

GOODMAN RESEARCH GROUP, INC.
Program Evaluation • Consultation • Market Research

The Science Festival Alliance: Creating a Sustainable National Network of Science Festivals

Final Summative Evaluation Report



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EXECUTIVE SUMMARY

Goodman Research Group, Inc. (GRG) served as the external evaluator of the three-year NSF-funded Science Festival Alliance (SFA), a collaborative started by the University of California San Diego, the MIT Museum (Cambridge, MA), the University of California San Francisco, and The Franklin Institute (Philadelphia, PA). The focus of the SFA over its first three years was helping establish and sustain science festivals in each of these four cities. The Alliance's long-term goal is to facilitate the creation of a growing network of festivals and a community of science festival practitioners. To this end, the SFA began work in December 2012 on a new three-year "broad implementation" grant from NSF.

This report focuses on the knowledge gained about who participated in science festivals, the benefits of science festivals (for attendees as well as participating STEM practitioners), the most important characteristics of science festivals (that were related to increased benefits for attendees), and the support that is needed to initiate and sustain science festivals. The SFA supports 31 science festival initiatives across the country, and SFA evaluation findings have significant implications for these many initiatives. However, unless otherwise indicated, for the purposes of this report the general term "SFA science festival" (or its equivalent) should be taken to refer only to these four festivals receiving NSF funds under grant 0840333.

KEY FINDINGS

Equity of access: Science festivals demonstrate potential for supporting the participation of underrepresented groups and families.

- Many of the attendees at the four SFA science festivals previously had never had substantive interactions with STEM practitioners of the type offered by the festivals. These attendees were more likely to be minorities.
- Women constituted a slightly higher percentage of "visitors" to the four SFA science festivals than to other informal science settings.
- Family groups constituted a higher percentage of visitors to SFA science festival *carnivals and expos* than to other informal science settings.

Benefits for attendees: The summative evaluation results provide evidence of the success of science festivals as an emerging informal science education sector.

- SFA science festival participants had high-quality ISE experiences and reported becoming more interested in science, learning something new about science, experiencing science learning as more fun and enjoyable, and feeling more connected to the science happening in their cities.

- Interaction with STEM practitioners during SFA science festival events was associated with greater benefits for attendees.
- One-year follow-up with festival attendees provided evidence of continued engagement with science after the festivals, from simply looking for information on something they had learned about at their festivals, to taking part in activities related to what they had learned, to using information in their work or studies.

Benefits for STEM practitioners: STEM practitioners and their institutions had new opportunities and increased confidence to reach their target audiences through the vehicle of SFA science festivals.

- Within six weeks of the SFA science festivals, many festival partners had received follow-up phone calls or emails from festival attendees and many reported new opportunities for new partnerships with local academic, civic, cultural, educational, or private partners, as a result of the festival.
- A majority of STEM practitioners who exhibited and presented at the SFA science festivals reported increased confidence interacting with public audiences as a result.
- While about half of festival partners came from organizations with year-round K-12 ISE activities, a far greater percentage (83%) planned to contribute to local ISE efforts after their festival.

Networking and Dissemination: The SFA engaged in substantial dissemination of promising practices for science festivals (and other public science events), with demonstrated success. In particular, the International Public Science Events Conference complemented – and in many cases added value that was missing in – public science event practitioners’ professional association activities.

- The SFA formally supported at least 31 science festivals in its first three years. It supported the launching of festivals, facilitated specific public programs at festivals, helped festivals attract sponsors and gain visibility, and created a network of linked festivals that assist each other with festival specific issues.
- The SFA’s International Public Science Events Conference helped form connections and relationships among science festival organizers, STEM experts, and researchers and evaluators (including international connections).
- A majority of conference attendees planned to follow up to obtain and/or share information and resources with someone they met at the conference for the first time.

- The conference also increased awareness of and follow-up with the SFA.
- The conference added to the ISE expertise of science festival organizers and supporters. Attendees learned something more about how their work fits into a larger field, how public engagement in science is conceptualized, information and resources to start a new public science event, and how to impact target audiences through science festivals.

The SFA is a vibrant and connected network that is achieving its impacts for public and professional audiences. There also is strong evidence that the SFA has played a central role in increasing the number of science festivals in the U.S. The future work of the SFA lies in creating a sustainability plan.

INTRODUCTION

DESCRIPTION OF THE SCIENCE FESTIVAL ALLIANCE

The mission of the Science Festival Alliance (SFA) is to foster a professional community dedicated to more and better science and technology festivals. The festival initiatives that are members of this community promote public interest in, engagement with, and new understandings of science, technology, engineering, and math (STEM). The SFA supports this community by building a network of science festivals and collaborators that support each other as colleagues.

The SFA was first funded in this endeavor by a three-year grant from the Advancing Informal STEM Learning (AISL), formerly Informal Science Education (ISE), Division of the National Science Foundation (NSF). That “full-scale development” grant was awarded to four institutions: the University of California San Diego (prime), the MIT Museum (Cambridge, MA), the University of California San Francisco, and The Franklin Institute (Philadelphia, PA). The majority of this first round of NSF funding provided direct support for regional science festivals produced by each of these four institutions. The SFA also made progress in the development of an expanding national network that establishes the legitimacy of the science festival concept and nurtures the growth of festival initiatives.

In December 2012, the SFA received a second three-year “broad implementation” grant from NSF to support further growth of the nascent science festival sector. The key deliverables of the next grant include a marked increase in the number of science festivals, enhanced capabilities for science festivals to positively impact their communities, and development of the growing SFA professional network.

Target Audience and Intended Impacts

In their original project description, the SFA team described their primary and secondary target audiences and their intended impacts on each. Table 1 provides descriptions of the audience and impacts.

Table 1
 Science Festival Alliance Target Audience and Intended Impacts

Target Audience		Intended Impacts
Primary/ Public	<p>Families (one or more adults with one or more children aged 5-16), including those from underserved communities (e.g., economically disadvantaged, ethnic minorities underrepresented in the sciences);</p> <p>Adults, particularly those residing in communities where scientific research and science based innovation take place, but who are not themselves either professionally involved or even necessarily aware of these activities</p>	<p>Families and adults will increase their awareness of the role that science, engineering, and technology play in their region.</p> <p>Families and adults will increase and sustain their engagement in science, engineering, and technology learning opportunities in their region.</p> <p>Families and adults will have a greater understanding of and interest in science.</p>
	<p>Children and youth (5-18), particularly public school students and those involved with ISE community organizations in underserved communities</p>	<p>K-12 students will increase their engagement with year-round ISE opportunities and festival extensions.</p>
Secondary/ Professional	<p>STEM practitioners, including undergraduate and graduate students</p> <p>Science communicators (e.g., school science teachers, science center practitioners, science journalists, writers, broadcasters, science-based corporate communications professionals)</p>	<p>STEM practitioners will increase their understanding of how to impact target audiences through STEM celebrations.</p> <p>STEM practitioners will increase engagement in public outreach through festival related experiences.</p>
	<p>The team members organizing science festivals</p>	<p>Individuals and organizations will both initiate and sustain new regional STEM celebrations as a result of support from the Science Festival Alliance.</p>

DESCRIPTION OF THE EVALUATION

Goodman Research Group, Inc. (GRG), a research and consulting firm in Cambridge, MA that specializes in the evaluation of programs, materials, and services, conducted the external evaluation of the SFA project. Before describing our evaluation, we briefly describe the state of festival evaluation.

The State of Festival Evaluation

Much of what we know about festival management and evaluation comes from the tourism literature. This literature is growing rapidly; however, there is little representation from the *science* festival community. Thus, the lessons learned in this and similar evaluations may serve as a useful guide for the science festival community.

Several festival evaluation frameworks exist. As a group, most are in the conceptualization phase. A few have progressed further and include “how to” information and/or instruments. Early festival evaluations were criticized for focusing solely on the positive outcomes of events; more recent frameworks have tried to present a balanced view of positive and negative outcomes. As a group, existing evaluation frameworks rarely include baseline, longitudinal, or experiential data collection. Further, the terms “learning” and “educational outcomes” do not appear often in the tourism literature. Rather these outcomes of interest to science festivals are often categorized as psychological or sociocultural.

General festival evaluations and frameworks to date have focused largely on economic indicators. Most mention the need for social and/or cultural indicators as well, but few models exist for collecting these data. The movement in the tourism literature is toward the Triple Bottom Line (TBL) approach to event evaluation. This model includes economic, social, and environmental indicators.

Research has found that practitioners, government agencies, and academics have different opinions about the priorities for a festival research agenda. The science festival community appears more united in its evaluation efforts.

The SFA Evaluation

GRG conducted a multi-method process and summative evaluation to assess the success of the SFA project at meeting its intended impacts. Evidence of success was gained largely through surveys of public and professional audiences as well as SFA document review, interviews with SFA science festival team members, and participatory observations at SFA meetings. Copies of the evaluation instruments are available upon request. The University of California San Diego’s Human Research Protections office approved this evaluation.

Survey of Public Audiences

Information about the primary target audiences for this project were gathered primarily through intercept surveys conducted at each festival each year (two festivals in Year 1, and four in each of Years 2 and 3, for a total of 10 festival data collections). GRG worked with a team of field researchers at each site to gather data from the primary target audiences that attended festival events. Data were collected from a sample of approximately 13 events hosted during each festival. One of these was the centerpiece Expo or Carnival event. Of the other 12 events, GRG randomly selected six and each festival director selected the other six.

The survey instruments varied somewhat from year to year (and, in Years 2 and 3, on whether the attendee was a first-time or returning attendee). The 2010 and 2012 attendee surveys were a single page, while the 2011 instrument was two pages in length. These changes were made in response to emerging findings and interests as well as logistics of data collection.

Surveys of Professional Audiences

GRG conducted two different types of professional audience surveys: surveys of the four collaborating institutions' festival partners and surveys of the larger community of public science event professionals (reached through the SFA's International Public Science Events Conference).

1. Festival Partners: GRG conducted two rounds (2011 and 2012) of an online retrospective, anonymous survey of festival exhibitors, presenters, and sponsors. The survey included partners affiliated with each of the four collaborating institutions: San Diego, Cambridge, Philadelphia, and Bay Area (2012 only) festivals. Because there was overlap in our 2011 and 2012 respondents and because the 2011 and 2012 results were very similar, we present the results of the last 2012 survey in this final report.

Three of the four festivals provided GRG with their partners' email addresses. GRG then emailed each partner a personalized invitation (where first names were provided) containing a link to the survey. Reminder emails were sent to non-respondents. The fourth festival sent the link and reminders directly to their partners, making that survey anonymous. Across the four festivals, we received feedback from 196 partners out of 455 (for a response rate of 43%).

2. Other Public Science Event Professionals: GRG also conducted an online retrospective, anonymous survey of public science event professionals who attended the SFA's two International Public Science Events Conferences (IPSEC). Within one or two weeks of each conference, GRG provided the SFA manager with an email invitation containing a link to the online survey. The SFA manager then sent the invitation to all attendees. GRG also worked with the SFA manager to send reminder emails to non-respondents. Across the two conferences, we received completed surveys from 141 attendees (97 from the first conference and 44 from the second).

ORGANIZATION OF REPORT FINDINGS

This report is organized around four key questions:

1. Who participated in the science festivals? This section of the report includes a profile of attendees and information on the extent to which the festivals reached groups that are underrepresented in STEM, as well as information on how attendees heard about the festivals and what motivated them to attend.
2. What were the benefits of science festivals? This section of the report explores the extent to which science festivals “work” as intended, including the extent to which they provide attendees with high-quality experiences and interactions with STEM practitioners, increase attendees’ interest in science, make science learning fun, help attendees learn something new about science, and connect attendees to the science happening in their communities. This part of the report also investigates the benefits of science festivals for the participating STEM practitioners.
3. Why were the science festivals effective? Here we discuss experiences at science festivals that helped explain more favorable outcomes.
4. What support is needed to initiate and sustain science festivals? Finally, we explore the role of the SFA in supporting the start-up and growth of science festivals.

WHO PARTICIPATED IN THE SCIENCE FESTIVALS?

Across the three years and four SFA festivals, we collected surveys from a grand total of 11,377 festival goers.¹ There were three characteristics of festival goers that remained relatively stable across festivals, across years (within each festival), and across type of event (Expo/Carnival or other): gender, education, and work or study in a STEM field. Thus, we can say with some level of certainty that science festival goers:

- are a slight majority female (55% overall);
- are highly educated (86% of attendees over the age of 25 had a college degree or higher), and that
- about half work or study in a STEM field (51% overall).

Overall, four in ten respondents (43%) had come to the festival as part of a family group (i.e., with one or more children aged 5-16); however, this percentage varied by type of event, by festival, and by year within two of the festivals.

- Expos/Carnivals attracted a far greater proportion of family groups than other events (71% compared to 28%, overall).
- The San Diego sample had the largest proportion of family groups (63% overall). (This was true of Expo goers as well as other event attendees.)
- Both the San Diego and Philadelphia samples were comprised of higher percentages of family groups over time: the San Diego sample was 51% family groups in 2010, 62% family groups in 2011, and 78% family groups in 2012; the Philadelphia sample was 23% family groups in 2011 and 37% family groups in 2012.

Overall, a majority (62%) of attendees who completed intercept surveys were White. This statistic also varied by festival (as would be expected given the different racial compositions of the host cities), by year for three of the festivals, and by type of event.

- San Diego and Bay Area samples were more racially diverse than were Cambridge and Philadelphia samples (46% and 44% minority, compared to 28% and 33% minority, respectively).
- The San Diego, Philadelphia, and Bay Area samples were comprised of higher percentages of minorities over time: the San Diego respondents were 38% minority in 2010, 50% minority in 2011, and 52% minority in 2012; the Philadelphia respondents were 27% minority in 2011 and 37% minority in 2012; and the Bay Area respondents were 39% minority in 2011 and 48% minority in 2012.

¹ This does not include 448 visitors from whom we collected “returning attendee” surveys. These respondents are discussed in a later section of the report. Including the returning attendees, we collected data from a total of 11,825 individuals.

- Expos/Carnivals attracted a greater proportion of minorities than did other events (47% compared to 33%, overall).

Finally, about one quarter (27%) of respondents overall were younger than 25. The San Diego sample looked considerably different than the others, with 41% of respondents overall below the age of 25. Note that we did not have permission from the IRB to intercept and survey children younger than 14.

To what extent did the festivals reach underrepresented groups?

We used Census data to investigate the extent to which the respondents from each festival represented the population of their host cities in terms of gender, race, and level of education, three variables that help identify underrepresented groups. See Table 2. Census data suggests that all of the festivals attracted the more educated segments of their local populations. With the exception of San Diego, the festival events included in the evaluation also attracted higher percentages of Whites than were represented in their populations.

In general, informal education institutions, such as museums, attract educated visitors and a higher percentage of Whites than in the population. For example, 73% of 2004 Smithsonian museum visitors (including visitors to the National Air and Space Museum, the National Zoological Park, and the National Museum of Natural History) had at least a four-year college degree. Further, a study of over 40,000 museum-going households reported that 84% of science center respondents identified as white.² The U.S. population is 63% White (and not Hispanic), a difference of 21%.

Women may constitute a slightly higher percentage of “visitors” to science festivals than to other informal science settings. For instance, 47% of the visitors to the Smithsonian science museums were female,³ compared to 55% of SFA festival goers across the four SFA science festivals.

In addition, family groups also may constitute a higher percentage of visitors to SFA science festival *carnivals and expos* than to other informal science settings. Seventy-one percent of SFA science festival *carnival and expo* respondents were attending with one or more children aged 5-16, compared to 43% of Smithsonian science museum visitors that came as part of a group of adults with children/teens.⁴

Women and family groups constituted a higher percentage of festival-goers than science museum goers cited in two other research studies.

Table 2
Population vs. Respondent Demographics

	San Diego		Cambridge		Philadelphia		Bay Area	
	Census	Festival	Census	Festival	Census	Festival	Census	Festival
Female	50%	56%	51%	53%	53%	65%	49%	54%
White	48%	50%	62%	71%	37%	73%	42%	61%
College	34%	75%	72%	93%	22%	88%	51%	88%

² http://reachadvisors.typepad.com/museum_audience_insight/2010/04/whos-coming-to-your-museum-demographics-by-museum-type.html

³ http://www.si.edu/opanda/Reports/Reports/SI2004_Survey_Booklet.pdf

⁴ http://www.si.edu/opanda/Reports/Reports/SI2004_Survey_Booklet.pdf

How did attendees find out about the festivals?

Attendees found out about their festivals through personal recommendations, school and work, the web, and print materials, such as flyers and newspapers. A small percentage of respondents did not know that the event they were attending was part of the science festival. Table 3 shows the percentage of attendees at each festival who discovered their festival through each of these means.

Of note, a far greater percentage of respondents in San Diego had heard about their festival event through their children’s school. This was also the most commonly cited outreach mechanism among the Bay Area respondents. In Cambridge and Philadelphia, personal recommendations (or word of mouth) played the biggest role in how attendees had found out about the festivals.

Table 3
Percentage of Respondents who Learned about Festivals through Various Mechanisms

	SDSF (N=1789)	PSF (N=968)	CSF (N=1887)	BASF (N=1510)	Total (N=6154)
Personal recommendation	19%	29%	33%	19%	25%
Through School	44%	14%	10%	22%	23%
Festival website/e-mail	9%	17%	18%	8%	13%
Other	11%	11%	11%	15%	12%
Postcard/Flyer/Poster/Banner	7%	12%	20%	5%	11%
Through work	7%	13%	9%	9%	9%
Newspaper	9%	14%	8%	6%	9%
Other websites (e.g., news, local event listings)	5%	12%	10%	10%	9%
Didn't know event was part of festival	4%	5%	6%	13%	7%
Social network Website	3%	7%	5%	6%	5%
Radio/TV	6%	5%	2%	6%	5%

Minority attendees were more likely than others in San Diego to have heard about the SDSF through schools (33% of minorities compared to 17% of Whites, overall). Overall, there were some other slight differences in how minorities vs. White had heard of the festivals; minorities were slightly less likely to have found out about it through a personal recommendation, the festival website, or the newspaper.

What were participants’ motivations for attending the festivals?

We were also interested in understanding the motivations of science festival visitors, especially since museum researchers have found a link between visitors’ motivations for coming to museums and their learning from the experience (Falk, Heimlich, & Bronnenkant, 2008). We concentrated on a small number of motivational categories adapted from Falk et al. (2008): a general interest in science; a specific interested related to a professional or

hobby; to support the experience or learning of children or others; and because it seemed like an important event to attend.

The most common reason for attending the festival, as displayed in Table 4, was a general interest in science. More than a quarter of respondents came to support the experience of others. A slightly lower percentage of respondents were motivated by a specific interest related to their work or pastime.

Table 4
Reasons for Attending the Festival

Reason for attending	Percentage
General interest in science	44%
Specific interest related to profession or hobby	19%
To support the experience or learning of children or others	27%
Seemed like an important event to attend ^a	8%

N=9794

^a Based on 2011-12 data

The motivations of underrepresented groups differed slightly from those of dominant groups. Most notably, among adults over the age of 25, minority attendees were more likely to have attended to support the experience of others than were white attendees (39% compared to 28%). In addition, more educated participants were more motivated by an interest in science (44% versus 35%) and by professional interests (20% versus 10%). In contrast, more educated respondents were less likely to be attending to support the experience or learning of children or others (30% versus 43%).

What was the profile of STEM practitioners who participated in the festivals?

There is another type of participant in science festivals and that is the science professional or STEM practitioner. SFA partner festivals engaged these audiences in their festivals as exhibitors, collaborators, and sponsors. Our two rounds of surveys with these audiences showed that the highest percentage of partner survey respondents were informal science educators. See Table 5. Many respondents chose “other” to describe their role. These included outreach and business professionals, non-science educators and respondents from arts organizations, and librarians. A lower percentage of the sample was professional scientists.

Table 5
Roles of Partner Survey Respondents

	Percentage
Informal science educator	29%
K-12 science educator	10%
Science undergraduate/graduate student	7%
Professional industrial scientist	4%
University science professor	3%
Professional academic scientist	2%
Science journalist/media	1%
Other	44%

N=190

Because NSF has a focus on increasing the science participation of historically underserved groups, we asked partners their own races/ethnicities. Across festivals, one-quarter of the partner representatives were non-white. NSF is also interested in the participation of younger professionals: 37% of respondents were younger than 35.

WHAT WERE THE BENEFITS OF SCIENCE FESTIVALS?

Attendees had high-quality informal science education experiences.

As illustrated in Figure 1, science festival participants had high-quality experiences. Table 6 breaks down these results across festivals and events in 2011 and 2012. Results were very stable from one year to the next. Overall, more than 80% of attendees rated their individual events as *very good* or *excellent*. The percentage of attendees rating individual events at this level ranged from a low of 50% to a high of 100%.

Figure 1
The Quality of the Festival Experience

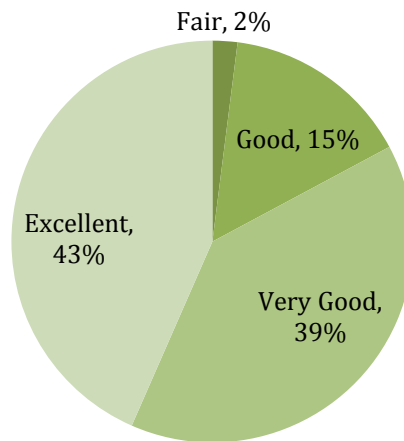


Table 6
 Percentage of Attendees Rating Events and Festivals as *Very Good* or *Excellent*, by Festival

	Festival A		Festival B		Festival C		Festival D	
	2011	2012	2011	2012	2011	2012	2011	2012
EXPO/Carnival	84%	83%	78%	88%	85%	83%	83%	84%
Event 1	94%	100%	92%	97%	98%	100%	100%	99%
Event 2	89%	100%	91%	92%	96%	92%	100%	99%
Event 3	89%	95%	91%	87%	95%	91%	99%	86%
Event 4	82%	93%	89%	83%	91%	91%	94%	86%
Event 5	80%	92%	84%	81%	85%	86%	91%	85%
Event 6	79%	86%	83%	80%	81%	86%	88%	84%
Event 7	77%	85%	77%	76%	75%	84%	82%	84%
Event 8	77%	82%	73%	76%	74%	84%	76%	82%
Event 9	75%	82%	72%	74%	67%	83%	74%	81%
Event 10	74%	75%	69%	74%	67%	83%	67%	80%
Event 11	72%	74%	69%	65%	50%	79%	57%	80%
Event 12	67%	66%	52%	62%	N/A	62%	N/A	54%
Total	81%	79%	78%	82%	86%	84%	85%	84%

In addition, in 2010, at 36 Cambridge Science Festival and 10 San Diego Science Festival events, a total of 1,358 attendees each chose three words to describe their experience. The “word cloud” below illustrates the results, with the size of the word corresponding to the frequency with which it was used. The public had a great time learning about science!



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Many attendees became notably more interested in, educated about, comfortable with, and connected to science.

Attendees learned about and became more interested in science as a result of festival experiences. They also had fun!

Science festival participants reported becoming more interested in science, learning something new about science, experiencing science learning as more fun and enjoyable, and feeling more connected to the science happening in their cities. See Table 7. Across festivals attendees rated them as having *some to quite a bit* of impact, on average, on these outcomes of interest.

Table 7
Science Festival Attendees' Ratings

Extent to which event ...	Mean (out of 5)	Percentage that reported quite a bit or a great deal of impact
Increased interest in science	3.66	60%
Made science learning fun	4.00	75%
Helped attendees learn something new about science	3.90	70%
Help attendees connect to the science happening in their cities ^a	3.63	59%

N=8577

^a Based on 2011 and 2012 data

Many attendees had meaningful interactions with science professionals, a first for some of them.

Attendees also reported whether they had had the chance to voice a question or comment in any discussion with a STEM practitioner, do an activity with a STEM practitioner in which they got to handle and manipulate materials, and/or hear a STEM practitioner talk about their work. See Table 8. Across the four festivals, a majority of attendees had heard a STEM practitioner talk about their work. About four in ten attendees had voiced a question or comment to a STEM practitioner and almost half had done a hands-on activity with a STEM practitioner. Figure 2 shows the percentage of respondents who had no interaction, one of these types of interactions, two of these types of interactions, and all three of these types of interactions; 88% of respondents had at least one type of interaction with a science professional, while only 12% had no interaction at all.

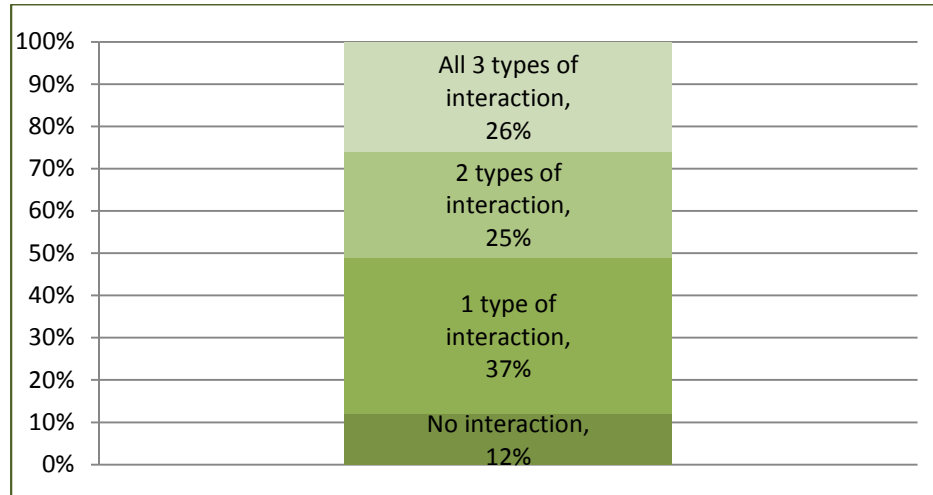
Table 8
Interactions with STEM Practitioners at the Festival

	Percentage
Voiced a question or comment in any discussion with a STEM practitioner	42%
Did an activity with a STEM practitioner where they got to handle and manipulate materials	48%
Heard a STEM practitioner talk about their work	78%

N=8487

Note: These results are based on 2011 and 2012 data. In 2010, 56% of respondents reported interacting with a science professional at their event and 56% reported completing an activity where they got to handle and manipulate materials in order to learn about science.

Figure 2
Levels of Interaction with STEM Practitioners at the Festival



In 2011 only, we asked respondents whether – before ever coming to the festival – they had had any of these types of interactions with STEM practitioners. While a majority of respondents had had previous interactions with science practitioners, 20% of those who had voiced a question or comment in a discussion with a STEM practitioner at the festival had never done so before the festival. Similarly, 21% of attendees who engaged in hands-on activities with a scientist at the festival had not had that experience before the festival. One in ten (11%) of those who heard a scientist talk about their work at the festival were having that experience for the first time.

Those attendees who had never had substantive interactions with science practitioners of the type offered by the festivals were more likely to belong to a minority group. Before coming to the science festivals, 39% of minority respondents had never voiced a question or comment in any discussion with a STEM practitioner, compared to 22% of white respondents ($p < .001$). Thirty-six percent of minorities had never done an activity with a STEM practitioner where they got to handle and manipulate materials, compared to 24% of whites ($p < .001$). Twenty-three percent of minorities had never heard a STEM practitioner talk about their work, compared to 11% of whites ($p < .001$).

The 2011 festival survey (unlike the 2010 and 2012 versions) also asked respondents to think about everyday things one might do related to science (e.g., science TV, reading, web), science places (e.g., science museums, aquariums), and science programs (e.g., clubs, citizen science programs), and then asked respondents the extent to which they had been involved in science in these ways over the past year and the extent to which they had learned or enjoyed science in these ways over the past year.

Across the four festivals, 19% of attendees had been involved in informal science education *only a little* or *not at all*, 25% had been involved *some*, and 57% had been involved *quite a bit* or *a great deal*. In terms of learning and enjoyment from informal science education, 9% enjoyed science *only a little*

Many attendees had never had substantive interactions with STEM practitioners of the type offered by the festivals and these attendees were more likely to be minority.

or *not at all*, 21% enjoyed it *some*, and 70% enjoyed it *quite a bit* or a *great deal*.

A majority of attendees were motivated to follow up in some way on something they had learned about at their festival and many returning attendees reported having actually followed up.

Across festivals, a considerable majority attendees were *likely* to *very likely* to talk about the festival with others, attend festival events again next year, and look for information on something they learned about at the festival. More visitors than not were also *likely* to *very likely* to take part in activities related to what they learned about at the festival and to use information from the festival in their work/studies. See Table 9.

Table 9
Percentage of Attendees Likely to Follow-up on Festival Experience

	Percentage likely or very likely
Talk about the festival with others	90%
Attend festival events again next year	84%
Look for information on something they learned about at the festival	79%
Take part in activities related to what they learned about at the festival	62%
Use information from the festival in their work/studies	51%

N=3939-4007

Note: These results are based on 2011 data, the only year in which these questions were included on attendee surveys.

In 2011, 72 Cambridge and 99 San Diego Expo/Carnival visitors who had attended the festivals in 2010 answered questions about their *actual* continued engagement with science after the 2010 festival. A total of 277 visitors (primarily those attending the Expo/Carnival) across all four festivals answered these questions in 2012 (when Philadelphia and the Bay Area held their second annual festivals).

The 2012 results are displayed in Table 10. A fairly sizable percentage of returning attendees had engaged in one or more of the following behaviors: looked for information on something they had learned about at their festival, taken part in activities related to what they had learned about at their festival, used information from their festival in their work/studies, and followed up with groups or organizations they learned about at the festival.

A majority of returning attendees had looked for information on something they had learned about at their festival, taken part in activities related to what they had learned about at their festival, or used information from their festival in their work/studies.

Table 10
 Percentage of 2011 Attendees Who Reported in 2012 Having Engaged in
 Follow-up Behavior

	Percentage
Looked for information on something they had learned about at the festival	69%
Took part in activities related to what they had learned about at the festival	64%
Used information from the festival in their work/studies (N=264)	58%
Followed up with groups or organizations they learned about at the festival	46%

N=259-265

STEM practitioners also benefit from their involvement with science festivals.

A majority (75%) of STEM practitioners who exhibited and presented at the four partner festivals reported increased confidence interacting with public audiences as a result. There was also evidence of their increased engagement in public outreach through festival-related experiences. When asked, a majority of partners (75%) reported having previous experience with Informal Science Education, but one-quarter (25%) were new to ISE. Thus, merely through partnering they increased their engagement in science outreach. More than half (55%) of the partners came from organizations that offered year-round K-12 ISE activities *directly associated with their festival exhibit or activity*, presumably offering opportunities for festival-goers to extend their ISE experience beyond the festival itself.

When asked to think about the upcoming year and their commitment to ISE beyond their science festival, partners (85%) were highly likely to contribute to local ISE efforts in the next year. On average, 30% more representatives planned to contribute to local ISE efforts in the next year than provided year-round ISE opportunities. This shows a driving interest and commitment to extend the circle of those who are effectively engaged by festival-related, year-around ISE initiatives.

Returning as exhibitors, presenters, collaborators, and sponsors was another indicator of the project's success. When asked in 2012 if they would participate in their city's 2013 science festival if given the opportunity, nearly every partner (88%) asserted they would. A small number of partners (10%) selected "Other," and these answers ranged from monetary concerns to relocation. The intentions of the partners to continue participating in their festivals also speaks to the quality of their experience and to the potential sustainability of the science festivals.

WHY WERE THE SCIENCE FESTIVALS EFFECTIVE?

There were some characteristics of attendees and their experiences at science festivals that helped explain why they had more or less favorable outcomes.⁵ The most important explanatory variables were those reflecting interactions with STEM practitioners during festival events. Attendees who did one or more of the following reported greater impact on their science interest, learning, and connection to local science than did their counterparts who did not interact with STEM practitioners in these ways:

- heard a STEM practitioner talk about his/her work,
- did a hands-on activity with a STEM practitioner, and/or
- voiced a question or comment to a STEM practitioner.

In addition, attendees who heard a STEM practitioner talk about his/her work and/or did a hands-on activity with a STEM practitioner rated their fun learning about science higher than did those who did not have such experiences. (Voicing a question or comment to a STEM practitioner did not predict whether attendees viewed the event as making science learning more fun.) See Table 11-13.

Table 11
Festival Success in Achieving Impacts, by Hearing a STEM Practitioner Talk about His/Her Work

To what extent did today's event ...	Percentage reporting quite a bit or a great deal	
	Heard STEM practitioner talk about work (N=6503-6541)	Did not hear STEM practitioner talk about work (N=1802-1824)
Increase your interest in science***	63%	47%
Make science learning fun***	77%	68%
Help you learn something new about science***	75%	56%
Help you connect to the science happening in your city***	62%	48%

p<.001

⁵ Our approach to this analysis was regression, a statistical method that accounts simultaneously for multiple confounding factors. The factors we examined were: the location of the festival, the year of the festival, the type of event (Expo/Carnival or other), interaction with a science professional at the festival (voiced a question or comment to a STEM practitioner or not, did a hands-on activity with a STEM practitioner or not, and heard a STEM practitioner talk about his/her work or not), gender, age (under 25 or not), race (white or minority), education (college education or higher, for adults over 25) and work/study in a STEM field. The effects reported here, therefore, are over and above any effects of the other variables included in the analysis. For example, the effects of interacting with a science professional at the festival are over and above any effect of working or studying in a STEM field. For the benefit of the reader, we have chosen to illustrate our findings using descriptive statistics rather than the actual regression results. The regression results are available upon request.

Table 12
Festival Success in Achieving Impacts, by Engaging in a Hands-On Activity with a STEM Practitioner

To what extent did today's event ...	Percentage reporting quite a bit or a great deal	
	Engaged in hands-on activity (N=3963-3983)	Did not engage in hands-on activity (N=4303-4332)
Increase your interest in science***	66%	54%
Make science learning fun***	83%	68%
Help you learn something new about science***	76%	66%
Help you connect to the science happening in your city***	66%	53%

p<.001

Table 13
Festival Success in Achieving Impacts, by Voicing a Question or Comment to a STEM Practitioner

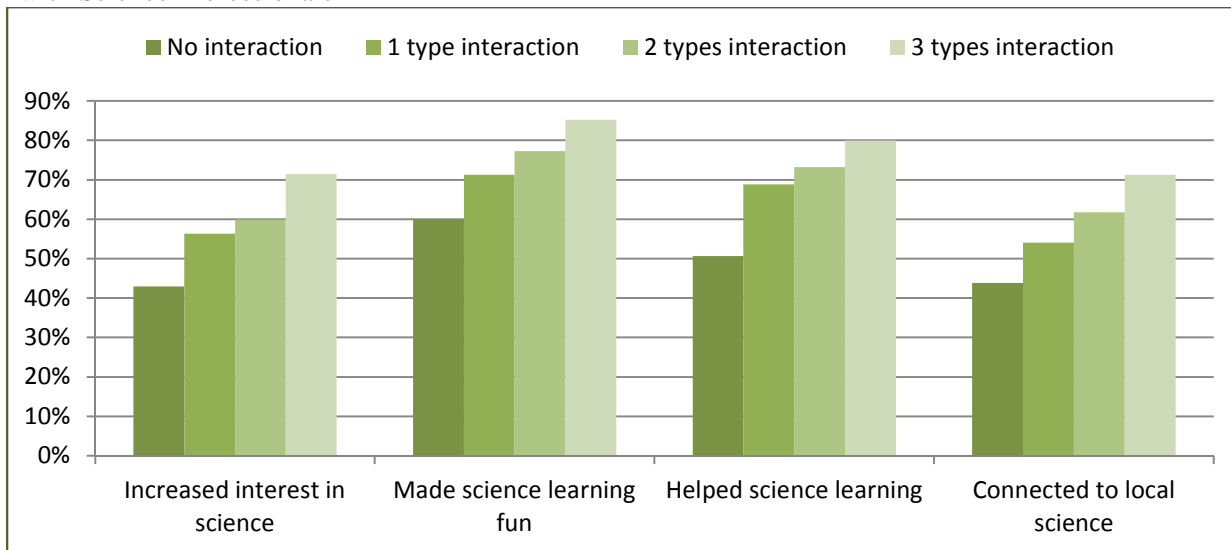
To what extent did today's event ...	Percentage reporting quite a bit or a great deal	
	Voiced question/comment (N=3439-3458)	Did not voice question/comment (N=4828-4859)
Increase your interest in science***	66%	55%
Make science learning fun***	81%	71%
Help you learn something new about science***	76%	67%
Help you connect to the science happening in your city***	67%	54%

p<.001

Attendees who intermingled with STEM practitioners at a festival had more fun, were more interested, and learned more than attendees who did not interact with a scientist.

In addition, we computed an “interaction score” for each respondent. The minimum score of 0 meant the respondent did not interact with a STEM practitioner in any of the above ways, whereas the maximum score of 3 meant the respondent had all three types of interactions with STEM practitioners. The results, shown in Figure 3, provide evidence of a “dosage effect”; that is, the greater the number of different interactions respondents had with STEM practitioners, the more impact they reported on their science interest, fun, and learning, and their connection to the science happening in their communities. On average, there was a 28% difference in the percentage reporting high impact between attendees who had no interaction and attendees who had all three types of interactions.

Figure 3
 Percentage of Respondents Reporting *Quite a Bit* or *A Great Deal* of Impact, by Level of Interaction with Science Professionals



There were other group differences⁶ that while statistically significant were not practically meaningful. These differences were detected as significant because of the very large sample size. The statistical significance simply means that the differences that were detected are real (i.e., not a fluke). However, it does not mean that the differences are important.

WHAT SUPPORT IS NEEDED TO INITIATE AND SUSTAIN SCIENCE FESTIVALS?

Individuals and organizations involved in initiating and sustaining new regional STEM celebrations relied on support from the Science Festival Alliance.

The SFA has supported 31 science festivals, including support to launch, offer specific programs, attract sponsors, gain visibility, and network with one another.

As of this final report, the SFA had formally supported a total of 31 science festivals or other STEM celebrations. This is 80% higher than its stated goal of supporting six festivals. These 31 festivals included the four SFA science festivals, with a major focus on the launches of the Philadelphia Science Festival and the Bay Area Science Festival (both new festivals launched

⁶ There were statically significant differences in outcomes between females and males (females had minimally better outcomes), between minorities and Whites (minorities had minimally better outcomes), between those who attended with children and those who did not (those in family groups had minimally better outcomes), between those who worked/studied in a STEM field and those who did not (those in STEM fields had minimally better outcomes), between Expo/Carnival attendees and other event attendees (Expo/Carnival attendees had minimally better outcomes), and between 2011 and 2012 respondents (2012 respondents had minimally better outcomes).

successfully under this project, in April 2011 and October 2011, respectively) and each hosted a second successful festival in 2012.

Among the other 27 festivals supported by the SFA were two statewide festivals, two festivals happening abroad, and three festivals whose first celebration was slated to occur before the end of 2013. The early Cambridge and San Diego festivals of the SFA directly inspired the *start* of 11 of these festivals and the SFA provided start-up support to a total of 18 festivals. The SFA manager personally provided direct consultation to all but two of the festivals.

The SFA has enabled specific programming for at least six festivals by fostering relationships with national exhibitors, or by offering a live link at one festival to an event occurring at another. The Alliance created sponsorship opportunities for six festivals, by promoting the sharing of corporate sponsor contacts. The SFA provided visibility to festivals by profiling them in the SFA-produced “First Look at Science Festivals” (five festivals) and by proactively garnering national press attention (12 festivals).

The network has provided on-the-ground support in the form of site visits involving at least 21 festivals. Eighteen festivals made site visits to other existing festivals prior to the start of their own festivals; and eleven made such visits after their first festival. Thirteen festivals served as hosts to other festival organizers, a practice encouraged and often facilitated by the SFA. Twenty-five festivals had advisory contacts with other festivals and 14 of the festivals had collaborated with other festivals.

Finally, the SFA facilitated the sharing of several key resources, including planning documents (20 festivals), online tools (18 festivals), evaluation resources (13 festivals), marketing materials (8 festivals), and programming support (6 festivals). In addition, representatives from 19 of the festivals attended IPSEC and representatives from 17 of the festivals attended SFA in-person networking sessions.

The Experience of the “First Four” SFA Festival Directors

We asked the four directors of the SFA science festivals to reflect on the most important ways in which being a member of the SFA had benefited their festivals. Several themes emerged. First and foremost was that the SFA had created a network of colleagues that can reach out to each other for input of every sort and create better programs and build upon their production value. The directors have spent time together revamping programs, both in terms of designing higher quality events and ones that penetrate target neighborhoods. They have discussed how to keep festivals fresh and exciting for partners who are handling much of the event production and design. They have revised models to engage corporate funders in new and interesting ways around STEM and have found that being able to leverage information from one another adds to their legitimacy as ISE programs.

This professional community of practice, in turn, has put their festivals in a broader context and facilitated a general awareness of the science festival movement. Directors cited the IPSEC meeting, in particular, for its value in enabling festivals to meet face-to-face, while discussing key hurdles for the

“My festival wouldn’t have happened at all without the SFA in-person meetings. There is no question I drew so many resources from SFA members.”

-Director of the Bay Area Science Festival

“The SFA was a source of motivation and our ‘cheerleader’ if you will.”

-Director of the San Diego Festival of Science & Engineering

movement. They also valued the opportunities they had through the SFA to visit other festivals to see firsthand new programming models that have allowed them to adapt successful events to their own festivals.

Another key theme was that of access to national professional associations and other important organizations outside of their regions and states. Directors emphasized they would not have obtained this access on their own. One way in which the SFA has accomplished this is by creating speaking engagements at key conferences, including AAAS, ASTC, and ACS President's Symposium. These SFA engagements in turn led to individual festival engagements (sometimes in the form of sponsorship) with scientific societies, such as ASHG, ASCB, and ACS.

A third way in which the SFA has benefited its founding members is by keeping on top of what is happening in the STEM world. In this way, the SFA has become the "go to" organization for the latest trends, concerns, and ideas on stimulating STEM informal education. The SFA has also provided directors with statistics and information on the national growth of festivals that they have used with potential funders.

An annual conference provided critical support for science festival organizers.

The SFA hosted two International Public Science Events Conferences (IPSEC), one in 2011 and another in 2012. Looking only at the one-third of post-conference survey respondents who were science festival organizers (N=54), more than half (59%) aimed to start or support the start of a science festival. The conference had other benefits that bolstered STEM practitioners to initiate, sustain, and improve their STEM celebrations. These benefits are discussed below, followed by Tables 14-16 presenting the relevant data.

The conference provided for face-to-face networking between attendees that was likely to lead to greater collaboration. This was perhaps the most successful aspect of the conference. Respondents mostly rated the range of attendees and the opportunities to network at the conference as *very good* and 88% said the conference had either *quite a bit* or *a great deal* of impact on their forming new connections and relationships. After the conference, nearly three-quarters of respondents said they would *definitely* be following up with someone they met at the conference for the first time to *obtain* information and resources. Similarly, approximately three-quarters of respondents said they would *definitely* be following up with someone they met at the conference for the first time to *share* information and resources.

The conference fostered exchange that demonstrated potential to improve the quality of science festivals and science cafes. On average, respondents rated the range of conference speakers and presenters as *very good*. They also felt the conference had *some* to *quite a bit* of positive impact on their understanding of how their work fits into a larger field, their conceptions of public engagement in science, their public science event practices, and their information and resources to start or help sustain a new public science event. All of the respondents reported that the conference had met their

The SFA's International Public Science Events Conference inspired many science festival organizers to commit to starting or supporting the start of a science festival.

expectations, either generally (11%), mostly (36%), completely (30%), or that it had exceeded their expectations (22%).

The conference created a current snapshot of public science engagement strategies related to events. After the conference, more than half of respondents said they would *definitely* adopt a new practice for their science event that they had learned about at the conference for the first time. Science festival organizers were more likely to do so than were organizers of cafes and other public science events.

The conference increased awareness of the SFA. Fifty-nine percent of respondents said the conference had increased their awareness of SFA resources and support either *quite a bit* or *a great deal*. Half of all respondents and 68% of science festival organizers were *definitely* going to follow up with the SFA after attending the conference.

Table 14
Participant Ratings of Conference Quality

	Poor	Fair	Good	Very good	Excellent
Range of topics	0%	4%	31%	48%	18%
Range of presenters	0%	6%	26%	47%	20%
Range of attendees	0%	5%	17%	48%	30%
Opportunities to network	0%	3%	19%	49%	29%
Schedule of events	0%	1%	26%	57%	16%
Size of conference	1%	1%	20%	45%	32%
Conference facility	0%	6%	25%	41%	28%
Time of year ^a	0%	0%	26%	51%	23%
Proximity to ASTC ^a	8%	5%	32%	16%	40%

N=138-140

^a Asked only after the second IPSEC (N=38-43).

Table 15
Extent to which Conference Benefited Participants

Benefits	Not at all	Only a little	Some	Quite a bit	A great deal
Better understanding of how your work fits into a larger field	1%	4%	25%	34%	36%
New/improved conceptions of public engagement in science	1%	2%	31%	40%	26%
New/improved public science event practices	1%	2%	29%	45%	23%
Increased awareness of SFA resources/support	3%	7%	31%	37%	22%
Information/resources to start a new public science event	2%	8%	27%	44%	19%
Information/resources to help sustain a public science event	2%	5%	35%	46%	12%
New connections/relationships	0%	1%	12%	39%	49%

N=113-140

Table 16
Public Science Event Practitioners' Planned Behaviors

	Definitely	Possibly	Probably not/No
Follow up with someone you met at the conference for the first time to obtain information or resources	74%	26%	1%
Follow up with someone you met at the conference for the first time to share information or resources	74%	25%	1%
Adopt a new practice for your science event that you learned about at the conference for the first time	52%	40%	8%
Start (or support the start of) a science festival	30%	39%	31%
Start (or support the start of) a science cafe	27%	41%	32%
Follow up with the Science Festival Alliance	51%	49%	1%

N=131-141

Public science event practitioners who attended felt the SFA Conference had *some to quite a bit* of positive impact on their understanding of how to reach and impact target audiences through public science events. See Table 17.

Table 17
Extent to which Conference Benefited Participants

Benefits	Not at all	Only a little	Some	Quite a bit	A great deal
Increased understanding of how to reach target audiences through public science events	2%	6%	39%	35%	17%
Increased understanding of how to impact target audiences through public science events	2%	6%	28%	37%	27%

N=130-132

Needs Assessment of Planned SFA Deliverables

As the SFA's first grant culminated and its second grant began, we conducted a brief needs assessment to ensure that the next phase of planned network activities and resources were those that science festivals most needed in order to respond to common challenges they face. We sent an invitation to an online survey to 23 festival organizers and received complete survey responses from 18 (78%). The results, shown below in Table 18, supported the future direction of the SFA.

Table 18
Number of Science Festival Organizers Desiring Planned SFA Resources

	Not at all desirable			Highly desirable
An inventory of SF programming effective in engaging hard-to-reach audiences	0	1	2	15
An online catalog of innovative science festival event ideas and formats	0	0	4	14
Guides to share with scientists on what constitutes an effective exhibit	0	1	5	12
A hands-on activity database to share with festival exhibitors	1	0	6	11
Help establishing mentoring relationships with other festival organizers	0	3	5	10
An “asset analysis tool” to help build partnerships and resources to effectively engage hard-to-reach audiences	1	1	6	10
Networking events associated with conferences and science festivals	0	2	8	8
Help establishing partnerships with national scientific societies	1	3	6	8
Strategies for using collaborations to extend science festival impacts across larger geographic regions	0	2	8	8
A guidebook for leveraging your existing science festival calendar system	1	4	5	8
A community organizing workshop	0	2	8	8
In-person communications workshops for scientists involved in your festival	1	5	6	6
A platform for disseminating new findings on issues of importance to the science festival community	0	2	13	3
A website that serves as a clearinghouse of science festival-related information	0	2	13	3

HOW SUSTAINABLE ARE SCIENCE FESTIVALS?

One of the overall goals of the SFA was been to facilitate sustainable growth of science festivals, beginning with its own four founding members. SFA data provides preliminary evidence of the four founding festivals’ transition to sustainability. This includes increasing percentages of festival budgets secured from sources other than NSF as well as increasing levels of festival attendance and general ISE attendance.

These results should not be generalized to other science festivals. As one SFA science festival director put it, *“I think that the best advice we can give a new festival is to look at financial sustainability early, seriously, and build accordingly, instead of the other way around.”*

Festival Donorship/Sponsorship

The SFA science festivals each showed an annual increase in the percentage of their festival budgets secured from sources other than NSF, including from festival donors and sponsors. See Table 19. The consolidating/maturing festivals, Cambridge and San Diego, have required proportionately less direct grant support than their new, start-up counterparts. As the festivals reached the end of their initial 2-3-year maturation process, each was on track to operate without further federal grant support.

These transitions to sustainability were not without challenges. In the words of one of the directors, *“The past three years ... was possible through a great deal of budget cutting, over-the-top fundraising efforts ..., a cash flow situation that is not desirable to most organizations, and what I would call a very big danger of ‘burning out staff’ over time.”*

Table 19
Percentage of Festival Budget Secured From Sources Other Than NSF

	Year 1	Year 2	Year 3
Cambridge	77%	82%	87%
San Diego	44%	61%	73%
Bay Area	40%	63%	69%
Philadelphia	45%	63%	63%
Total	54%	67%	73%

Festival Attendance Levels

The SFA festivals each either met or exceeded their audience target level of 25,000-50,000. See Table 20. Of note, the two new festivals well exceeded their targets. The festivals also achieved their secondary audience target level of 125-150 exhibitors, presenters, collaborators, and sponsors. See Table 21.

Table 20
Estimated Festival Attendance

	Year 1	Year 2	Year 3
Cambridge	~40,000	~50,000	~40,000
San Diego	55,000	55,000	50,000
Bay Area	N/A	70,100	53,609
Philadelphia	N/A	124,500	91,500

Table 21
Estimated Number of Exhibitors, Presenters, Collaborators, and Sponsors

	Year 1	Year 2	Year 3
Cambridge	200+	200+	200+
San Diego	143	135	146
Bay Area	N/A	300+	287
Philadelphia	N/A	176	185

General ISE Attendance

Finally, results from our survey of SFA partners provide evidence of an increase in general ISE attendance. See Table 22. Within approximately six weeks of the SFA science festivals, about one in four of the festival partners had received follow-up phone calls or emails from festival attendees and about three in ten had received visits or enrollment from festival attendees. These data suggest that audiences engaged by festivals may subsequently engage in year-round ISE activity.

Table 22
2012 Science Festival Partners' Follow-up Results

	Percentage
Follow-up phone calls or emails from Festival attendees	43%
Follow-up visits or enrollment from Festival attendees	27%

N=188-193

CONCLUSIONS

Based on the evaluation results, we offer the following conclusions about the SFA science festivals, cautiously generalizing to other science festivals:

- Science festivals help address equity issues in the informal science education sector. Most notably, the festivals offered many attendees first-time substantive interactions with STEM practitioners. A higher proportion of “first-timers” were racial minorities.
- Science festivals further contribute to the informal science education sector by providing the public with the opportunity to learn about science while having fun, and, uniquely, to connect to the science that is happening in their own communities. This connection motivates further engagement with science beyond the festival itself. These opportunities are enhanced through the interactions with STEM practitioners that are a hallmark of the festivals.
- Science festivals also provide scientists and other STEM practitioners the opportunity to be a part of growing community of practice as well as establish connections with the public. This type of networking, in turn, builds the confidence of science professionals to continue seeking out ways to engage the public in their work.
- Science festivals need support. They need help getting off the ground, developing innovative programming, growing, and sustaining their festivals. The Science Festival Alliance has become the “go-to” organization for this much-needed support. It is a vibrant and increasingly connected network that is developing the types of resources in high demand from science festival organizers. As the SFA continues to foster more and better science festivals, one of its most important tasks becomes creating its own sustainability plan.

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