less as special guests. We are currently recruiting for a brand new cohort, however, and we have a new team in place that just attended the PoPNet Booster Shot workshops. Most of the original PoP elements and characteristics have been incorporated back into our program now. We're even trying the "Science Communication Fellows" language, which we've never tried before.
4. I haven't made any changes.
5. As a fairly new member, we have completed two cohorts, are still working from our initial implementation plan, and have not made changes.
6. I have introduced some new activities that have been shared with the network since we have joined (still PoP curriculum).
7. I haven't made any changes.
8. There was an issue with sustainability after the initial implementation of the PoP Framework. For our current implementation plan, we are trying to put more measure in place to better assure program longevity. These include involving other departments, involving youth from our Cr3w program, increased communication between PoP staff at our institution, and employing better (and other site-tested) evaluation methods.
9. We're working hard to align our Portal efforts more closely with our Development team's work; our two groups are each trying to engage the same companies across the region, so we want to coordinate our asks more carefully. We're also more focused on building ongoing support for our participating scientists and building a sense of community among the Fellows.
10. offering build sessions to set aside time for our participants in any cohort to come work on their activities and get mentoring help. These sessions are drop in for 2-4 hour periods with access to supplies and tools for completing their station
11. Our PoP focused on museum researchers (not outside), focused on improving communication for "expert is in" program rather than on activity development, and incorporated joint teen/mentor workshops.
12. We are in the process of formalizing arrangements with area universities to incentivize graduate students to participate in Frost Science (formerly Miami Science Museum) science communication program by receiving credit, travel stipends to conferences, and other options.
13. I haven't made any changes.
14. I left Explora in 2013 so I have not been involved in that work since then (hence all of the blanks in the middle column).
15. Not sure
16. We have added a mentorship program that will make PoP more sustainable in our institution. We have more staff and more departments involved to make the program relevant in our entire museum.
17. It has become a slightly less formal process over the past few years--tailored more to individuals than groups.
18. Explora hasn't made any key significant changes
19. I haven't made any changes.

20. I haven't made any changes.
21. We have spent more effort on individualized support for scientists, including creation of a hands-on activity. We also broadened the venue(s) for our Scientist Spotlight by taking the scientists into the general community ("Science in the City" at an outdoor shopping mall)
22. Most of the initial framework has stayed the same however we have developed a fee structure and a local university is paying to have their researchers take part in the program.
23. Other staff members have taken over all PoP duties and correspondence as I have moved into a new position. So I am unsure of our current framework and plans.
24. We had a dedicated event to get feedback from and appreciate our PoP Scientists as we were rebooting our program.
25. I haven't made any changes
26. Since our first training in 2012 we have made significant changes to the program, the biggest being our ongoing relationship with the BEST (Broadening Experiences in Scientific Training) program at the University of Rochester. This relationship has included funding for staff time and materials so I was able to spend more time on this project. Also, my new immediate supervisor and I were able to attend the Booster Workshop so I was able to get buy in from her as well as our new VP.
27. Follow up workshops to help scientists engage the very young or the very old. Also new modules being developed that focus on Teen audience
28. Our implementation has remained dormant since our initial implementation. It will wake up one of these days when the stars realign.
29. We have implemented PoP PD elements in other trainings - not formal workshops but for volunteers, part-time staff and scientists participating in "events" where we provide the activities.
30. I haven't made any changes.
31. We are currently assessing what changes will be made to make it financially sustainable.
32. Due to staff changes, Adventure Science Center has been unable to support its Portal program for the past year, but we are currently working on plans to revive the program this fall. Two new educators attended the Booster Shot workshop this spring, and our four person team, which includes our new volunteer coordinator looks forward to reaching our to previous participants and recruiting a new cohort of science professionals this fall. Changes in our implementation include the addition of ASC's volunteer and facility events coordinators to our POP team, increased involvement of other departments, revisions of expectations for participating scientists, participant use of current ASC floor cart activities in the initial phase of professional development and the addtion of prototyping workshops during the process of project development.
33. Added an additional training workshop to focus on giving a good lecture (TED Talk style). Require participating scientist to participate in two open-house format programs, as well as one informal lecture. Altered the original PoP plan/format to better meet the needs of our scientists, as well as the programs they support here at the Museum. Are using past Fellows to help train new Fellows on the specifics of the Museum programs they will run.
34. I have maintained a working relationship with some of our original PoP scientists. When I have the opportunity to engage with a POP scientist we discuss facilitation approaches and what they have been learning from their interaction with the public at Explora.
35. Since we are so new with PopNet, we have not made any changes. We are still implementing it
36. Increased focus on training for the scientist-public interaction. Essentially more practice with staff before going to the floor.
37. This is our first year, so we haven't made any changes.
38. As an institution we have not made major significant changes to our implementation of the PoP Framework. Our initial implementation plan was successful and has continued to be so for several rounds since.
39. We are currently getting organized to start our initial implementation, so we plan to do many of the items listed above, but haven't yet as we are still in the planning stages. We plan to roll out our PoPNet program/course in the spring. We also haven't made any changes to our plan yet.
40. I haven't made any changes
41. We've expanded and grown. We've evolved the program to be a fee-based tuition model for scientists, deepened partnerships with universities (even running a workshop series at OSU), and expanded public

program offerings (bringing scientists to outreach science fests, OMSI After Dark, Teacher Evenings, Family Science Nights, Science Pubs, etc.).

42. I haven't made any changes
43. We had hoped we'd have more success recruiting corporate STEM professionals than we have. We work with several research institutions on training workshops but they aren't formal or fee-based.
44. People closer to the day-to-day operation can answer this better
45. The key change we made was around appreciation opportunities and having the work the scientist do be more central to our public programs plans moving forward.
46. I haven't made any changes as we are not running this program.
47. We have added social events such as happy hours, and begun inviting previous Fellows to review the demos of new Fellows at our prototyping workshops. We have also begun offering one-off PD workshops that are free to Fellows and a fee for non-Fellows. We hosted a cohort on-site at a university.
48. We have developed a shorter, more intensive training program for our Portal Scientists who have limited availability, and are unrolling it next month. We have decided to add this to our implementation plan, for 2 training programs and sets of scientists per year.
49. I haven't made any changes.
50. I haven't made any changes
51. I haven't made any changes
52. When we first implemented, we had one group of students from one program, who together developed 2-3 demos. We did not have individual meetings with these students. Now we have Fellows apply on an individual basis, pay a tuition fee, and each develop their own demo.

**List 2:** ***How has being part of PoPNet helped advance your broader institutional goals? This might include making connections to the local scientific community, bringing in scientific expertise into my institution, and enhancing the public's view of the scientific integrity of our education programs. If applicable, write, "I don't know."*** **[N=56]**

53. Making connections to local scientific community, connecting the public with real and current research
54. PoPNet allowed Explora to form and maintain valuable partnerships with the scientific community that lead to additional scientific participation with exhibits and visitor services. It enhanced public's view and knowledge of scientific concepts and helped to make many of our local scientists and their ideas accessible and understandable.
55. It has helped us to bring in real scientists to interact with our guests.
56. PoP has strengthened our public programs, shown our visitors that scientists are neighbors in our community, enhanced our relationships with local STEM professionals who can help in many different ways, expanded our volunteer pool, and developed new content expertise among educators and exhibit developers on staff.
57. PoPNet increased the our audience's awareness of scientific research. Students especially learned about how the scientists got started, what their career paths were like. This often surprised them. It also allowed us to better connect with founding donors and Board members. PoPNet gave us another super science program that meets our 21st century needs.
58. PoP has allowed us to engage with the broader scientist community in a new way to create a collegial environment of experts. We are viewed in a new light being able to support their endeavors and needs through meeting our own with public experience.
59. One of our institutional goals is becoming a regional science hub, for all ages. Not only do the scientists help us keep involved in current science but it gives us an opportunity to educate an entire new science audience, the scientists themselves!
60. We are still in the beginning stages.
61. Being a part of PoPNet has given us access to other institution's program resources and evaluation methods. These additional resources have helped advance our institutional goal of using scientific expertise to confirm and enhance our program content. PoPNet staff at other institutions have also connected us with members of our local scientific community.

62. For many years PoP was seen as somewhat peripheral to the core work of the institution, but under new leadership this work is absolutely core to our focus on connecting our guests with active, local science.
63. helping internal scientists share their science with others
64. enhanced connections between researchers and educators within institution; improved communication strategies
65. The initial training and workshop resources provided were excellent. The mentoring during the initial implementation phase was also very useful at keeping our institution focused.
66. The structure of PoPNet helped to support work we wanted to undertake but hadn't yet started. Participation in the project forced us to assign staff time and effort and gave a great platform to experiment with the work and learn from peer institutions.
67. PoPNet has helped us to strengthen our connection and relationships with our parent institution, Baylor University. In addition, it has allowed us to
68. The booster workshop was great for jump-starting a struggling program! We heard from a variety of institutions and got lots of ideas on strategies for best implementing PoP. It was great that we could fit all of that into the short amount of time we were together.
69. It has helped our institution work with our University partner's scientists to help them achieve broader impact requirements in a more meaningful way for our visitors, and to has helped us develop longer lasting more robust relationships.
70. All of the above, + the role of facilitating the engagement of visitors and community members with STEM
71. Having a coordinated way to train volunteer scientists and communicate with them
72. I haven't really been a part of PoPNet.
73. Created a greater sense of community on campus among outreach staff
74. Being part of PoPNet helps us address our strategic plan, in particular Strategic Heading 3: Lead in the Dissemination of New, Relevant Science; 2. Form partnerships with organizations and universities that are now generating new STEM in the region for public dissemination; 3. Increase adult education opportunities at Sci-Port both in-center and through outreach; 4. Continue to collaborate with area institutions; and 5. Create and promote a culture of STEM literacy
75. Part of our strategic plan is to bring together researchers and cutting edge STEM with the general public. This has been an excellent tool to help achieve this mission. We find that the researchers are more connected with the institution after participating the PoP workshops.
76. We helped quite a few scientists develop their communication skills. Unfortunately, most "seasoned" scientists thought they do not need this training, but it's "great for my students." When actually, younger scientists are more engaged with public whereas older tend to be weaker in this area.
77. Having PoP scientists on the floor has helped visitors understand the scope of scientific research being done in our community. Some of our PoP scientists have also helped educators create and refine their programs.
78. Public awareness of science is part of strategic goals for institution
79. PoPNet has helped us bring local, current science into our museum. We are slowly becoming the "place to go" when a Broader Impact requirement is needed. PoP has given us the ability to have a larger relationship with local universities, which has been beneficial to the RMSC as well as the university. PoP has also allowed us to bring our community together to learn about current science research happening in our visitors own town.
80. We want to reach all audiences, and improve the public's understanding of science, as well as see themselves as scientists and meet scientists in their community. PoPNet has helped all these things.
81. We are looking for new ways to meaningfully engage scientists with children and adults.
82. It has neither helped nor hurt, we are hoping that it will help in the long run bring scientists into a more diverse array of educational programming than they currently participate in, however there are things shifting over our heads about the role our internal scientists play with the public that are putting our dreams on hold for the moment.
83. We've been able to make a better case for inclusion as a partner for Broader Impacts.
84. It has guided how we approach professional development in other aspects of our institution.
85. Increased engagement with STEM professionals, higher education institutions, and corporations.
86. ASC's Portal program helped the science center formalize and strengthen its connections with engineering groups, university research teams, medical professionals, government science professionals and other

scientists in Middle Tennessee. In addition, information shared with student and general public audiences by Portal scientists have helped ASC accomplish its mission of igniting curiosity and inspiring visitors to pursue the lifelong discovery of science.

87. Better levering our connection to the University. Better utilizing our own collection staff. Better representing the researching going on inside the Museum. Adding to the public's' excitement and curiosity in the natural world. Deepening connections to scientists for future collaboration and projects.
88. connections with professionals active in current research.
89. I advocate for the PoP program any time I meet any of our community scientists or engineers. I sometimes advise local students on their science projects and try to connect them to a scientist who can be their role model and advisor on their project. When I am at local schools I encourage students and teachers to come to Explora to meet a PoP scientist.
90. We are looking forward to attending our first ASTC conference in September and meeting informally with other PopNet institutions around the country.
91. All of the above and showing our visitors that Scientists are "regular" members of our community who enjoy sharing their passion with learners of all ages. It also provides a forum to discuss cutting edge scientific ideas with actual scientists.
92. Raising awareness of our institution in our local community (via outreach event), meeting broader impact goals by training scientists in our community to be better communicators, workforce development (giving graduate students marketable skills)
93. PopNet has helped us to work with other departments across campus.
94. Being a PoPNet site has allowed our institution to broaden our connections within the local scientific community, as well as deepen any existing relationships that were in place from before joining PoPNet. We now have a rich (and growing) pool of scientists willing to share their work and expertise with the museums, beyond their initial involvement through the PoP program, which has meant an increase in the number of "expert" lead programs we are able to offer.
95. We are just beginning to get started, but we hope to increase connections with scientists and engineers on campus and connect those scientists and engineers with the public to enhance and improve scientific integrity in statewide STEM education programs and recruit students into these fields.
96. PoPNet helped bring neuroscience down to a level that all people could understand.
97. PoP helps us deepen relationships with our scientific community (with a concrete platform and method for participation). It also helps us act as a trailhead for our visitors--inspiring interest in STEM and connecting them to the web of resources in our community. The program also helps keep the visitor experience fresh (something new at least once a month!).
98. I do not know. I haven't worked directly with PoPNet
99. has increased opportunities to reach out to local universities and research centers helps us strengthen collaborations. also helps us bring more scientists to the museum and programs to our visitors. we see older children attending during the programs.
100. It has identified the institution as a national leader in science communication and advancing efforts that can be duplicated across the country.
101. The PoPNet program at our institution has led to broader partnerships and participation from the scientific community at almost all of our local universities and institutions. It has also provided a bridge for our visitors to engage with local scientists in meaningful ways and is very popular with our visitors.
102. Our hope had been to expand the visitor interaction with our scientists but soon after we returned from Seattle new plans were put in place to combine our research and conservation departments. PoP was put on hold until more plans could be made around the new staffing in these departments.
103. It has helped us make connections to the scientific community which we've used to improve programs across the museum, found us corporate sponsors, and added value to the museum experience for visitors.
104. Participation in PoPNet has been a key element in aligning with our institution's strategic plan goals - primarily as a university botanical garden to showcase university research and connect to the general public, as well as to broaden the STEAM-related programming we offer for all ages.
105. this program has been instrumental in helping us reach some of our strategic goals
106. NHMU has always had a commitment to science communication. PoP excellent planning model and training materials made it possible for us to formalize the way we train our scientists. PoP also connected us with

the science communication community of practice, which has been extremely helpful. We now know who to call when we need help on a science communication related challenge.

107. all of the above!
108. Acknowledgement of researchers' willingness to share science.

**List 3: EXTENDED IMPACT ITEM: Explanations given for choice on question "Involving scientists in outreach is now integral part of your institution".**

**Yes, it is true:**

1. Our Science Communication Fellows Program has become a regularly recurring program, and participating scientists have consistently been actively involved in public events.
2. Albuquerque's scientific community has become integral in many areas of the museum's culture and has partnered with Explora on a number outreach projects
3. We have invited scientists in the past to participate in outreach, and continue to do so today.
4. It always has been. As a research university involving scientists in outreach has been a part of the mission since 1904
5. This was true before our involvement in PoP through other institutional initiatives and other national collaborative projects like the NISE Network.
6. …and always has been true
7. Research and Collections based museum
8. Involving scientist has ways been a big part of our institutional goals but after joining PoPNet it has become an even larger goal than we ever imagined.
9. We continue to run public programs with PoP Scientists. We will be starting another cohort this fall and we are broadening it to also include Teen Science Cafe'.
10. We think about how scientists can enhance the visitors' experience - and are better able to communicate the importance of the visitors' experience
11. This is a pillar of our engagement strategy
12. We now have two retired scientists on our staff who are charged with facilitating family science events as part of our outreach to local schools.
13. It is part of our strategic plan, but we are still new in developing those relationships with scientists on Baylor University's campus.
14. We have scientists from the original group who still come to the museum to set up their kits with the public. Some, but less, take their kits outside the museum
15. Once we started working with a few scientists, the word spread quickly.
16. The Children's Museum doesn't hold scientists accountable for outreach, but they do use it as a tool to help visitors learn and understand science in different ways.
17. We recruit 2 cohorts and do 2 trainings each year. Recruitment is ongoing opportunity that is mentioned to STEM professionals by all staff
18. Our CEO would like us to have scientists on the floor of the museum every weekend.
19. Whenever possible, we include our trained scientists in our outreach programs in the community, or with outreach endeavors at our site.
20. As mentioned, it aligns perfectly with one of our strategic plan goals, and we hope to keep expanding our programs and relationships.
21. PoP has helped the museum further NHMU's mission: Foster an understanding of science as a journey of discovery and wonder; Promote the preservation of biological and cultural diversity; Encourage new perspectives on and inspire passion for the natural world; Celebrate Utah's native peoples and cultures; Showcase Utah's unique and extraordinary environments; Demonstrate the myriad links connecting the past, present and future. Transcend scientific disciplines to reveal the networks inherent in nature; Serve as center for science literacy, acting as a bridge between the scientific community and the public; and, Empower people to make thoughtful decisions about the future.
22. Always has been.

**Yes, it is partially true**

1. We have a regular meet a scientist event and the PoP program is the avenue to get more scientists participating in it.
2. In addition to our PoP public programs, we've added Teen Science Cafes with local scientists, Science on Tap programs with UNM, Science Cafes with KNME (public TV), and we've added more scientists to the pool of volunteers working with exhibits and programs.
3. Our onsite programming has been stronger with scientists, but we have not utilized them enough with outreach. This is a goal we still have in place.
4. We are still working to re-establish our PoP program, to be called "Scientist on Site". We do currently involve scientists in outreach for other existing programs, such as Science Cafes and Camp programs.
5. We're working on it! Our first cohort of the new era of PoP at ASC is beginning this month!
6. While I don't have my finger on the PoP pulse anymore, we still run PoP programming periodically.
7. We involved scientists in outreach when it was a PoPNet specific event, and for some special events, but we would like to include scientists in more events on a regular basis.
8. We have always involved scientist however the buy-in from scientist is now deeper.
9. Unlike most PoPNet members, our institution is built around scientists, but this program helps us to focus on teaching them outreach skills.
10. We do have several programs that involve scientists in outreach (Science Fair, Women in STEM Conference, Campus STEM visits, STEM Saturday, etc.), but we are still working to get buy-in from upper-administration, so that this will become an integral part of the institution.
11. I think that partnerships with scientists has always been an integral part of what we do. PoP helped us create one more (and perhaps the richest) avenue for these collaborations.
12. It has become a major program, but many things happen without them, and they are occasionally moved in place of another event.
13. When creating programs or events, we often explore ways to see if we can utilize the talents of our scientist contacts.
14. More departments are seeing the need for scientists to do outreach beyond a lecture. We're hoping this will continue to grow!
15. Fellows come to many events here and in the community, but they're a "bonus" addition more than an integral part of the institution at this point. They enhance the programs greatly, but the museum could also get by without them.
16. we have our PoPnet scientists participate in several of our events.

**Not True**

1. Our scientists do not take part in outreach, only in special PoP events on the floor 6 times a year.
2. It has not changed since our implementation. We still have scientists as integral roles in the same educational programs as when we started. We wanted more variety of educational programs as a result of pop, but it hasn't happened.
3. We have been having difficulty gaining more traction with scientists to show them the value of participation.

**Not sure**

4. We are just beginning to train scientists.

**List 4: Role of the Network in embedding scientist outreach into institution:**

***What was the role of the network, if any, in making the involvement of scientists in public engagement an integral part of your institution?***

1. The strategies and curriculum, and initial support of our mentor were key in initiating the program and providing the conceptual basis for our activities
2. Explora has been a part of PoP since the beginning of the network. Some participants from the first cohorts are still part our regular programming.

3. Our initial involved in the three-year Portal to the Public NSF funding played the biggest role; next was our relationship with CU Discovery and our collaboration with them and the Teen Science Cafe Network.
4. The network provided an excellent, well thought out training program. The foundation provided by the staff at the Pacific Science Center through the workshops and the wonderful notebook, gave our staff and scientists confidence.
5. The network has enabled us to better train the scientists we are bringing in for outreach purposes.
6. PoPNet has given us the tested and proven resources to successfully increase the involvement of scientists in public engagement at our institution.
7. scientists were already an integral part of our outreach, but PoP helped structure and enhance the relationship.
8. It gave us a focus and framework, training for a key cohort of staff, and some excellent NSF/IMLS resources that validated the initial formal training we were able to provide. It also helped us build up internal language for talking about this program to gain support for it in-house, including among some senior staff (like our Chief Scientist) who were initially skeptical, but are now believers.
9. It's great to hear what other museums are doing, get advice, troubleshooting suggestions and encouragement!
10. Supportive
11. Gave it a framework
12. It's mostly about helping the participants ("scientists") communicate more effectively with people who aren't familiar with science concepts.
13. allowed us to establish a "named" training program--Wisconsin Idea STEM Fellows program
14. Absolutely essential. Participating in PoPNet gave us the tools and the confidence to involve scientists in outreach to the point that we now consider scientists as integral as evaluation: in other words, instead of making a special program for scientists, we plan to involve scientists in virtually every major project.
15. The network help to refine our speech in working with universities to include broader impacts. Because of this understanding, we were able to partner with universities in other ways than just at our center. We have now hosted camps off-site at local universities and have sponsored days from one university.
16. We did it well before PoP Net, but we improved allot after being part of the network
17. so many scientists had not idea how to talk to the public, this was perfect to them and they pass on tips to others that were not in the workshops
18. PoP played a large part in this because it showed our institution that we would bring in local science experts and it could be educational and FUN for our visitors. Because of PoP we have found funding for some of these trainings as well as have been written into grants for Broadening Impacts which has also made the involvement of scientists integral the the RMSC.
19. Integral to having a training program which gets scientists ready for our preferred type of engagement.
20. It helped us to be more systematic in our approach
21. It gave us an additional way to engage with STEM professionals.
22. Members of the network's team provided new ideas and ongoing support and encouragement for implementing ASC's Portal Project.within the structue of our organization.
23. I don't know.
24. The organization of it, the activities and all of the resources that it offers
25. I am an exhibit developer and using the network wasn't something I did regularly. Others outside the exhibit group likely made more consistent use of the network.
26. The PoP materials and guidance from PoPNet staff at the PSC and our mentors at Science Central gave us the push to offer professional development in public engagement for an internship program that previously lacked any formal PD opportunities. We are going to keep the PoP hat tightly on and continue to make PD in public engagement part of our toolkit and market it as one of our strengths.
27. The network gave us the tools to work with scientists.
28. We are still working on it. PoPNet has helped, because we are now part of a national network of institutions with the same purpose, which gives credibility to our efforts.
29. It helped the scientists to feel more comfortable with our visitor population.
30. I'm not sure how to answer this. I think our membership in the network gave us a foundation for this work.
31. I don't know the extent of the network's role.

32. Implementation plan, training with a team, national network and affiliation
33. Given that we started the network, it not possible to answer this question
34. The network provided an initial foundation and credibility (with its NSF/IMLS funding).
35. None that I can think of at this time.
36. almost all of our involvement of scientists in public engagement was due to POPNet
37. The guidance offered by staff at Pacific Science Center, our mentor, and discussions with other institutions helped us create, and evaluate our program. Resources offered through the website have also been invaluable.
38. i think it helped to establish an ongoing interest for researchers and grad students to desire to improve their communication skills for outreach purposes
39. Scientist already played an integral part of our institution's public engagement. PoP helped us improve the training we give our scientists.
40. Meet a Scientist is a reoccurring monthly event that is super popular, and we've tried to incorporate scientists into many areas of our public programs including omsi after dark, outreach science festivals, teacher pubs, etc.

**List 5:** ***Please share anything else that would help us understand the value of this PoPNet to you and/or your institution*****.**

1. The PoP program at explora has been a valued and integral part of explora programs and led to a number of collaborations. Explora's visitors have expressed great interest and joy during the programs and love meeting the scientists and the opportunity to engage with their ideas in a hands on way. Meeting and working with the scientist has been exciting, informative, engaging and a true pleasure!
2. Great program! Wonderful support systems. We have continued to use our training for staff meetings, volunteer enhancement, and other groups of scientists not in a PoPNet cohort.
3. We are currently working on a business model for PoP at our institution to create a self sustaining program.
4. I think this program is well laid out, well tested, and not only facilitates communication between scientists and the public, but also between informal science institutions and networks of science organizations.
5. I am no longer at NMNH, so can't say anything with certainty about the current situation there. I can say PoPNet helped a larger group of people there think about how to engage researchers in outreach and improve communication of research to different public audiences. Also, I have taken PoPNet lessons/approach with me and will incorporate as applicable in my new institution.
6. Our science communication program is an integral part of our strategy to delivery a wide range of cutting edge science on a regular basis. By recruiting a diversity of scientists this program also supports our STEM career pipeline initiative to the extent that scientists serve as inspiring role models to youth and children who engage with them at our museum.
7. We plan to continue PoPNet programming but programming is on hold right now given other priority initiatives and shifts in staffing.
8. I really appreciate all of the input/advice, as well as the reminders of how important this project is.
9. I understand that we are one of only a few universities involved in the program. I think it is valuable. The weakness is that it only promotes a very limited type of educational outreach - making tabletop interactive exhibits. It does not promote or provide training for long-term community partnerships and collaborations - things that will truly make a difference.
10. The website is also useful, and we are proud to be a member of PoPNet.
11. Our organization is committed to the PoP program. Scientist that go through the program are more likely to volunteer on a consistent basis in a way that relates well to the general public.
12. We have had some staff changes but I hope that we can train others in the techniques
13. PopNet has been valuable to our institution not just with scientists. We have used PoP PD elements for after school staff workshops, RMSC staff trainings and I was even asked to be a panelist at a science communication conference because of our involvement with PoP. PoP has helped us to grow our relationships with local universities and has brought more scientists to the museum than ever before. I truly believe that it has assisted us in achieving our goal to "be the place to go for science" in our community. I personally feel that my involvement with PoP has helped me to grow at my institution. I feel that I have

been able to take on a bigger role because of my involvement with PoP. I am so grateful to have had the chance to be a part of such a wonderful network of people.

14. We see the value, but are having difficulty in the implementation of the program. Particularly funding and sustainability.
15. The challenge is developing a financially sustainable model. That is where we are focused now. We clearly see the value of the program, but need to determine how to implement in a way that is cost-neutral.
16. In addition to helping ASC achieve its mission, POPNet offers much needed professional development and team building opportunities for the staff members responsible for implementation of Portal activities. Participation in POPNet helps with staff retention by helping to provide staff with a larger vision for the potential impact of informal science education.
17. I have been a science educator for many years. It is my observation that probably most American citizens have little understanding of science and its importance of creating a strong and viable nation. Many are somehow intimidated by the thought of meeting a scientist and either hold them on a pedestal or have a negative view of science and scientists. We need to have a more vigorous and relevant approach to science education and PoP scientists can have a great influence in our education efforts.
18. The scientists who were most involved gained from the experience in my view so the benefit is not limited to the museum and its visitors. Close, collaborative work between our exhibits and education department is always good and the program encouraged that. Developing kits with scientists to help them convey what they do in a tangible way was very rewarding.
19. While the museums were always committed to working with scientists and other outside experts, being a part of PoPNet has helped us formalize our approach and has lead to an ever growing network of scientists who support and want to continue to work with the museums.
20. The training workshop and PoPNet curriculum will be very useful once we start implementing our plan. Also, having the support of a national network to provide credibility and to share ideas/get new ideas is incredibly helpful. Thank you for all of your efforts!
21. The program is fantastic!
22. As noted before, the network has positioned us to be a leader in scientist engagement with public audiences and science communication training for scientists. This has led to additional grant funding of related projects.
23. It is an important and unique link for scientists and the public with the museum as a forum (and training ground) to make it happen.
24. Involvement with PoPNet has enriched our education program, as well as our public events, in more ways than can be described. We have developed partners and friends in various university departments, fortified bridges between the public and the university, and made the work of scientists seem fun and accessible to our wide audiences. I am also assuming, as I have only testimonial data yet to support it, that we have provided our scientists (students) with a valuable set of skills and experiences communicating their work and demonstrating broader impacts.
25. we are part of Iowa State University so we have essentially an unending pool of scientists from many fields to bring into our program
26. In addition to helping the Natural History Museum of Utah, PoPNet offered me a PoPNet faculty position, in which I mentored two science museums through their PoPNet implementation process. As a result, my resume, professional networks, and science communication skills were expanded and strengthened. My work with PoPNet has been an extremely rewarding experience, and on behalf of my institute and myself, I am grateful to PoPNet for the knowledge and professional opportunities.
27. I was invited to participate in Portal very early on as an advisor. In my opinion, the best thing about Portal is that it is the only NSF funding I know of that acknowledges the power and importance of researchers sharing science one on one, one on two, or one on a few, through conversations. Everything else at NSF (and I worked there for 20 months) that I know of emphasizes that science communication leads with the mouth, preferably through a microphone. Portal is the one example I can cite that emphasizes (and not as much as it should) that communication begins with the ears. It begins with listening. It rejects the "it's all about me" mindset of the horrible 'elevator pitch.' Conversations at an Exploration Station allow visitors/learners to chat with researchers, to hit the ball back and forth over the net, to see a researcher in casual setting far from the lectern or camera. This is also why I think the Portal training is way too weak on

conversation and with too much emphasis on explanation. This can lead to explanaholism, a horrible, horrible disease. Also, the Portal to the Public title is one of the best titles ever--and I was baffled when I heard staff at PSC start using the moniker "pop"--what is pop? I asked. Oh, it's the way we refer to Portal to the Public, they said. I have never understood this. Pop? It's not an acronym for Portal to the Public. It's a nickname that says absolutely nothing. They could have, should have, stayed with Portal--a distinction that makes a difference because the name is a brand that underscores the commitment to welcome the public into the world of researchers, and vice versa. In the world of brands and metaphors, Pop is fizzy water full of empty calories. Choose your brands well--and guard them fiercely.

**List 6: If not communicating with another institution in PoP, why?**

1. We have a few staff working on PoP related projects over time; I did not personally, other than webinars etc
2. My boss does the communicating
3. Time and resources....
4. I was not one of the team members involved directly in the project.
5. I am not the primary contact at the Sciencenter.
6. I am not involved in that way. I just provided training to the scientists at our institution.
7. I haven't really been involved with PoPNet.
8. It's not part of my role.
9. I've been running the logistics of individual events, and haven't had the opportunity or need to.
10. We worked a lot with our mentor mostly. I participated in one webinar but nothing with any specific institutions.

# Appendix 4: Scientist Survey

**List 7: Example of changes to participating scientists' broader professional work**

1. Easier to explain research to public audiences or high school students that are working in the lab
2. Techniques for engagement - drawing someone in to get them to interact with you - have been very helpful when interacting with lay audiences during my day to day research in the field, as well as when interacting with researchers of different fields at a scientific conference, and during "small talk" at social events.
3. I am better informed for presenting to new students, who don't understand all the details of my research.
4. Training new students in the lab.
5. During my training in PoP I was working as a postdoctoral fellow at a university with an interest in science communication and public engagement. I am now working full-time at a museum-science center. This is largely due to my training.
6. It's easy to get overly indoctrinated in your work, but the PoP workshops really emphasize clarity and big-picture.
7. Better broader impact statements in grant applications
8. I have gotten much better at taking the very complex work that I do and distill it into a form that is easily understood. I also put more emphasis on telling people (particularly those not in science) why the research I am doing matters in a big picture way.
9. I am better able to explain my PhD dissertation hypotheses and results to committee members who are outside my area of expertise.
10. Asking more questions to engage
11. Discussions with a local state representative.
12. I try to make sure that summer students have an opportunity to work hands on collecting data and I leave them considerable leeway to figure out what approach works best for them as an individual.
13. I am finding diversified ways of communicating with my students so that all students get access to the material in a fashion that is beneficial for them.
14. When I start a dialogue with others, I'm more conscious of the vocabulary I use as well as try and ask them more questions.
15. More hands-on programs with the community
16. I used the skills learned from PoP to my thesis writing, especially the Introduction chapter. And improved my presentation skills.
17. The PoP workshops helped me think more about what the audience may or may not know about my research topic(s), and so I feel I am more effective at "mentoring and advising students" and "communicating my work to colleagues" because as I prepare to discuss topics, I first think about what gaps in their knowledge may exist. This helps me provide more information up front to help be sure students, colleagues, or other audience types will not 'get lost'. If I teach in the future, this will also inspire me to conduct a pre-assessment of students' background understanding and knowledge to help me figure out where to start and to assign small groups such that students with a mixture of background knowledge (novice, average, expert) are together to encourage students to learn from and teach each other.
18. use more questioning strategies, don't lead with just telling about the topic.
19. PoP provided me with a forum to think about how to present my research to the general public, something I had not taken the time previously to consider. So, it provided me with not just an outreach project, but also a "5-minute elevator speech" for general audiences.
20. Significant improvement in presenting science
21. One of our incoming grad students this year has a biophysics background. He's extremely smart, but sometimes he requests background information for chemistry concepts unfamiliar to him. The training I received through OMSI has helped me to slow down and ask more questions, rather than cram as much info into a sentence as possible.

22. I currently work in a cultural institution focusing on a broad range of topics, many unrelated to my field of study. My ability to communicate my studies to my colleagues and highlight the broader impacts has greatly improved.
23. The interactions that I have with small groups of people at the science museum are a perfect practice ground for the variety of conversations that I could have with decision makers. Many of the best practices (for example, making it a two-way conversation) apply equally well to a conversation with a decision maker
24. I adjusted my training sessions to include more inquiry-based learning.
25. I have increased my University teaching
26. I feel that I was able to more successfully design an introductory class that I currently teach.
27. Part of my research is in graph theory, and explaining what I'm doing in these public engagements has helped me in refining my proofs and helps me be more concise in discussions with colleagues.
28. Grant writing improved
29. I often get complimented for my presentation skills at conferences, and recently won "Best Talk" at one of them. I tell people its not that I'm naturally gifted, but rather, I've had to learn to explain science to 3 year olds in my outreach work. That has made me a much better communicator, even when talking to other scientists.
30. I have recently retired, so my daily activities have changed significantly. However, I intend to increase my involvement with public outreach.
31. Having engaged with a non-scientific audience, I can now better understand key terms and interests that can help place the justification for my toxicology research in a perspective the public can understand
32. I have reduced, even further, the amount to which I allow myself to talk about a science concept or a way of interacting with an exhibit when facilitating an experience around it.
33. I have been better about taking a step back when presenting my data instead of jumping in to the heart of the project.
34. I've learned how to better explain my research in a broader context to help promote a clearer understanding of not only my work, but of how science works in general, to the public.
35. I have learned to simplify my explanations to focus on the most important points I want to make. Before, I would often give too much information, and it would decrease the impact of the main point I am trying to make to people when teaching and communicating my science to co-workers and decision makers.
36. I do my research on private lands, and had the opportunity to meet with the landowner, his son, and a few professionals from outside the sciences. I explained my research using similar language as I had practiced during communication workshops to make sure I wasn't using jargon and connected the research to their interests.
37. My class lectures seek to use more student engagement -- often with direct demonstrations using experiments.
38. I anticipate questions about what I do and explain my job in small steps.
39. I am including community outreach projects as part of an undergraduate course I am teaching.
40. I use techniques that I learned in my undergrad teaching.
41. I have become more aware of how students are reacting to my teaching attempts
42. Showing the impacts of my work on the broader community at my institution to senior administration officials.
43. I am more confident in speaking to my colleagues when we are problem solving experiments.
44. I've used the info about how people learn to make sure there are a variety of ways students in my class at the University of Washington can learn the material. I understand better different learning styles.
45. I often enlist graduate (and undergraduate) students to assist with public outreach engagement events. Training at the Mayborn on how to engage with audiences in informal environments was extremely helpful to grad students in preparing to do that, and so plan to have future students do the same.
46. Better at explaining job to laypeople in the administration.
47. I find what I do to be interesting regardless of connections to other research, but I didn't know how to explain why I do it and what the results are used for in a larger context. The PoP forced me to concretely define why I enjoy it, what is cool about it, why it is important, and why it is useful.

48. Seeing the engagement of the public at discovery museum events made me realize how small experiences can excite individuals and influence their future.
49. I used lay language in explain my research and potential to clinicians, which lead to a partnership to translate our research to the clinic
50. With my colleagues, I engage in more of a dialogue of ideas instead of just presenting my own.
51. Since my training, I work with undergraduates entering the laboratory somewhat differently. I work hard to make sure they understand everything about the project, in terms that are useful for them
52. I find that I'm being asked more about what purpose science serves and how it works in the context of today's society since my PoP training by decision makers and by the public outside PoP events and work. I'm not sure why that is, but I'm excited to be part of that discussion.
53. Since the training, I have been comfortable enough to talk to high school students that visit, taking on more teaching roles for undergraduates, and am in the process of preparing to engage with lawmakers on Capitol Hill about science policy and funding.
54. While TA-ing a genetics class, I felt like I was more prepared to engage my students in dialogue and get them to figure out problems themselves than if I had not recently taken the PoP workshops.
55. I think more about how to present my work to non-specialists
56. As a mentor and teacher, I try to limit the amount of jargon I use, even in specialized classes, and I try to lead my students in a way that enables them to explore the answer (rather than just giving the answer to them).
57. In mentoring students I am more likely to ask them questions rather than just telling them everything.
58. Doing less didactic teaching by providing the audience more interactions.
59. Better able to communicate the goal and scope of my project to a summer high school intern.
60. I ask a lot more questions to engage people. Instead of telling them what the northern lights/aurora are, I ask if anyone has seen them and where (in person, on television)?
61. In the classroom, I engage students more by asking them questions to lead our discussion/activities and am able to be highly interactive in many cases.
62. More confident speaking at lab meeting and conference presentations
63. I took the helm on developing communication materials for our group's research project
64. The training has helped me better assess student learning and I bring more of a dialogue-based strategy into my teaching.
65. Better understanding of how people perceive risk and explain coastal disaster risks to decision makers
66. When explaining my work, even to people who I think may be on the same page as me, I always put my research in context of a larger issue (mainly biodiversity).
67. I proposed an idea and guided a team of computer science interns to gamify my research for an exhibit at my institution. Took a lot of 1 sentence writing for the general public
68. While working on a research project, I more actively think about a potential set of public engagement points and how it may articulate with current popular concerns. As a "social scientist" I am concerned about how I can make certain my discipline is viewed as more inclusive and valuable to other scientific efforts beyond my own work.
69. When I work with my undergraduate students I try to think of ways to explain concepts that can be explained in many ways to ensure that they understand various ideas. Also in the way that the ideas are delivered to them.
70. By speaking with a broader audience during my outreach activities, I have become more effective at speaking with undergraduate students about the importance the science we conduct in our lab. I believe that I am able to recruit more students interested in science.
71. PoP training made me more aware of the need for my research to have practical applications.
72. After thinking of ways to present my complex research to the public, I was able to better understand the "big picture" of my research impact, which has lead to me better understanding of the goals of my research and where I want to take it.
73. Conducting research that is more relevant to general public.
74. I am more comfortable and effective when talking to my students 1-on-1 during lab activities.
75. I've always felt it is important to communicate to the public the importance of scientific literacy and its application to decision making (both personal and at the policy level). My experience at OMSI

underscored the fact that scientific literacy varies tremendously, even among people who visit science museums. Hands-on activities are important, although I still believe watering down content too much can be detrimental.

76. I organize a booth at the Corvallis Farmer's Market for my department and this training has helped me engage and pass on effective communication techniques to the students who work at the booth each week.
77. I now write about science and scientific-based discoveries for broad audiences.
78. I teach undergrads in a lab setting - they learn how to do research and contribute to our research program. After this training, I realized that I often just dictate tasks to them, rather than try to get them to really understand what they are doing. I've made more of an effort to make them become actively involved in our protocols, rather than just following a list of instructions.
79. I did public engagement training before I started teaching, so it has always affected my teaching, thus “no change”.
80. I think I can articulate the broad implications of the research and explain the research with useful analogies better now that I ever did before.
81. Being able to effectively communicate research to lawmakers so they can enact change at a statewide level.
82. The PoP training had a positive effect on staff and students working with the general public.
83. Techniques learned here carry over to what I do in the classroom as I work to move away from a primarily lecture mode of instruction.
84. I have become more tuned into how the teach and mentor are internalizing material; I am more likely to ask them conversational questions to check their understanding and to see if they are thinking about material.
85. I try to apply the training I received about exploratory questioning to my teaching during small class-size discussions.
86. I have been able to effectively engage others in conversation about my work without losing them and seeing their eyes glaze over. Being able to clearly and concisely talk about my research has also helped me figure out how to organize presentations about my research.
87. I've turned training into a very structured lesson plan with goals at certain points along the way. It is much like the demonstration skill I was taught.
88. The prototype workshop at the Miami Science Museum (now Frost Museum of Science) helped me generate information pamphlets which summarize some of my projects.
89. More Socratic style of classroom teaching at University level.
90. Communicating by telling a story of my research at conferences
91. My experience in the PoP program inspired a career change for me, away from applied research in my field and toward science education and communications in a museum setting.
92. After completing the Science Communication program, I went back to my university and helped to create "Open House" events where researchers bring the public into our department and show them cool animals, talk about research, etc. This would not have been feasible without the training I received at my PoP institution.
93. I am much more comfortable communicating my research and ideas to other people with various backgrounds (e.g. scientists outside my field, my non-scientist (art major) mother, 5-year-olds at the museum). I feel ready for anyone who asks!
94. Advising undergraduate students who are unfamiliar with the field, but ready for an internship, benefit from me being better about explaining what and why we do things the way we do.
95. Reminded me to think more from the perspective of an intelligent and interested, but not necessarily knowledgeable, audience.

**List 8: Example or personal stories that illustrate how PoPNet might have influenced participating scientists**

1. I have given several talks to elementary school teachers on incorporating engineering into the curriculum. I have used information taught to me in PoP to guide how that conversation goes.
2. I believe this public engagement project improved my skills on how to start an appropriate dialogue regarding my research and my field of research with people of various ages and levels of education. I have recently met new people and I was more confident in discussing my work with them than I was before this project and I was more easily able to gain interest in the topic whilst also knowing that they were learning.
3. I did not know this program was available to scientists interested in citizen science. It was a great resource for students participating in the program and the public events.
4. It has been fun to watch kids learn things and do things based on what they've learned by participating in an activity with me.
5. I feel better prepared to engage younger students about science, and I realize that the most important thing isn't that they learn exactly what I do but that I help them engage with the science at their own level, whatever that may be.
6. When working with young children I came to appreciate how central parents are in fostering the child's creativity and thinking. They are able to play important intermediaries between myself and the child. Since noting this, I have tried to engage both the parent and the child in activity.
7. Through this program, I was able to construct a demonstration of my research that is ready to take to a public engagement event. I even attended a chemical education conference and presented a poster on my demo to tell others about my success.
8. I made friends with the other scientist in the workshop and am still close friends with some of them today. We meet when I'm in town to talk about ideas; its the best conversation I get in life right now.
9. The public engagement project gave me access to a diverse group of people (various ages, ethnic backgrounds, scientific interest). This provided an opportunity (or forced me to adapt) to diversify my scientific content.
10. The hands-on experience of engaging with the general public provides really refreshing reminders of diversity of thought processes, backgrounds, interests, and goals. After so many years isolated from the public in the lab, participating in this project reminded me how much I love outreach.
11. It showed me that the material in my field can be presented with a hands-on engaging activity and instilled in me confidence that I can adapt and respond to the needs of an audience in real time.
12. I enjoyed the challenge of explaining concepts to multiple ages at once and forced me to really think about the best analogies to explain my research.
13. Learning about the different modes of discovery was very powerful. I realized that listening to my audience can be just as important - and powerful - as what I'm trying to communicate, and that I should approach public engagement not as a teaching opportunity but as an ongoing dialogue. The trick is figuring out how and where to start that discussion. Techniques I learned from the Powerhouse Science Center PoP workshop have given me the skills, and confidence, to start those conversations and make personal connections with the public, a vital step in broadening participation in, and appreciation for, science.
14. Participating in this project helped me to learn how to better speak with the public. When talking with small children, I quickly had to adjust how I talk about my work, the focus, and find new ways to engage with them to help them relate.
15. Gave me the confidence and tools to engage in other outreach programs like "Dinner with a Scientist".
16. The program challenged me to develop a creative, hands-on demonstration of my research. I took this model to a middle school where the students were extremely eager to learn. It also opened the to answering questions about the career of a scientist, letting them see the job is both exciting and within their reach. I received a beautiful binder of their thank you letters as a follow up and I hope that I inspired them to pursue careers in science
17. Because of my involvement in this program and other public engagement opportunities I had, I am now working full-time at a museum-science center to develop content for programming and exhibits.

18. My research involves gametes which is a touchy subject for many parents. During my talks/demonstrations I had to give enough detail to be accurate/informative but not too much detail as then it could be taken as inappropriate. Given I didn't have any negative commentary or signs I assume my level of detail was appropriate.
19. A little girl at a fruit & veggie botany dissection ran up to me to get a carrot because she was so excited about the science of plants. Her parents said she had never been so enthusiastic about anything before and they were planning to get her some botany books afterwards. As I continue to progress through my PhD program, I find a lot of my colleagues have given up on the general public - they feel as though people are just too stupid to understand science or logic. But having regular exposure to the public, I can attest that people *want* to learn and grow - they are just confronted by a Wild West of misinformation to navigate with very little training on how to discern the quality of information sources. I don't think I would see the roots of our systemic education failings without the PoP program tools, and without understanding the problem, you can never solve it.
20. The development and presentation of a self-selected topic to elementary age children was a learning experience in deciding what would be the most engaging materials and information.
21. I think the biggest change is realizing how my work is perceived outside of my field and taking that knowledge to find better ways to interact with the public, whether it's family, friends, students; to share what I am doing and why it should matter to them.
22. Prior to participating in the PoP program, I had not considered a career in science communication. Now, I am actively seeking job opportunities that value science communication skills and opportunities.
23. Now able to run Science Saturday workshop at RMSC if I have a free Saturday and know about it in advance
24. As mentioned above, the PoP program inspired a career change. Moving away from an isolated applied research setting and toward a broader science communication role was an excellent fit for me.
25. It has helped me remember what I really love about being a scientist. Getting to watch children and teens exhibit that "spark" of excitement when they discover something new reminds me of how I felt as a kid. I am grateful to this program for letting me be part of that experience.
26. A young girl ran up to my exhibit table (it was covered in neon pipe cleaners, glitter, and foam construction paper), her eyes huge with excitement, I saw the look of bewilderment come over her face as she asked, "Is this SCIENCE or is this ART? Just what is this exactly?" I wish I had said something clever, but in that moment, I was struck that these two things were so disparate in her mind. We spent the next few minutes trying not to completely cover ourselves in glitter while waxing philosophically about the connectedness of the two fields.
27. I am better able to engage transient audiences. Young children and adults strolled by and joined the activities according to their available time and level of interest.
28. Getting to know like mind, outreach-oriented fellow scientists form my institution helped me to communicate my research better.
29. It has made me consider the different ways (eg. hands on interactions) to present my work rather than more passive approaches (posters, talks, even displays)
30. I have met people externally who remembered me and my activity at Explora. The activity seemed to have left a strong impression on the children and parents alike!
31. My PoP topic has been digital signal and image processing. I let the participants work with colored tiles for a tactile experience, and let them take their own pictures and do image processing on them. I remember one grade school aged girl who was rather quiet and "shy" but who spent quite a long time on the various activities. It was very gratifying to see her face light up at times and realize that she was very engaged and was enjoying things in her own way.
32. I am now recommending PoP to all my students, because it had a profound effect on how I view learning and the importance of being able to communicate technical topics to a broader audience.
33. When I start telling people what I do, I now start with asking them what they know about it. I was just talking to a high school class and began with "what do you think geophysics is?"
34. All of us enjoyed the program working with the SC staff. They did such a great job.
35. Participating in the OMSI Science Communication Fellowship Program has impacted how I explain my research to the public, as well as how I communicate in transdisciplinary research groups, and how I write

grant proposals. It has helped me frame my research in the context of the world's grand challenges of water, energy, food, and health, and helped me improve my research questions and design based on public feedback and communicated needs.

36. Immediately after completing this program, I participated in a program with the Center for Community Health called Teen Health & Success Partnership. I used the communication skills I learned to help with my interactions with the participating teens. It was a great experience.
37. By finishing the PoP program, I understand how to design a hands-on activity to teach a fundamental concept of DNA structure, like double-helix, major groove vs. minor groove. I use x-ray crystallography to study 3D structures of biological molecules. Hands-on model is a very good tool to trigger public engagement.
38. One of the exercises we did was "teaching by asking questions". This is much harder than I expected, and helped me understand how others thought and learned.
39. I have always enjoyed the limited opportunities I had to engage the public (mostly school-aged children) and share my enthusiasm for the nervous system before my PoP workshop experience. At the time I was able to apply for a position at the Pacific Science Center's Science Communication Fellowship, I was starting to lose interest in my research work largely because the daily grind of lab benchwork seemed less and less satisfying. My participation in this PoP program not only helped provide me with greater opportunities to conduct science outreach with the public (and with more varied age groups), but it also helped me remember how to put my work into perspective. Articulating the larger questions that my work was attempting to address helped revive my motivation to continue in the lab, and helped me feel more like I was actually contributing to something meaningful again. This, in turn, inflated the enthusiasm I could share with others as I helped them understand something about the science I am involved in.
40. Helped establish a community of like-minded individuals who value public engagement in science.
41. It surprised me how many people were familiar with the general topic of my research, and it was great to talk with them about their perceptions and feelings on it.
42. I was really impressed by the interest of 8-12 year-old children in the sciences. I think that this project made me consider spending more time with that age group to instill a positive view of scientific research in general.
43. My committee members saw improvement in my presentation skills.
44. The greatest aspect of my PoP experience was that my university's research committee, IRSC at IPFW, decided to include scholars like me--a scholar of medieval texts and languages--on equal footing with "STEM" scientists.
45. The program has greatly increased my connections to the Science Central staff and facilitated the creation of two weeklong summer camps.
46. I just forwarded information about OMSI's Science Communication Fellowship to a colleague in my graduate program, with the hope that he participates.
47. Best thing happened was a father brining two of his sons for science to public program conducted by Sci-Port, Shreveport in a mall here. He was extremely happy to hear I'm working on peripheral vascular disease, a problem runs in his family. He said that we, scientists, should be funded and rewarded more by the government and are true heroes. He and his sons left with a better understanding of the disease and how the body tries to correct it.
48. Participating in this public engagement makes me learn how to simplify my explanation to broader group of audiences. It also encourages me to see my value in sharing and giving to others.
49. I have a new appreciation of the first few sentences of a conversation. The invitation to participate. The sharing of something about myself, and the vice versa. The exchange of names. This is a skill that I will use for much more than just science outreach.
50. I found a great activity that I can adjust for different age groups that is hands on, and I can ask questions to get the participants to get the point.
51. I have increased the amount of hands on teaching I do, both in public engagement and in university teaching
52. Participating in this public engagement project helped me better communicate my field and what I do to the public.

53. Often times I feel burnt out when I get into the nitty-gritty of my research. Preparing for these public engagements reenergizes my love for what I'm doing. At one public engagement I showed off a game I hadn't worked in months. That engagement was one of the most successful I've ever had. Three families said they were so glad they came to Sci-Port that day, two kids told their parents they wanted to download Unity (a free game making engine) when they got home, almost everyone said they learned something new about sound waves (the focus of the game), and there was a group of kids that stayed for an hour asking me questions about math and game design, and gave me suggestions that I have used to improve the game.
54. I can communicate at all levels more effectively, from coworkers, to friends and strangers.
55. It has helped my feel part of my community. This, for me, was the biggest impact, and a very important one. As a researcher, I often feel very isolated in the lab, and that my work will only have an impact in the long run. By adding outreach to my work, I can also know I am making an impact in the short term as well.
56. Presenting activities to a wide age range was not something I had done frequently. I found it very enjoyable and rewarding.
57. My current research field is behavioral toxicology with an emphasis on the effect of nanoparticles which was the basis for my tabletop activity, I was pleasantly surprised to hear many young children recognized the term nano and many were interested in the topic. When I was their age, I'm certain I was not at all familiar with the term and it was great to see children at the museum actively wanting to know more about it. One parent told me that her daughter was very passionate about seeing the nano exhibit and I could almost see the early beginnings of a future nanotoxicologist.
58. It was very rewarding to see children having fun while learning about something I am researching; it is a great reminder that what we do as scientists is important and to share that excitement is very motivating for me.
59. I have become a better science communicator. Being an OMSI Science Communication Fellow will allow me to remain engaged in science communication after graduate school, which I am very thankful for.
60. Already very experienced in public engagement, the strongest aspect of this program, for me, was the interaction with local experimental scientists, and the direct interaction with the people who facilitated it.
61. I went with a group who is involved in outreach to local elementary schools. We had not previously targeted other ages, but because we were successful with both the children and adults, we have since started working with high school students as well.
62. Participating in this public engagement project has made me comfortable and adaptable when speaking to laypersons about my project and about science in general, which I believe has made me a more effective communicator.
63. My favorite moments involve children under 5 learning about science -- this project helped me engage better with these budding scientists.
64. I have accepted a job as the climate science education coordinator at a science museum in Virginia instead of accepting a post-doctoral research appointment.
65. At the Mayborn, Charlie, Lesa, Denise provided a wonderful environment and support for interacting with visitors. Their training was supportive, helpful, and has encouraged continued participation in science outreach.
66. I put much more thought into the relevance of my research for individuals outside academia.
67. I have yet to complete my "Scientist in the Spotlight" event, but my POP training will allow me to communicate more effectively with museum patrons.
68. I never thought that I would enjoy working with children when it came to science. I didn't appreciate their ability to grasp complex scientific concepts and I also felt that in diluting the content to simple tasks, the exercise would turn into another play session rather than something educational. The POP experience has been a revelation to me in this area; I have come to realize that through simple exercises children as young as 4 years old have the ability to grasp very advanced scientific concepts albeit not in a mathematical manner. I am now a true believer in working with the public (in particular children) to explain complex science and in their ability to retain the concepts taught.
69. I loved working with Explora. They took my idea and created an exhibit and it is almost self explanatory. It has made my project fun and interactive.

70. My increased participation in PES lead me to apply for a fellowship to work on science policy, focusing on providing an overview of PES in different disciplines.
71. Learning how to properly express my research to all types of individuals has helped me to become more confident and knowledgable with the projects I am currently involved in at work.
72. Talking with people who have a burning question but no scientist to ask, until me, inspires me to keep doing the outreach work.
73. We really just did one training. But it was very useful prior to a big public event. It allowed grad students particularly to realize that, although they are "experts", what is more important in this type of environment is that they effectively engage with audiences, and how to do that.
74. Seeing how little interactions can drive a child's interest in science.
75. My outreach skills improved, leading to reliance on them by my agency, followed by redefining my position to include 15% of my time devoted to outreach for my agency.
76. I really enjoyed being able to share my research with people of the "scientist on the spotlight" event. Just the fact of communications with people I rarely can reach out to was a whole new eye-opening experience.
77. As a follow on to the PoP program I participated in a donor event. A personal interaction at this event led me to a new job and has opened tremendous opportunities for me.
78. How to cope with a group of audience at different ages and organize fun experiments which can convey scientific ideas
79. I took the materials to a local school science fair, and a 4 year old girl came to the table (she must have been a younger sibling) - so, not the target age of our audience and the mom was looking kind of tired. This little girl was amazing and mastered some high level genetics concepts. She looked (appropriately) proud, and then started doing the "work" without the materials in her head - she really had it. And her mom said, "Wow! Maybe she could be a scientist." It was really only a few minutes, but the mom's reaction that still gets me. I hope she still thinks of her daughter as a future scientist.
80. 1 on 1 conversations with individuals who show some spark of curiosity in the midst of a larger presentation / venue is always memorable-- and motivating to do more
81. Well, I've had many, many, many (many) incredible conversations with visitors of all ages (I talk to elderly folks about their concerns as they grow older, to kids about having fun with science, to teenagers about the parts of science that nobody can solve and that they can help advance science/fix those problems, to their parents about the actual science of neurodegeneration and how it tangibly connects to our lives and society, and to adults about concerns they have about their parents' or families' health) where I frequently get to share hilarious moments and moments of heartbreaking honesty and vulnerability. I recently had a chance to talk to a little girl - maybe about 6 or 7 years old - about the proteins that build up in the brain and can hurt the brain and make you sick if they aren't cleaned out, and, after going on to talk about other parts of the activity we just did, she cocked her head and said, "The stuff that builds up and hurts your brain, are those like memories?" In the hundreds of conversations I've had about my activity, I don't know that anyone's said anything so profound. The little girl's poor mother immediately looked chagrined, probably worrying that I'd interpret the question as a sign that something untoward happened in the little girl's life, but I read her question as a tremendously insightful analysis of the complicated emotions that she's seen in those in her life. I was floored by her maturity and her power of perception; it was almost like that moment at the end of Willie Wonka and the Chocolate Factory when Gene Wilder looks up at Charlie and yells "You did it!" It was all I could do not to give her a big hug and tell her what a great scientist she was going to be when she grew up.
82. I've always dreaded the question "So, what do you do?" at parties because I've struggled to answer it in a coherent way. I've become so much more comfortable talking about science, estimating how understandable my dialogue is, and making my science interesting to the public. Not only has that helped me with adults, but now I know how to tailor it to anyone - children, young adults, grandparents. Because I am more comfortable now, I am out there communicating more and encouraging others to do the same. A passion of mine is to get younger kids exposed to a life in science, and because of this training I am able to make science relatable to the next generation.
83. Developing my activity has influenced the way I talk about my research, because I now have a simple visualization that I can draw on (and even just sketch out on paper) to explain a complex concept and its

importance, and therefore explain why it is relevant to people. I didn't have a succinct way of doing this before.

84. I have had so many interesting conversations with people about my research. It has helped me to both figure out ways to introduce it to others in my life, and to identify the aspects of it that are most compelling and relevant to people in general right now.
85. This program presented me with an opportunity to communicate and share scientific research with the public. My research focus is nutrition and my goal in future is to be able to design tools to help people use research findings to make daily food and nutrition choices. I am looking for more opportunities to interact and develop programs for the public but haven't found many other opportunities since the program.
86. It was amazing seeing the joy on childrens' faces as they discovered the principle I was teaching
87. I have greatly enjoyed my work at the Pacific Science Center -- I love interacting with the visitors, staff, and personnel. I have been on an academic career path, but I am now considering jobs related to informal education in museums.
88. I have really enjoyed having conversations with parents about how the brain works while their kids play with the activity I have made.
89. This opportunity to build a hands-on activity is quite different from the typical interactions of lecture based interactions I usually have with the community. It is very helpful to have this type of interaction and also go through the whole thought process.
90. Through PoP, I designed a hands-on demo of a technique I use regularly in lab. Conveying the goals of this technique and possible applications to the public has strengthened my understanding of what we do as well as improved my ability to present my project in logical manner. Even for grant applications, I have a clearer picture of what my research questions are.
91. My experiences explaining my hands-on activity and interacting with children and families has helped me explain my science to stakeholders in government or funding agencies (clearly helpful!)
92. At the Discovery Museum Public Night, I had to balance describing a complex climate phenomena with an older boy and his family while also helping a very young girl count to 10. Flexibility is important!
93. I often seek out opportunities or look for a way to include engagement in our laboratory's activities. I am also more interactive in other opportunities that I have to engage scientists. For example, I was invited to give a seminar and have decided to make it more interactive instead of me reciting a PowerPoint presentation.
94. I have gained a greater understanding of public opinion of science and scientists. I have a better idea of where my audience is coming from and what their concerns are. I was struck by the analytical capabilities of a particular high school student that stopped by my booth at the museum, who was making all sorts of connections between my work and his previous knowledge.
95. I now actively think about who my audience is and shape how I describe my research and the issues facing our region in more a context-dependent fashion
96. Did the same thing for fun at another museum where I now live. Got invited back based on the success
97. I am now a faculty member in Colorado, and am on a committee to help design a biology exhibit at a math and science center on campus. The training I received at the Natural History Museum has helped prepare me for this project.
98. This was a fun project that focused on science in general and got me away from the details and particular concerns of my own subject. The interdisciplinary nature of the training and presentations was a refreshing, positive, and exciting opportunity. I do think about the workshop training in how I structure my classroom teaching and public engagement in new ways because of the program. I would like more advanced training opportunities.
99. The program at the NHMU was extremely useful to my professional development. I do research in an area that is of great interest to the public and learning how to successfully communicate these ideas to adults and to children as young as 5 years, was important to me. Working with the coordinators of our program I was given feedback on my presentation styles and stories that I could tell with them and improve discussions with that larger audience. In particular our program provides us with an opportunity to be part of a Science Cafe, where we were asked to talk about our science to the general community that visits the museum, but we were highly encouraged to style the talk more like a TED style talk. I was unsure of how to do this, but the coordinators of the program were available to field ideas and questions and

overall the section on storytelling helped to improve my talk. I have taken away valuable skills from this program and I hope to continue my engagement with the institution.

100. I was very pleased to have the opportunity to interact with adult community members. I was able to understand the perspectives of people across a broad spectrum of social/political opinions. Since I am interested in science policy, this helped me understand some of the challenges that are ahead in my career.
101. I have been doing volunteer work outside of science for years, and this program has given me the ability and opportunity to incorporate my research and teaching into the time I devote to public engagement activities.
102. I've learned how to better communicate my research to the public and was given opportunities to practice what I learned.
103. Has prompted me to become more active in public activities at museums.

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