Research and Development on Understanding STEM Identity Using Live Experiences
Summative Report
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A Report Prepared for Pratt Institute

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Executive Summary

Introduction

Dedicated science learning spaces such as science museums, science cafes, or science media attract mostly those who seek out science learning experiences. This self-selection represents a major challenge for broadening participation in informal science learning (ISL). In this project, we examined an approach to ISL that aims at reaching audiences who may not ordinarily engage with science. Termed Guerilla Science, this approach blends elements of *access*, by removing barriers to participation by embedding science into unexpected places, with those of *inclusion*, by designing activities that speak to the learning identities of participants.

Guerilla Science is a model and an organization of the same name that blurs the boundaries between ISL and cultural experiences and spaces. Guerilla Science develops live events that bring scientists into face-to-face contact with the public as part of transdisciplinary immersive story worlds that draw on elements of theatre, visual arts, and music—elements to which, by design, the visitors relate and therefore find *inclusive*—and embeds these events into places and spaces where science is unexpected, for example, music and arts festivals, disused urban spaces, and nightclubs—locations which, again by design, visitors find *accessible* (Rosin, Wong, O'Connell, Storksdieck & Keys, 2019; O'Connell et al., 2020). These live events aim to create unique opportunities to engage with science for culturally-interested publics who typically do not choose to attend science events or otherwise engage in science (Barron, 2006; Miller, 2010).

A primary focus of this study is to investigate whether Guerilla Science is accomplishing this goal, and therefore test whether providing easy access and designing inclusive experiences is indeed enough to attract some audiences to science, or whether, when an opportunity to engage with science is presented in non-science contexts and in atypical formats, these activities still just attract those portions of the audience who are already part of the 'science choir.'

Scope of the Study

The project and evaluation included multiple activities: Guerilla Science (GS) events featured at festivals and multiple professional development programs. Guerilla Science events were featured at the Oregon Eclipse Festival and the Figment Festival. The Oregon Eclipse Festival combined music, arts and culture, and was held around the date of the total solar eclipse in 2017 (August 21, 2017). It took place at Big Summit Prairie, Oregon, from August 17 to 23, 2017, and attracted approximately 30,000 attendees. The Figment Festival took place on June 23rd and 24th, 2018 on Governors Island, a 172 acre island in the heart of New York City's harbor; a five minute public ferry ride away from Brooklyn and Lower Manhattan. It hosts a rich array of arts, culture and educational programs - nearly 70 free exhibitions, installations, performances and festivals in 2018 - as well as expansive open spaces and historic buildings. During FIGMENT, Guerilla Science transformed a disused officer's quarters on Governors Island into the "Sensorium," an otherworldly exploration of how the human body works inside and out.

In support of the Oregon Eclipse Festival and the Figment Festival, Guerilla Science designed and implemented an Art-Science Residency. In both cases, the Art-Science Residencies supported teams of artist, writ large, and scientists working together to create and produce an

original work for Oregon Eclipse and the Figment Festival. The residencies included skills-based workshops, weekly meetings, curatorial guidance, and an iterative development forum for residents to share their work with each other. . The 2017 residency for Eclipse provided a more intense experience with in-person workshops, and in some cases, studio space and access to fabrication facilities at the Pratt Institute, whereas the 2018 residency for FIGMENT was entirely virtual up until just before the festival.

Building on lessons learned from the festival programs, Guerilla Science created and executed a further follow-up activity in the form of a professional development workshop for two cohorts of science and art professionals. Each professional development experience consisted of a three-day workshop at the New York Academy of Sciences and field experience in August and September 2019. The field experience consisted of a public festival event at which graduates from the workshop created, performed, and engaged large, scientifically-underserved audiences in a range of pop-up, immersive, and playful events.

This summative evaluation report focuses on the following research questions:

1. Who participates in the Guerilla Science events and what are their motivations for participation?
2. What impact did Guerilla Science at Festivals have on audiences?
3. How effective were the professional development models developed and implemented by the project, both for Artist/Scientist Residencies and for Science Communication professionals?

At both festivals, we conducted a multi-method study that included participants who engaged with Guerilla Science events and those who did not, with a focus of understanding whether these two groups were different in key characteristics associated with their interest in, and engagement with science.

For the Artist/Science Residencies, we conducted pre/post interviews with the residents investigating motivations for participation, identity, and expectations and the experience itself. For the purpose of this report, we provide results from only the 2018 residency (FIGMENT).

For the professional development experience at the New York Academy of Sciences, we used workshop observation, workshop post-surveys, field experience post surveys, and a six month follow-up survey to provide feedback about: 1) the quality and usefulness of the professional development experience for participants, and 2) effectiveness of the professional development experience for achieving the key participant outcomes of increased dispositions to and increased self-efficacy in three areas: 1) creating experiences that live in the intersection of science and theatre, 2) creating experiences that connect to the emotions and interests of the audience, 3) creating experiences that communicate science in non-science settings.

Results

Festival Audience Characterization

Science Interest

We gathered data on audience members who attended the Guerilla Science events at both festivals. We grouped respondents into five audience segments, ranging from 'science enthusiasts' to 'disconnected from science' (Table 1). People from all audience segments participated in the Guerilla Science activities at both festivals. Across both festivals, about a third or more of Guerilla Science participants were 'disconnected' or 'uninterested' in science, showing that embedding science into unexpected cultural spaces (as represented by Guerilla Science events) can attract an audience beyond the science choir. Overall, a higher percentage of participants in Guerilla Science Sensorium (GSS) were segmented as science disconnected or uninterested as compared to the comparison group of individuals who attended FIGMENT. This result strongly supports the underlying hypothesis that GSS was able to attract participants beyond the science choir, even at a greater proportion than the FIGMENT Festival and Governor's Island itself. This kind of result was not as strong at the Oregon Eclipse festival, where participants segmented as science connected and science enthusiasts were slightly more likely to opt into GS activities, which might reflect the potentially different context for FIGMENT vs. the Eclipse Festival. FIGMENT is a free, participatory event on Governors Island, which is a five minute public ferry ride away from Brooklyn and Lower Manhattan. The island is a popular seasonal destination for locals and tourists during the summer months with tens of thousands visiting each weekend. On the other hand, the Oregon Eclipse Festival was situated in rural Oregon in an area devoid of cell phone reception and permanent infrastructure, where attendees paid a significant entry fee to spend five days camping and enjoying a wide variety of day- and night-time activities.

Table 1: Sample composition by science interest segmentation

	FIGMENT		Oregon Eclipse	
	Guerilla Science (n=227)	Comparison (n=627)	Guerilla Science	Comparison
Science Disconnected	21%	13%	9%	14%
Science Uninterested	21%	13%	23%	22%
Science Interested	37%	39%	30%	35%
Science Connected	13%	25%	25%	19%
Science Enthusiast	8%	9%	13%	10%

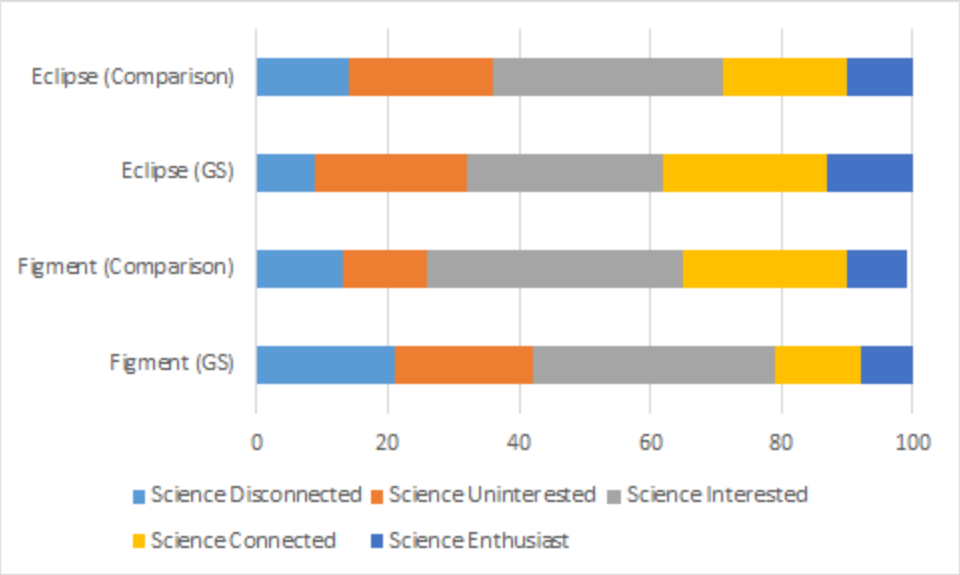

Figure 1.

To give context about participants at Guerilla Science events, we asked visitors to the GSS at FIGMENT about their prior engagement with science-oriented and art-oriented spare-time activities that require visits to specified locations. While national data suggest members of the public have higher visitation rates to science-related places than art-related ones (NSB, 2018), GSS seems to have attracted an audience that is more art- than science-oriented with regard to their spare-time engagements. In comparison to national data that reports 58% of the adult population visiting some kind of informal science institution at least once a year vs. 33% who visit art museums at least once a year (NSB 2018), our data indicate that GSS participants may not only have a much higher interest in all things cultural (whether they are art or science related), but show much stronger relative participation levels in art vs science (namely roughly equal) to the one in the general public. 82% of GSS participants visited an informal science institution at least once during the prior year, and 91% did so for art-related places. Thus, FIGMENT festival-goers represent a slice of the population that generally engages in cultural activities and make use of cultural institutions in their environment. The data become even more dramatic when we look at higher frequency visits that may not show up in aggregate annual data: 50% of GSS participants stated that they visit art-related spaces at least once a month vs. only 20% who visit informal science institutions once a month. That is, coarse national indicators might not capture the true story of difference in the expression of art and science engagement in GS-typical populations. These finer-grained data suggest that GSS attracts an audience that, on average, attends science-related activities far less frequently than art-related events, and therefore express a much stronger affinity for art than for science, while also representing an audience that may visit science institutions more frequently than the average US resident. The data, therefore, suggest that GSS attracts and serves an audience that while far more art- than science-oriented might nonetheless engage in science-oriented spare-time activities, but less so out of string interest in science, but because a general high level of participation in all cultural places, spaces and opportunities.

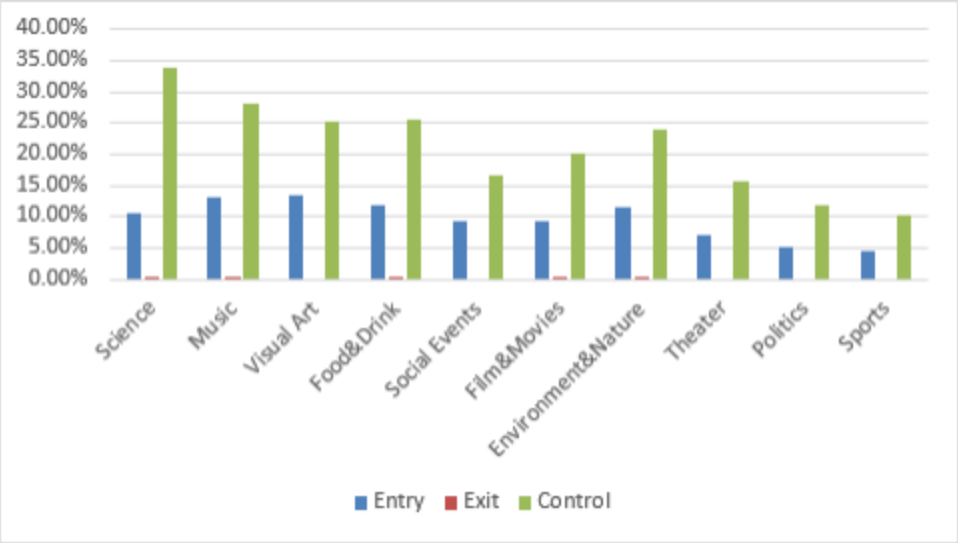

Figure 2. Distribution of how respondents (GSS participants and Comparison) chose from a 'list of topics that best describe you and your interests' (check all that apply). n= 1234

Table 2: Prior engagement with art and science; only GSS participants (n=232)

"Can you tell me how many times you have visited *[…]* in the past year, that is, the past 12 months?"	*[zoo or aquarium, natural history museum, or science or technology museum]*	*[art museum, gallery, or concert]*
I've gone at least once a month	22%	50%
I've gone every couple of months	33%	34%
I've gone at least once this year	27%	7%
It's been over a year since I've gone	9%	1%
I can't remember the last time I went	6%	4%

Motivation

Curiosity was the primary motivation for participating in Guerilla Science at the Oregon Eclipse Festival. In general, each audience segment had a range of motivations for participating in Guerilla Science, indicating that the distribution of participants' relationship to science, from science disinterested to science enthusiast, had little to do with their motivation.

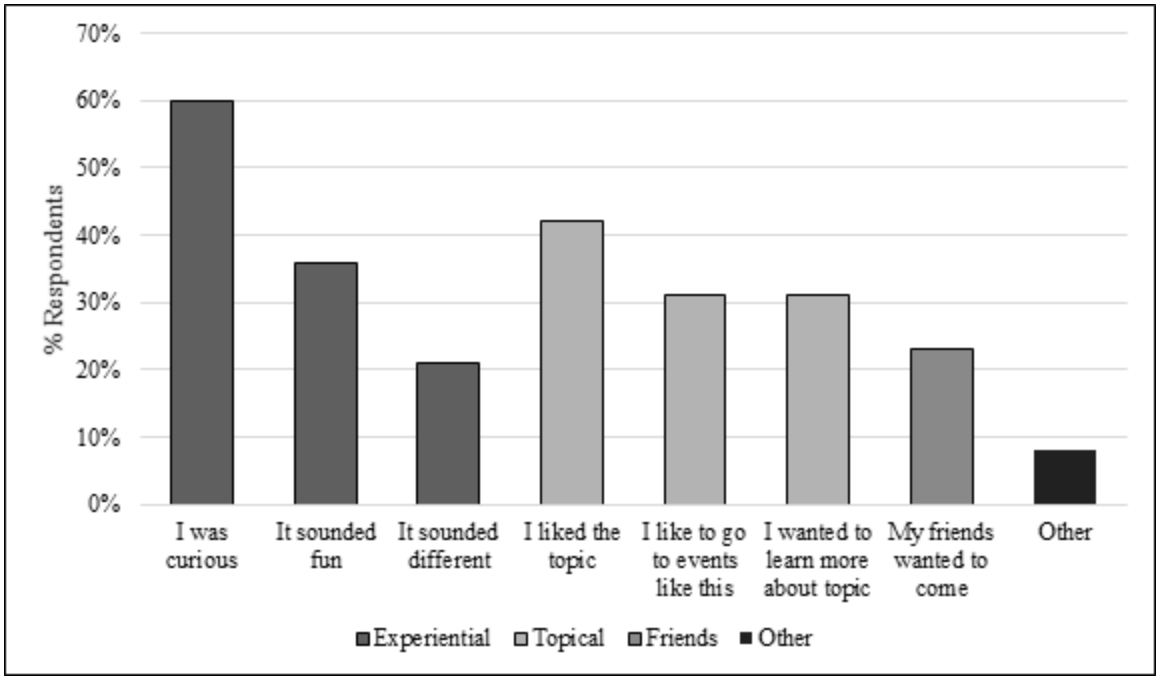

Figure 3. Motivation for participation in Guerilla Science at Oregon Eclipse. Distribution of how Guerilla Science participants responded to, “why did you decide to come to this Guerilla Science event (check all that apply)?’ n=567. Principal Components Analysis indicated that eight distinct motivations could be grouped into four motivation categories (Experiential, Topical, Friends, Other).

When choosing from a close-ended list about motivations for participating in the GSS , on average, respondents chose 2.4 of 6 answer options, showing the complexity of visit motivations. The dominant reason for attending within a complex set of motivations was to experience something new, which was chosen by 56% of respondents. But the picture that emerges from the answer choices is that GS attendees wanted to experience something novel with friends or family that was culturally enriching and entertaining.

Table 3: Reasons for attending the Guerilla Science Sensorium at FIGMENT

	Percent of respondents (n=227)
To experience something new	56%
To have a social experience	44%
To explore culture or increase knowledge	37%
To spend time with family	37%

To relax or refresh	31%
To escape routine	28%
Tagged along	10%

Audience Takeaways

Learning about science was not the most common motivation for participating in GS participants, but most of their immediate primary takeaways were (science) learning-related. Most of the respondents' comments referenced specific facts they discovered or experiences that instilled new topic-related knowledge, and overall, participants' responses indicated positive experiences and takeaways.

Science relationship had little influence over what participants took away from their Guerilla Science at Oregon Eclipse experience ($p>0.05$). Overall, participants from all audience segments described Guerilla Science events positively, most often as 'thought-provoking,' 'informative,' or 'fun,' and rarely as 'intimidating,' 'confusing,' or 'boring' (Table 3). These responses are an indication that their experiences aligned with the stated goals of Guerilla Science, namely to have enjoyable encounters during which they have opportunities to learn about science (Rosin et al., 2019).

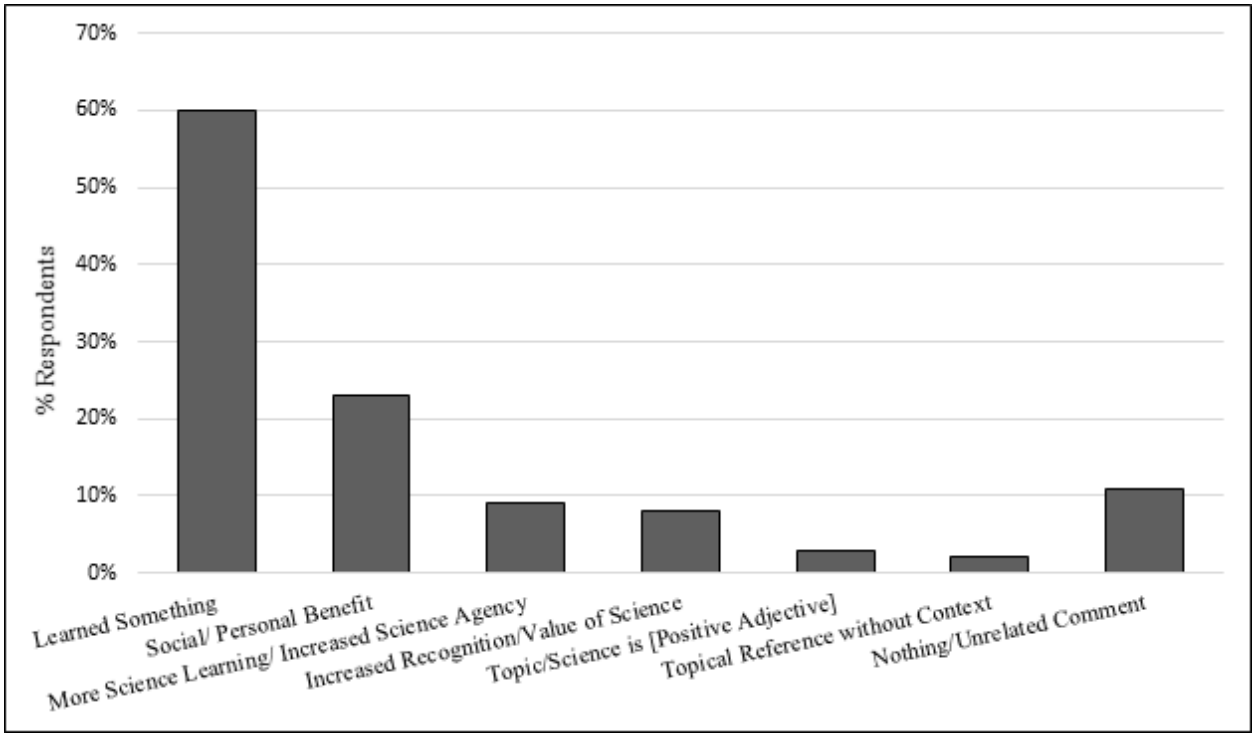

Figure 4. Guerilla Science participant takeaways from Oregon Eclipse. Responses from, ‘What did you take away from this event?’ Question was asked open ended and responses were coded for emergent themes. n=492. Some respondents gave multifaceted answers that elicited more than one code.

At FIGMENT, exit interviews and written feedback forms included a closed-ended question around take-aways that provided a rough estimate of the self-reported impact on participants. Written feedback forms resulted in about twice the rate of answers than exit interviews, but again a similar pattern emerged between both forms of audience feedback. A catch-all response item (I had a great experience) garnered the highest response, followed by perceived knowledge gain, and increased appreciation for science and for art. Few respondents did not experience any of the provided answer options.

Table 4: Take-aways from the experience at Guerilla Science at FIGMENT (check all that apply)

	Percent Exit Interviews (n=326)	Percent House feedback forms (n=202)
I had a great experience	38%	74%
I've gained new knowledge	28%	61%
I gained an increased appreciation for science	23%	50%
I gained an increased appreciation for art	25%	46%
I realized something about myself	10%	25%
I realized I can learn science	8%	19%
I experienced none of these things	5%	7%

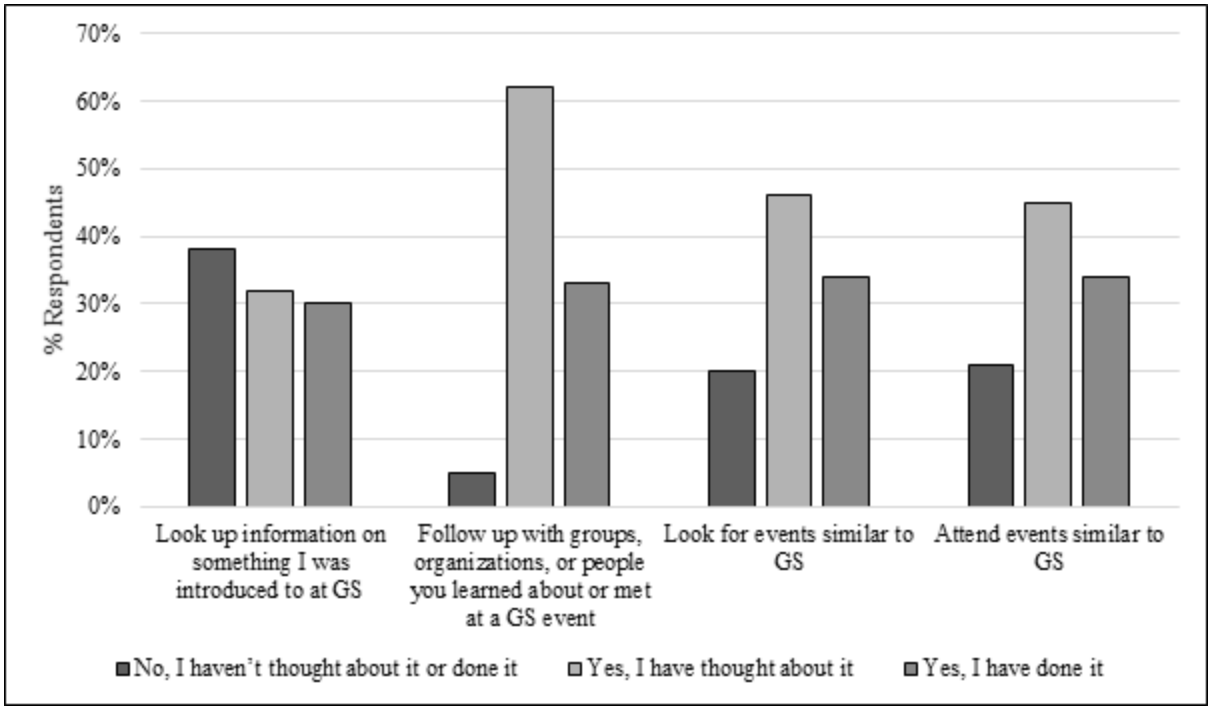

Figure 5. Follow up after participation in Guerilla Science (GS). Since attending the Guerilla Science event(s) at Oregon Eclipse Festival, have you considered or done any of the following? Responses (n-82) from an online follow-up survey sent 12 weeks after participation in Guerilla Science at Eclipse.

Professional Development

Art-Sci Residency

Artists and scientists who joined the festival residency programs were excited about the opportunity to combine science and art, and to work with Guerilla Science, specifically because of its playful nature. They described excitement about the residency nature as less prescriptive, less boring, more creative, more open to interpretation, and open to all audiences. Many were excited about the festival component, however, in the second iteration of the residency, several noted concern and/or disappointment in switching from Lightning in a Bottle (festival in California) to FIGMENT. Residents' expectations included learning how to do experiential science communication, taking an idea from conception to design to implementation, learning audience engagement strategies including how to try to make sure people leave with a lasting impression, and receiving general support and community-building Expectations for FIGMENT include interacting with audiences and hoping to leave lasting impressions. Larger ambitions include changing people's perspectives on life and how they interact with the world and with others.

In the interviews post FIGMENT, residents shared that they valued the opportunity to collaborate with others who share a different perspective than they do (i.e. artists and scientists working

together). Few Residents noted a shift in their own identity, though the general consensus was that the Residency boosted their confidence in engaging with the other side of the art-science spectrum and their abilities to create successful interactive experiences that incorporate authentic science. Residents had noted that they already existed, or wanted to exist, in this space of "not quite artist, not quite scientist" and the GS Residency really gave them the opportunity to mesh these identities and opened pathways forward for work and collaborations in the art-science arena. One resident noted that, "I actually feel really interested in doing more experience design work now. I feel like this [Residency experience] has totally shifted my career path. [It has had a] very large influence on me." Many shared that the community-building potential of this Residency was one of the more exciting aspects, but often felt that it fell short, mostly due to its virtual nature.

Many Residents shared that the GS residency really gave them the opportunity to put into motion projects that had already been percolating for some time, but they didn't have the means or the wherewithal to pursue them. The Residents valued working with GS and the expertise that GS brought to their development. Residents shared that GS really helped them understand how to do experiential, immersive experiences, and how to do them well. Residents shared that GS helped to instill the importance of starting with, and continuing to focus on, the audience as the central actor in the experience. Along with this, to pay careful attention to the environment and what the audience might be looking to get out of engaging with you (e.g. what is a person at FIGMENT wanting to experience). Along this same line, most Residents noted the lack of control they felt, the uncertain nature of working in a festival setting and the continually changing directions and context that were shared with them (examples shared: the change from LiB to FIGMENT, the uncertainty of if GS would be staged in a house or entirely outside, which individual Residents would be inside versus outside, which rooms they would have, what the rooms looked like (dimensions, set up, etc.), what the crowds would be). Despite the high variable nature of planning for a festival event, like FIGMENT, all agreed that GS's help on the ground at the festival was invaluable. For example, the guidance and support with set up and break down was especially helpful. The fact that GS was so experienced with festivals and these types of events in general meant that often GS had thought of and prepared for things the residents hadn't—and were prepared with support for them.

New York Academy of Sciences

A year after FIGMENT, GS launched a professional development program for 30 people, hosted at the New York Academy of Sciences. The majority of the attendees who responded enjoyed and valued both the workshop and the field experience. They felt excited and inspired and felt they took away useful ideas, tools, and potential collaborations that would help them in their work. They discussed the networking, ideas and practical tips for developing public engagement experiences, and having a "safe place where we could fail and learn" as especially helpful elements of their professional development experience. However, participants expressed disappointment and frustration that they did not get more time for creative collaboration and to work on a new science-art experience they could use in their own situation. Many participants had expected more making and creating together based on the advertisement and recruitment

information about the workshop. Most of the same participants who expressed these disappointments, still expressed having a positive experience. After the workshop and field experience, a majority of respondents to the survey reported they felt more committed, prepared, excited, and confident about creating experiences that live in the intersection of science and theatre, connect to the emotions and interests of the audience, and that communicate science in non-science settings. Several participants shared examples of the public engagement activities they conducted after the professional development experience. We provide several recommendations for future professional development, including the incorporation of more opportunities for creating and making in a collaborative, interdisciplinary way, building up and expanding upon the successful networking aspect of the experience, and development and advertisement of clearer objectives.

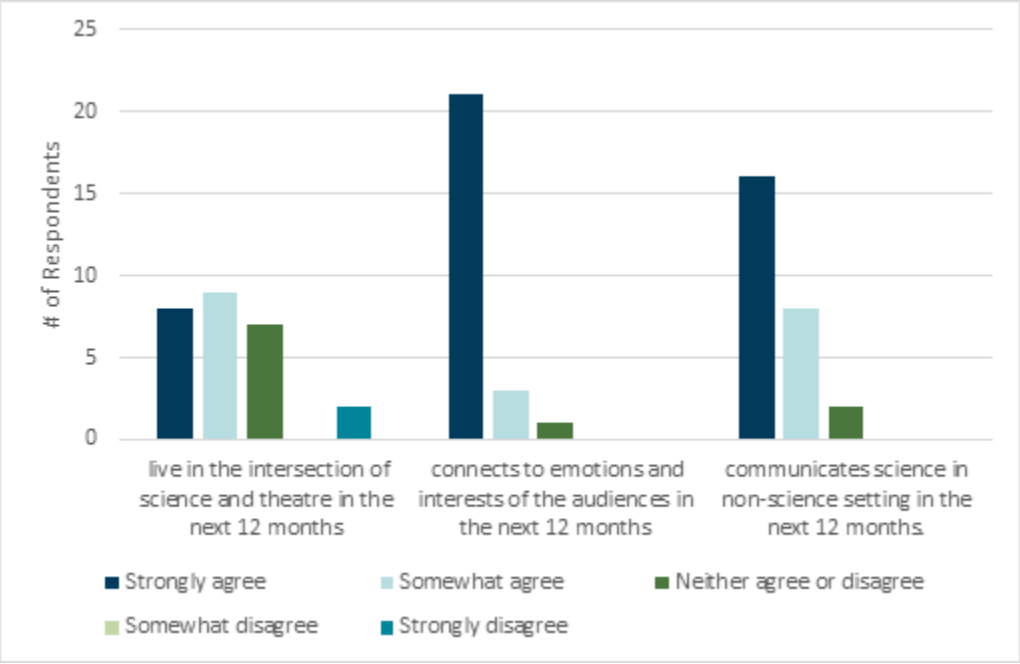

Figure 6. Responses to a Likert scale question about intention. Figure shows data from three questions that all started with, "Since participating in Conveying Science through Art: A Public Engagement Workshop and Field Experience, I intend to create an experience(s) that….." n=26.

Respondents expressed strongest intention for creating an experience that connects to emotions and interests of the audiences in the next 12 months. This takeaway was also often mentioned in open-ended answers about their takeaways (see above). Intentions were not nearly as strong for creating an experience that lives in the intersection of science and theatre in the next 12 months, which is also supported in data.

Figure 7. Examples of public engagement events facilitated by participants in the six months after the professional development experience and their reflection about what they wished they knew from the beginning.

Conclusions

Providing access points to science engagement within non-science cultural contexts and designing the science experiences to align with cultural identity of the audience represents an evidence-based practice for broadening participation.

This study provided evidence for a model of engaging adults from beyond the science choir in ISL. The model combines elements to improve access *and* inclusion. Firstly, it provides access points to science engagement within non-science cultural contexts where people who do not normally engage with science gather, thereby minimizing elements of self-selection and exclusion. Secondly, the science experiences are designed to align with audience expectations (e.g., access) for these cultural settings. Termed Guerrilla Science, this model is promising for

providing opportunities for new audiences to engage with science. Evidence collected about the Guerilla Science participants and their take aways at a large multi-day music and/or art festival demonstrated that a broad spectrum of festival goers, from those with little or no connection and interest in science to science enthusiast participated. Not only was Guerrilla Science successful in reaching beyond the 'science choir,' participants also identified the experiences as enjoyable and of value for learning. We found that people chose to participate out of curiosity and benefited because they learned something new. We acknowledge the limitation of the study - we would not expect those with low cultural capital or limited financial means to attend cultural festivals with a significant entry fee (Dawson; Jensen & Wright, 2015); nonetheless, the study indicates that using elements of cultural inclusion in Informal Science Education and Science Communication represents an evidence-based best practice for broadening participation.

Technical Appendix

Data collection and analysis

Oregon Eclipse Festival

We sampled from both the general Oregon Eclipse Festival population and the population of participants of Guerilla Science events. We employed a combination of methods with the aim of methodological triangulation (Jensen & Buckley, 2014). Data collection instruments (see supplementary materials) included short entry and exit 'spot' interviews at the Guerilla Science tent surrounding exhibits, paper-pencil feedback forms available at the event for post-event completion, in-depth structured interviews, 'spot' interviews of Eclipse goers who did not attend Guerilla Science, and an online follow up questionnaire administered around twelve weeks after the event. We designed the data collection approach and instruments to collect unmatched pre and post data as we did not anticipate the ability to capture the same individuals at multiple times. Each instrument used a combination of closed-ended and open-ended questions to gather a robust set of data (Table A1).

Table A1. Overview of instruments and population from which they sampled.

Instrument (n)	Population	Constructs
Entry Spot Interview (n=173)	Guerilla Science Participants, before events	· Views on science · Engagement with science · Motivation and expectations for attendance

Exit Spot Interview (n=185)	Guerilla Science Participants, after events, as they exited the tent	· Views on science · Engagement with science · Perceptions and evaluation of event · Takeaways from participation
Feedback Form (n=300)	Guerilla Science Participants, immediately after events, before they exited the tent	· Views on science · Engagement with science · Perceptions and evaluation of event · Takeaways from participation
Structured Exit Interview (n=95)	Guerilla Science Participants, after events, in a “tea tent” next to the main tent	· Views on science · Engagement with science · Perceptions and evaluation of event · Takeaways from participation · Comparisons to other Eclipse events · Demographics
Roaming Spot Interview (n=149)[1]	Oregon Eclipse Festivalgoers around the festival grounds	· Views on science · Engagement with science · Motivation for attending Eclipse · Knowledge of, attendance, interest in Guerilla Science

Online Delayed Post (n=96)[2]	Guerilla Science Participants who provided email addresses, three months post-Eclipse	· Views on science · Engagement with science · Changes of engagement with science since participating in Guerilla Science event(s) · Changes in perceptions on science and topics since participating in Guerilla Science event(s)

[1] Total: 172. Included in comparison analyses: 149 (23 removed due to reporting attending a Guerilla Science event)

[2] Invited: 308, Respondents: 96

Table A2. Descriptive titles and criteria for five mutually exclusive audience segments of relationship to science.

Segment (n)	**Criteria**
Science Enthusiast (n=115)	● That science is fascinating, fun and valuable, ● That science is one of their interests, and ● Highly agree (5) on 4 Likert scale questions about their attitudes towards science.

Science Connected (n=219)	● Answered that science is one of their interests, and ● Highly agreed (5) or agreed (4) for Likert scale questions “In my spare time, I sometimes like to engage in science activities” and “I know a lot of people who work in science- or research-related fields”
Science Interested (n=288)	● Answered that science is one of their interests, and ● Scored lower than 4 for Likert scale questions “In my spare time, I sometimes like to engage in science activities” and “I know a lot of people who work in science- or research-related fields”
Science Uninterested (n=206)	● Did not choose science as one of their interests
Science Disconnected (n=96)	● Did not choose science as one of their interests, and ● Scored lower than 4 for Likert scale questions “In my spare time, I sometimes like to engage in science activities” and “I know a lot of people who work in science- or research-related fields”

Figment Festival

We sampled from both the general Governors Island visitor population at various locations on the island that were distant from the FIGMENT festival, and the population of participants of Guerilla Science events. We employed a combination of methods with the aim of

methodological triangulation (Jensen & Buckley, 2014). Data collection instruments (see supplementary materials) included short entry and exit ‘spot’ interviews at the Sensorium and surrounding exhibits, paper-pencil feedback forms available at each scheduled event and in between rooms in the Sensorium for post-event completion, in-depth structured interviews, and short control spot interviews for visitors to Governors Island who did not attend Guerilla Science events. Each instrument used a combination of closed-ended and open-ended questions to gather a robust set of data (Table A3).

Table A3. Overview of instruments and population from which they sampled.

Instrument (n)	Population	Constructs
Entry Spot Interview (n= 232)	Guerilla Science Participants, before entry into the Sensorium or exhibit area	● Views on science ● Engagement with science ● Motivation and expectations for attendance
Exit Spot Interview (n= 324)	Guerilla Science Participants, after events, as they exited the Sensorium	● Perceptions and evaluation of event ● Takeaways from participation ● Intentions for future behaviors ● Motivation for attendance* ● Views on science* ● Engagement with science*
Feedback Form (n=)	Guerilla Science Participants, immediately after events, before they exited the stage area	● Perceptions and evaluation of event ● Takeaways from participation

Control Interview (n= 335)[1]	Governors Island visitors	• Views on science • Engagement with science • Motivation for visiting Governors Island • Knowledge of, attendance, interest in Guerilla Science

[1] Total: 172. Included in comparison analyses: 149 (23 removed due to reporting attending a Guerilla Science event). *Not asked if the entry interview was conducted.

New York Academy of Sciences

In partnership with the New York Academy of Sciences and Pratt Institute, Guerilla Science conducted professional development experiences for two cohorts of scientists and art professionals. Each professional development experience consisted of a 3 day workshop and field experience with a total of 53 participants. We conducted a blended, formative/summative evaluation of the professional development experience. An OSU researcher observed the August workshop and oversaw data collection which included the following elements: post-workshop, post-workshop and field experience, and delayed post. In our analyses, we only included those respondents who completed 100% of the survey. The number of respondents included in analysis for each element of the evaluation are presented in Table A1.

Table A1. Number of respondents for each element of the evaluation.

	Date	Number of Respondents	Evaluation Methods
Post workshop	August 1 – 3, 2019 Sep. 6 – 8, 2019	53	Online Follow-up Survey
Post Workshop + Field Experience	August 20 – 26, 2019 September 2019 (various dates)	26	Online Follow-Up Survey

Delayed post	6 months after Field Experience	17	Online Follow-Up Survey

We asked the following kinds of questions in the evaluation:

- To characterize the participants, we asked about:
  - professional identity
  - prior experience with outreach
  - participant motivation
- To investigate the quality and usefulness of the professional development experience, we asked about:
  - Net promoter score questions
  - Usefulness of elements of the workshop
  - What was most (and least) helpful for achieving the goals of the workshop

- To investigate participant takeaways,
  - Self-efficacy and intention
  - Main takeaways
  - Descriptions of outreach they conducted post-workshop

Given the small sample size, quantitative data were analyzed using simple descriptive statistics.

Open-ended data were analyzed and summarized thematically.