RESEARCH ARTICLE

REVISED **"Science Fiesta!" Combining student-led community outreach with local culture [version 2; peer review: 1 approved, 1 not approved]**

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Abstract

Science outreach improves science literacy among the public and communication skills of scientists. However, despite the array of well-documented benefits, robust outreach efforts are often absent from communities which stand to benefit the most from these initiatives. Here, we introduce "Science Fiesta," a graduate student-led outreach initiative which utilizes cultural traditions of South Texas as a vehicle to establish self-sustaining interactions between scientists and their local community. Event assessment surveys indicated that attendees found the event both fun and educational. At the same time,

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1. Greg B. Clark , University of Texas at Austin,		

graduate students who organized the event and participated in outreach reported that they strengthened a variety of professional skills important for their future careers. More importantly, the event had a substantial positive impact on enthusiasm for science outreach. Both public attendees and graduate students reported that they were likely to participate in future science outreach events, even though a majority of both groups had not been previously involved in outreach efforts. Science Fiesta is a model for a highly effective graduate student-led outreach initiative that is capable of 1) improving public scientific literacy, 2) reinforcing graduate education and career development and 3) creating a culture of science engagement within local communities.

Keywords

science outreach , science communication , graduate education , career development

Austin, USA

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Any reports and responses or comments on the article can be found at the end of the article.

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The manuscript was modified to improve clarity of methods to address the concerns of the reviewer. Further, additional references were added to support the discussion section of the manuscript.

See referee reports

Introduction

There is a growing appreciation for the importance of community outreach among scientists¹. However, there is not yet a consensus regarding the most effective method of engaging the public. Instead, a number of public outreach models have emerged, each with a share of supporters and critics from within the scientific community^{2,3}. Even the meaning of “outreach” has also proved contentious among scientists, alternatively defined as either unidirectional communication from scientists to the public or as bidirectional exchanges intended to foster dialogue². In our initiative, we used “outreach” to broadly describe all efforts performed by scientists to communicate scientific information to non-expert audiences. Finally, perceptions regarding the benefits of outreach for scientists are continuing to change³. Recently, the traditional view of outreach as a “duty,” which solely benefits public literacy, has been challenged by the view that scientists, and particularly graduate students, also benefit from interactions with diverse public audiences⁴. Science Fiesta was conceived as a platform for scientists to inform, engage, and excite the public, while providing graduate students a unique opportunity for practical training in communication, leadership and project management.

San Antonio is a rapidly-growing metropolis and the largest city in South Texas⁵. The city features a vibrant biotechnology sector. Nearly 1 in 6 jobs are in healthcare or biosciences. The city is home to multiple public and private research universities, and has two large, private, world-class, non-profit research foundations⁶. Furthermore, South Texas can play a critical role in bolstering diversity in science, technology, engineering and math (STEM) education at all levels. A number of colleges and universities in the region are federally-designated “Hispanic-Serving Institutions” (HSIs)⁷ and receive funding from the U.S. Department of Education for programs in STEM and healthcare education and NIH-funding for biomedical science training through the Research Centers in Minority Institutions (RCMI) program⁸.

Still, South Texas is faced with specific challenges relating to science education. San Antonio lags behind other major cities in educational attainment with less than one-quarter of adults holding a 4-year degree and the region as a whole is affected by rates of poverty above the national average⁹. Moreover, many of the counties in the region have been designated as “Healthcare Professional Shortage Areas” (HPSAs) by the U.S. Department of Health and Human Services, indicating a need for more STEM professionals in the region^{10,11}. These challenges represent an opportunity for science education, outreach and workforce development to improve quality of life in the entire region. While

normative public engagement efforts can be constrained by specific goals, such as educating the public on a particular topic, Science Fiesta’s ultimate aim was to spark a culture of outreach and demonstrate the value of science to the San Antonio community.

Science Fiesta was developed by the Graduate Student Association (GSA) of the University of Texas Health Science Center at San Antonio (UTHSCSA) in order to fulfill the need for broader science outreach and to create awareness and appreciation for the central role of science in the future of South Texas. To achieve this goal, the GSA sought to integrate the branding of its outreach efforts with a widely-attended, yearly event. Held each April, “Fiesta” is an over century-old San Antonio tradition, featuring a full two weeks of parades, festivals and community service activities across the city¹². As a major local tradition, Fiesta presented a unique opportunity for scientists to engage with the San Antonio community.

Seamlessly integrated within this larger cultural tradition but held a month prior to the yearly Fiesta event, Science Fiesta aimed to preserve both the aesthetic qualities and festive environment of Fiesta events. Science Fiesta was held in venues used for traditional Fiesta events and featured a mixture of science outreach and local entertainment. The event featured dozens of booths representing San Antonio science institutions and industry, interactive science stations, discussion panels, a “Q&A” poster session (featuring science from undergraduate and graduate-level scientists), science-themed art exhibits, food vendors, Mexican folk dancers and musicians. Through these diverse offerings, Science Fiesta was an event embraced by the entire community. By providing activities that engaged both children and adults, trainees in attendance were challenged to practice multiple levels of science communication and tailor their scientific messages to a variety of diverse audiences. Furthermore, graduate students who organized the event further refined their scientific communication skills through selecting the modes of outreach best suited for the different groups in attendance. For example, the student organizers developed a poster template for the “Q&A” poster session accessible to a broad age group but selected questions for the discussion panel on science policy that engaged a more sophisticated audience. For trainees, Science Fiesta was more than an opportunity to practice science outreach and communication, but a unique educational opportunity to *design* and *direct* interactions between scientists and the general public for the maximum benefit of both groups. Importantly, organizing an event of this type allowed graduate students to develop career-specific skills not typically exercised in graduate-level science education.

Methods

The educational evaluation and assessment of Science Fiesta outlined below was deemed to be Not Regulated Research by the UT Health Science Center Institutional Review Board Office (Protocol Number: HSC20160219N).

Marketing

Science Fiesta was promoted through local magazines, as well as via public service announcements on Texas Public Radio, flyers posted in local businesses, and a social media campaign managed

by graduate students. The social media campaign consisted of regular updates on the planning through Facebook and Twitter, using the hashtags #ScienceFiesta and #ScienceinoldSanAntonio.

Interactive science stations

More than a dozen interactive science stations hosted “hands-on” activities that allowed attendees to conduct simple science fair-style experiments. In order to draw foot traffic into Science Fiesta, interactive science stations were positioned immediately adjacent to the entrances of the venue. All groups were welcome to participate and either responded to direct invitations or applied to host a booth using a link on the event website. These groups were furnished with tables, chairs, table cloths, and electrical outlets, but were expected to furnish activities and information about their group.

Informational booths

Over two dozen informational booths were hosted by local universities, professional societies, scientific organizations, and local industry partners. The booths were intended to promote the awareness of local research and provide the public with ways to engage with science. While informal groups such as astronomy and botany clubs promoted science as recreation, representatives from local universities described educational opportunities to aspiring scientists and representatives from local companies educated the community about the scientific enterprise in San Antonio. Informational booths were recruited in the same manner as interactive stations.

“Q&A” poster session

The poster session served to engage the public with basic science that is being conducted in San Antonio and allow trainees to explain their research directly to the public. The session included more than 50 posters, representing several Texas universities. However, unlike traditional research posters, those featured at Science Fiesta were specifically designed by trainees to maximize their accessibility to a broad audience (Figure 1). The graduate students organizing

the event produced a template to guide presenters in tailoring their posters to the public. In communicating their research, trainees were instructed to keep their talks concise while allowing for plenty of time for questions from the public. Students could sign up to present posters on the event website. An invitation for no-cost registration was sent to leaders of all local universities with the template for tailoring posters for public consumption.

Discussion panel

The graduate student planning team organized a discussion panel featuring local, state and national authorities on science policy and communication. The goal of the panel was to enrich the appeal of Science Fiesta to the public and scientists alike. The panel discussed topics related to supporting scientific education and research in South Texas, as well as sharing views on the importance of outreach as a driver of science in the region. Texas Public Radio recorded the panel and posted the audio to their website (www.tpr.org).

Keynote

We hosted a keynote speaker in order to increase interest in attending the event, entertain attendees, and set an example of effective science communication for students and career scientists. Therefore, we invited a nationally-recognized science journalist and New York Times® Bestselling Author.

Participant surveys

An anonymous feedback survey that contained six brief questions was collected via convenience sampling. The survey featured one nominal response, two binary responses, two ordinal responses, and one free-response question. Surveys were distributed at a table where Science Fiesta memorabilia was being sold. People who approached the table were offered a free Science Fiesta pen in exchange for completing the survey. Surveys were handed out and collected at this table from the start of the event, at 12pm, until approximately 5pm. This survey was available for the

Short Title Accessible to the General Public		
Your Name & Institution		
<p>Why Does This Matter? List three to five bullet points explaining why your project is important.</p> <p><i>Example:</i></p> <ul style="list-style-type: none"> • X % of People Smoke • Many Smokers Get Cancer • Cancer is Dangerous • Current Methods to Stop Smoking Not Effective 	<p>Info Graphics (LIMIT 2)</p>	<p>Take Home Message Summarize the most important conclusions from your research in one or two sentences.</p> <p><i>Example:</i> “We made substance Y and showed that it helps people stop smoking better than any method we have today. Helping people to stop smoking can save their life.”</p>
<p>Question Describe question that drives your project.</p> <p><i>Example:</i> “Can we find more effective methods to help people stop smoking?”</p>		

Figure 1. Poster presenters were provided this template to guide their preparation for the event. The template stresses simplicity.

duration of the event. Attendees also had the option of scanning a QRS code and completing the survey online. We collected a total of 198 surveys.

Graduate student surveys

An anonymous graduate student survey was given to participants in the week following Science Fiesta. All respondents were PhD students who actively engaged in communicating their research to the public via the poster session as well as greeting the public throughout the day. For the purpose of administering surveys and analyzing results, graduate student participation was defined as having played a substantive role in the planning and execution of any part of the event in one's own judgement. The survey contained twenty-two questions featuring ordinal- and free-response questions. Some questions asked the respondent to compare perceived personal abilities before and after participation in Science Fiesta in a retrospective fashion. Out of fifteen surveys distributed, twelve were returned.

Data analysis

Data were manually input into Excel (Version 15.24) for graphing. When appropriate, Fisher's exact test was computed using Graphpad Prism (Version 6.0d) software in order to compare student confidence in their own abilities before and after participation in science fiesta.

Results

Community impact of Science Fiesta

Dataset 1. Results of Science Fiesta attendee surveys

<http://dx.doi.org/10.5256/f1000research.9560.d135258>

The spreadsheet contains questions and responses for each of the 198 surveys collected, as well as a table of compiled results.

Science Fiesta was attended by approximately 3,500 people. From those who completed the survey we found that most had never previously attended science outreach events (73.7%). Survey results indicate that the abundance of hands-on/family-friendly activities were the most popular element of the event, with 40.2% of respondents listing in an open-ended response that those were their favorite aspects of the event. Next most commonly-cited (37.3%) were the educational activities of the event, including informational booths, learning about science, and meeting local scientists. The least common responses were aspects such as the venue, music and food offerings (3%). A large fraction (19.5%) of attendees answered more broadly, saying that they enjoyed the diverse offerings (Figure 2A). More importantly, Science Fiesta substantially increased interest in science events within the community. Even though only 26.3% of attendees said they had attended a science event before, over 90% of respondents said they were likely or very likely to attend other science events (Figure 3).

Graduate student benefits of Science Fiesta

Dataset 2. Results of student organizer surveys

<http://dx.doi.org/10.5256/f1000research.9560.d135259>

The spreadsheet contains questions and responses for each of the 12 surveys collected, as well as compiled results for each question.

Trainees participating in Science Fiesta were characterized by varying degrees of prior engagement in science outreach (Figure 4). However, after taking part in Science Fiesta, 100% of participating graduate students reported the highest level of enthusiasm for future outreach initiatives. In addition to improved appreciation for public engagement, trainees reported perceived improvements in a number of professional skills (Figure 5). Most notably, trainees were significantly more likely to characterize themselves as confident communicating science to the public, and setting and following through with goals ($p=0.047$, for both) (Figure 4A,D). Overall, trainees derived considerable value by participating in science outreach and consider the skills gained from the experience to be highly relevant to their career development (Figure 5).

Discussion

Science communication and public engagement are fundamental roles of scientists. Here, we describe "Science Fiesta," a student-led outreach initiative tailored to engage the local community of San Antonio, Texas. Science Fiesta combined science outreach, entrainment and local culture in order to attain an exceptionally diverse appeal within the community.

Science Fiesta succeeded in attracting segments of the public who either were not previously inclined, or lacked the opportunity, to engage with science. This assertion is supported by data provided by public attendees, citing Science Fiesta's diversity of activities as the primary sources of satisfaction with the event (Figure 2A). Interestingly, while relatively few respondents specifically cited the educational activities as their favorite component, more than 80% reported receiving a positive science learning experience at the event (Figure 2B). While educational activities were not the primary focus for attendees, learning outcomes were achieved through immersion in science. The vast majority of attendees indicated that they learned "some" or "a lot" about science at the event (87.3%).

Through Science Fiesta, we planned and executed an event that was perceived by all parties to be enjoyable, family-friendly, and educational. In doing so, we created enthusiasm for engaging in future science outreach efforts amongst graduate students and attendees. Thus, Science Fiesta-"like" events could achieve a sustained improvement in the culture of scientific engagement within a community, such as that of San Antonio. This is supported by evidence from public attendees, as approximately 90% expressed a likelihood of attending future science events

Figure 2. (A) A survey of attendee's favorite aspects of Science Fiesta show that people enjoyed a variety of aspects (*n*=169). These responses were further broken down into general themes of family friendliness, educational value, and entertainment value. (B) The vast majority of attendees reported that they learned about science as a result of attending Science Fiesta (*n*=198).

(Figure 3). This result is even more remarkable when considering that over 70% of respondents had not previously attended science outreach events. Similarly, trainees participating in Science Fiesta were not uniformly involved in science outreach prior to the event. Although the graduate student survey results are based on responses from a small number of students (*n*=12) we are encouraged by these initial results. Before Science Fiesta, 42% of graduate students participating in organizing the event were not previously engaged in outreach. However, following participation in this initiative, trainee enthusiasm for science outreach increased dramatically. All participating trainees reported that they were "very likely" to engage in future outreach initiatives as a result of their experience with Science Fiesta. It is our hope that the increased interest in

science engagement among both the public and graduate students will seed a culture of science-awareness and appreciation in the community.

Importantly, as the job market for scientists with post-secondary training continues to diversify into areas outside of academic research (i.e. public policy, scientific journalism and education) and become increasingly competitive within academic research, increased emphasis on developing programs to promote the career preparedness of trainees is required. We present evidence that graduate student-led outreach initiatives not only instill a consciousness for the importance of public engagement, but offer an effective method for career training. Mastering

Figure 3. After attending Science Fiesta, 90% of community attendees are either “likely” or “very likely” to attend other science events (*n*=198).

Figure 4. Science Fiesta facilitated student training in a number of skill-areas associated with professional success, including communication to the public (**A**) and other scientists (**B**), (**C**) leadership and (**D**) organizational management. In each case, results suggest that students benefitted from participation in Science Fiesta (*n*=12).

Figure 5. (A) Career development adds considerable value to student training through outreach. (B) Science outreach provides valuable training for early-career scientists (n=12).

communicating research to diverse audiences, as well as organizing outreach initiatives, develops career skills not taught through laboratory training. Importantly, the graduate students reported positive impacts in key professional skills: communication (Figure 4A–B), leading teams of peers (Figure 4C), as well as setting and achieving project objectives (Figure 4D). As indicated by student responses, these skills are valued by trainees as an important part of their professional growth (Figure 5A). As a whole, the trainees deemed their participating in outreach to be a beneficial learning experience that added value to their education (Figure 5B).

It is important to know that all surveys deployed were dependent on self-reporting. Specifically, the positive impacts of participation in Science Fiesta were all dependent on self-report. The authors are aware that self-reported perceived outcomes are not always aligned with actual results, as discussed in Brownell and Kloser (2015)¹³. Therefore, additional methods to assess the effectiveness of science outreach efforts will be investigated in the future. Additionally, limits to the benefits of short-duration outreach programs have been previously discussed (see Laursen *et al.*, 2007)¹. Therefore, we must acknowledge that although our results indicate multiple positive outcomes this could be a reflection of the short

duration of the program². However, these efforts are a foundational starting point towards accomplishing our goals of increasing public science understanding, enthusiasm and engagement as well as outreach participation and career readiness within graduate student scientists.

It is clear that planning and participating in Science Fiesta addressed professional development gaps in graduate education. Science Fiesta engaged every level of the STEM pipeline, developed career skills among graduate students, and connected local industry and academia with the larger community. However, the most promising outcome of Science Fiesta was enthusiasm for science within the community, as reflected by survey results citing increased interest in science outreach, among both the public and graduate students. This enthusiasm has the potential to lead to sustained improvement in science awareness and literacy. We propose that Science Fiesta, and events which employ its model, may address issues, such as STEM workforce development, barriers to diversity, low educational attainment, and public investment in the sciences. We assert that weaving science into the local cultural fabric may establish a tradition of engagement between scientists and the community.

Data availability

F1000Research: Dataset 1. Results of Science Fiesta attendee surveys, [10.5256/f1000research.9560.d135258](https://doi.org/10.5256/f1000research.9560.d135258)¹⁴

F1000Research: Dataset 2. Results of student organizer surveys, [10.5256/f1000research.9560.d135259](https://doi.org/10.5256/f1000research.9560.d135259)¹⁵

Author contributions

All authors contributed to, concept and design, critical review and edits, resources and data collection, and data interpretation. TJB, MM, and TME were primarily responsible for manuscript drafting and data analysis. PD also helped with data analysis. JD was primarily responsible for the organization and execution of key fiesta events.

Competing interests

No competing interests were disclosed.

Grant information

The event described was paid for by San Antonio Science (www.sascience.org), the City of San Antonio (www.sanantonio.gov), and the University of Texas Health Science Center at San Antonio (www.uthscsa.edu). No funds were allocated to complete the surveys described in this manuscript.

The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

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This is an interesting testimonial from a group of graduate students at the University of Texas Health Science Center in San Antonio. It demonstrates the enthusiasm of the students for the communication of science and for the development of speaking and communication skills, but it provides no credible evidence about the impact of the event on the population of San Antonio or even of the people that attended. Unfortunately, the graduates students' enthusiasm for their science exceeded their knowledge or understanding of educational evaluation or social science. The resulting data do not rise to the level of credible educational evaluation and cannot be used to assert any level of impact on the public. Many physical and life scientists assume that educational evaluation or social science are things that they could learn in a couple of hours and disregard the methods of social science measurement and analysis.

Had the students read the relevant literature (or included some education or social science graduate students in their group), they would have recognized that the core of the problem is that about 30% of American adults have obtained a credible level of scientific literacy -- sufficient to read the Tuesday *New York Times* science section -- and that most of the remaining 70% are attentive to other issues and problems. Many American adults who are not scientifically literate may be very knowledgeable about economic policy, foreign policy, agricultural policy, or other realms of public policy. The issue is that science is not salient to many American adults and science needs to compete in the marketplace for adult time and attention. The first task is not to simply try to talk to people about the science that these graduate students are doing, but to argue why it is important for someone to know about that science or other science.

There is a literature covering the last three decades that demonstrates that civic scientific literacy is closely associated with exposure to college level science courses (Miller, 1983, 1987, 1998, 2004, 2010, 2016). In this context, it would have been useful to know whether the San Antonio Science Festival attracted adults who were already scientifically literate, who had been exposed to college level science courses, and who already thought that understanding science is important. Unfortunately, the questionnaire administered to a convenience sample of attendees included

only six questions and no educational background questions. The literature on the use of science museums suggests that some adults are drawn to science because they want their children to become scientifically literate or to consider a career in science or engineering. An evaluation rooted in the literature would have asked about whether each attendee had children and whether the children were attending with the adult. And some understanding of this literature could have informed the marketing effort for the fiesta.

The 12 graduate students who completed a post-fiesta questionnaire indicated that they felt that they had improved their science communication skills. I have no doubt that presenting scientific ideas and material to a non-scientific audience is a learning experience and I think that events like this are useful for graduate students and for many faculty. This is a beneficial result, but it is not clear whether the same result could have been obtained by sending graduate students to work in a local science museum or center, to speak to PTA groups, or to talk to other community groups.

If the rationale for science fiestas and festivals is that they increase public interest in science and foster continuing science-oriented information acquisition activities, this report provides no useful or credible information. A convenience sample may be easier to collect, but it demonstrates an ignorance of why survey research quit using convenience samples 50 years ago. Currently, there is a strong move to address-based national sampling to reflect a probability based sample of respondents. I doubt that these health science graduate students would seriously consider allowing patients to select the arm of a clinical trial that they might prefer. It is important for health scientists and other scientists to recognize that social science methods are important and try to include trained social scientists in the design and evaluation of outreach efforts like the San Antonio Science Fiesta.

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Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Version 1

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This manuscript describes a recent science outreach event which was held in San Antonio. The authors provide the results of surveys completed by the public as well as the graduate student scientists that participated in the event. Overall this is a well-written manuscript and provides an exciting model for combining outreach with a long-standing cultural event which is to my knowledge a novel approach. It deserves to be published and will hopefully inspire other groups to try this approach in their science outreach. However, I have listed revisions which the authors need to address before this manuscript is indexed.

1. Both surveys are dependent on self-reporting of the positive impacts of participation in Science Fiesta. However perceived outcomes do not always match actual results as discussed in Brownell and Kloser (2015). Please add references and text discussing this issue to the Discussion section.
2. The n-value of 12 for the surveys of the graduate students is relatively low so please also add a statement to the Discussion section acknowledging that this data is based on input from a small number of graduate students.
3. Please add text to the Discussion section describing previous literature discussing limits to the benefits of short-duration outreach programs (see Laursen *et al.*, 2007). In general the Discussion section needs to be modified to include the perspective that although the surveys indicate multiple positive outcomes may have occurred from this outreach program due to the short duration of the program, the main accomplishment may have been as a starting point towards the goals of increasing public science understanding and enthusiasm and science communication and outreach participation by graduate student scientists.
4. Please indicate how many of the participants were Ph.D. students and how many were Masters' students. Did all the students have the opportunity to communicate science or were some more involved in organizing and greeting the public? This might also be an important point to make regarding your data, if a student did not present a scientific topic then he or she did not likely improve their science communication skills.
5. I had difficulty determining if this event was completely separate from the other Fiesta events physically and/or temporally? Please make it clear if the public participants in Science Fiesta were only participating in science outreach or if there were other non-science

outreach activities occurring at the same time in close proximity.

6. I am curious if there is additional background as to how the authors arrived at this outreach model. For example, is there literature to support the idea that pairing scientific outreach with culture events is an effective outreach model? Please add references for any similar models found in the science communication literature and emphasize this approach in the Discussion section.
7. At the beginning of the Results section, the following two statements are misleading and refer to data not shown in the Figures: (1) "Science Fiesta was attended by approximately 3,500 people, most of whom had never previously attended science outreach events (73.7%)"; (2) "Even though only 26.3% of attendees said they had attended a science event before, over 90% of respondents said they were likely or very likely to attend other science events." Please revise the text to indicate that this data is found in the Dataset 2 link and that the 73.7% and 26.3% is for only the attendees that participated in the survey not all 3,500 people.

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

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