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"Science Festival" may not mean what we think it means: an analysis of how researchers and practitioners use this term

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Abstract

The modern science festival movement has grown significantly since the Edinburgh International Science Festival launched in 1989. Hundreds of science festivals now occur annually and vary widely. This article examines how the term "science festival" is used within research and practice. We find that most research articles fail to describe the science festivals they study. A subsequent analysis of festival websites and other publicly available information confirms the wide variability of science festival formats, which suggests the need for descriptive information about science festivals in scholarly work.

Keywords

Public engagement with science and technology; Public understanding of science and technology; Scholarly communication

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Introduction

The modern science festival movement can trace its roots to Edinburgh, Scotland, where city leaders launched the Edinburgh International Science Festival in 1989. Science festivals have since become a popular medium for engaging public audiences with science concepts and activities, with hundreds of these festivals occurring around the world each year. Researchers have taken notice, with the term "science festival" first appearing in scholarly and peer reviewed literature in the early 1990s and citations increasing exponentially ever since (see Figure 1). However, the term has been used to describe efforts that vary considerably in their geographic reach, duration, budget, and cultural practices [Wiehe, 2014]. This variability presents a challenge for practitioners and researchers alike, particularly when determining the generalizability of science festival research.

In this article, we examine the variable uses of the term within research and practice. We begin by reviewing the literature on science festivals and their impacts on public audiences. Here, a recurring problem emerged, where researchers often fail to describe salient features of the individual festivals they are studying. Given

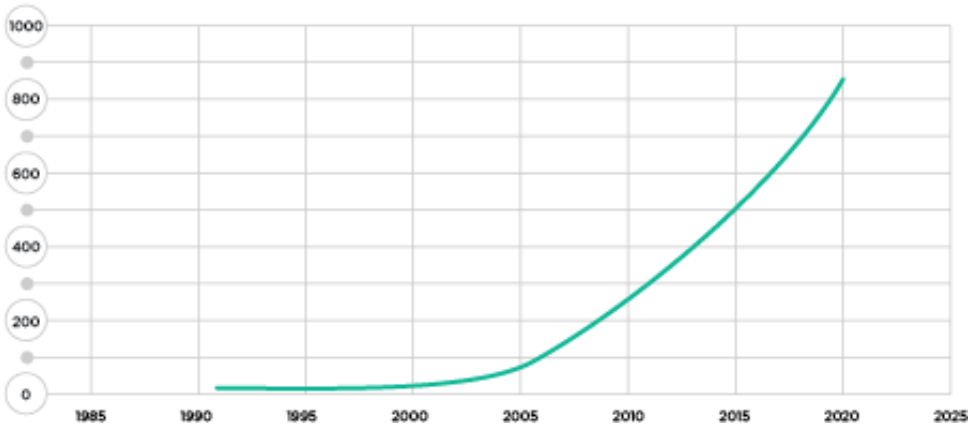

Figure 1. Cumulative scholarly publications containing "science festival".

the diverse nature of science festivals, this omission could limit the generalizability of the findings.

Next, we expand upon Wiehe's [2014] analysis to further highlight the differences in size, duration, theming, geographic reach, and programming of science festivals. To do this, we searched web sites, social media pages and annual reports of member festivals of the Science Festival Alliance (SFA), the primary professional association for science festival organizers in the United States and Canada. During this phase of analysis, we also identified four common characteristics of science festivals: (1) an intent to increase public awareness of science, (2) an intent to encourage young children to pursue careers in STEM, (3) the use of hands-on or otherwise interactive programming, and (4) a reliance on inter-organizational collaboration. These commonalities amplify the widely employed science festival typology developed by [Bultitude, McDonald and Custead, 2011].

We conclude by detailing the limitations of this analysis and by proposing future avenues for research. We also recommend that future research on science festivals make a more concerted effort to identify the salient features of the festivals being studied.

Known impacts of science festivals

Although science festival research has only begun to grow significantly in the last decade or so, initial findings indicate a wealth of potential with respect to engaging public audiences in science content. Large-scale evaluations of science festivals demonstrate that these endeavors are successful in teaching science content to visitors, raising visitor awareness of STEM careers, improving public attitudes toward science, and achieving all of these things in welcoming, enjoyable settings [Jensen and Buckley, 2014; Adhikari et al., 2019; Boyette and Ramsey, 2019]. Science festivals may also encourage visitors to adopt environmentally-sustainable behaviors [Pennisi and Lackey, n.d.] and increase general understanding of the content and moral implications of complex subjects such as human gene editing [Rose et al., 2017] The benefits of science festivals may also extend to the scientists who staff them. Scientists who have volunteered their time at science festivals have reported increases in self-efficacy with regard to public science communication and increases in their willingness to participate in other informal science education events [Science Festival Alliance, 2013].

Several studies have investigated how families with children have engaged with science festival activities. Though families often attend festivals together, parents and children characterize their experiences in entirely different ways. Children tend to take on active roles as learners, participating more frequently in interactive, hands-on activities than do their parents [Idema and Patrick, 2019]. Parents tend to prioritize learning goals and have stronger preferences for lecture formats [Fogg-Rogers et al., 2015]. Notably, observations of family interactions at science festivals have shown that increased dialogue between parents and their children led to increased levels of engagement from both parties [van Beynen and Burress, 2018].

It is important to note, however, that science festivals occasionally fall short of their goal of engaging public audiences with science content. Science communication at festivals is a complex process that encompasses a wide array of personal, professional, and political aims [Davies, 2019b]. Some visitors to science festivals find that engaging in science communication is challenging, ultimately choosing to abstain from meaningful participation in festival activities [Davies, 2019a].

One important criticism acknowledged by the science festival community is that visitors tend to come from well-educated, middle-class families [Kennedy, Jensen and Verbeke, 2018; Nielsen, Gathings and Peterman, 2019]. Moreover, the families who attend are typically those who are already interested in science to some degree [Adhikari et al., 2019]. If festivals are to achieve a goal of reaching more diverse audiences, festival organizers must reflect on the ways in which science festivals are designed, marketed, and carried out. A mixed-methods study of the Lancashire Science Festival shows the potential of festivals to improve low-income families' attitudes toward science, knowledge of science content, and desire to participate in other informal learning opportunities [Canovan, 2019]. One strategy for more effectively reaching these families is to hold more activities in central, public spaces where casual visitors — those who are less likely to attend science festival events intentionally — are more likely to happen upon such events by chance [Crettaz von Roten, 2011]. Some festivals are using social media to engage with public audiences, although two-way dialogues between festivals and their audiences via social media have been too infrequent to sustain meaningful engagement, and it is not clear whether or not this strategy could prove viable in reaching more diverse audiences [Su et al., 2017].

Methodology

In the first phase of our analysis, we sought to identify how science festivals have been described in the extant literature. To this end, we conducted a systematic search for articles that contained the term "science festival" in their abstracts. These articles were pulled from the Articles+ database via the University of North Carolina at Chapel Hill. Web of Science was also used to verify that the generated list of articles was exhaustive. The literature search was limited to peer-reviewed publications that featured science festivals — or some aspects of science festivals — as a research focus. In total, 24 articles met these criteria.

When articles provided descriptions about the science festivals they analyzed, the descriptions were extracted into a text document for further review. An a priori coding scheme guided the collection and tagging of any information contained within the descriptions which was deemed to be relevant to the analysis. A priori

codes were generated from the findings of Wiehe [2014] and Bultitude, McDonald and Custead [2011] and attended to the various dimensions of science festivals, including size, duration, geographic reach, theming, and programming. When articles did not describe the science festivals in question, the descriptions were classified as missing.

In the second phase of analysis, we sought to quantify the differences between science festivals on all of the aforementioned dimensions by using the information provided on current science festival web sites, social media pages, and any available annual reports. For each of the 55 member festivals named in the most recent SFA Annual Report [2018], we attempted to find any information related to their size, duration, geographic reach, theming, and programming. We prioritized information contained within annual reports as this source of information was viewed as being the most reliable, though only eight of the 55 science festivals made their annual reports publicly available. Social media pages were examined only when festivals did not have an official web site or when their web sites lacked information relevant to the analysis. For festivals that operate annually, we collected data on only the most recent iteration with publicly available information . When analyzed together, these data sources provide a recent "snapshot" of the rapidly evolving science festival community.

In the final phase of this study, a thematic analysis methodology was applied to the data in order to identify any recurring patterns which might inform a more holistic typology of science festivals [Braun and Clarke, 2006]. In employing this methodology, we utilized a combination of inductive and deductive coding techniques. Some of our initial codes were developed based on previous research related to the nature of festivals, notably: Wiehe [2014], Davies [2015] and Bultitude, McDonald and Custead [2011]. Other codes were developed as we became increasingly familiar with the data as it was presented in festival web sites, annual reports, and social media pages. This combination of coding strategies allowed us to maintain a rigorous, yet flexible approach to our analysis. In all phases of the analysis, intercoder reliability was established through ongoing discussions between the co-authors.

How science festivals are described in the literature

In our analysis of science festival research, one emergent theme proved to be particularly problematic. We found that researchers were wildly inconsistent in the ways they go about describing science festivals in their research. In nine of the 24 articles, researchers either relied on a general description of science festivals or provided no description at all. In the remaining articles, researchers frequently omitted salient features of science festivals, such as size, duration, geographic reach, theming, and programming. We found that only three of the 24 articles described all of these features. Without this information, future researchers may find much of the extant literature difficult to replicate. Moreover, the lack of such information raises confusion about the contexts in which research findings may be best implemented.

Where science festivals were described, there were stark contrasts in the festivals being studied. Adhikari et al. [2019], for example, analyzed the impacts of the Pint of Science Festival in Thailand — a six-day effort which featured interactive talks that were 12–20 minutes in length and were designed to elicit public discussions of

science content. Bevc, Young and Peterman [2016], on the other hand, focused on the North Carolina Science Festival — a month-long festival that featured events in a variety of formats (e.g. a large-scale expo, sky watching sessions, technology demonstrations, science shows, competitions). These two festivals differ greatly in number of important ways. Indeed, the way science festivals are described in the literature suggests a large degree of variability in the way researchers are conceptualizing the term "science festival." To add to the ambiguity, some researchers like van Beynen and Burress [2018] seem to use the terms "science festival" and "science expo" interchangeably, while Boyette and Ramsey [2019] conceptualize science expos as street fair-style events that comprise only *part* of a greater science festival *whole*.

As science festival research continues to evolve, we strongly encourage researchers to consider the salient features of the festivals they are studying. Describing these features to readers will confer a degree of generalizability and replicability to the research being published. These descriptions will also add clarity to ongoing discussions about what constitutes a science festival. We feel that this small step will go a long way in moving the research forward, particularly when it comes to determining best practices for practitioners.

The diverse nature of science festivals

Wiehe [2014] notes that science festivals constantly evolve, such that each festival undergoes changes from year to year and that no two festivals are exactly alike. In this phase of the analysis, we sought to quantify the differences between science festivals on a number of important characteristics. To do this, we reviewed the web sites, annual reports (when available) and social media pages of all 55 member festivals named in the most recent SFA Annual Report [2018]. These festivals provide a recent "snapshot" of the rapidly evolving science festival community. We collected data on the size, duration, geographic reach, theming, and programming of science festivals. For festivals that operate annually, we collected data on the most recent iteration that had publicly available information.

According to the most recent SFA Annual Report, more than two million people participated in science festivals in the United States and Canada in 2017. Twenty-one individual member festivals of the SFA publicly reported their attendance numbers, which ranged between 1,000 and 365,000 visitors, with a median of 30,000 visitors. Audience figures could not be determined for 34 of the 55 festivals.

Member festivals also demonstrated a great deal of variety in their duration (Figure 2). Ten festivals were listed as single-day efforts, though most festivals were a collection of events that took place over the course of multiple days or weeks. Six festivals lasted for a month or longer, with Mind Trekkers describing itself as a year-round effort conducted at locations throughout the United States.

In terms of geographic reach, ten festivals hosted events throughout their home states. The 2018 North Carolina Science Festival, for example, reached 87 of the state's 100 counties. Mind Trekkers was the only SFA member to produce events in multiple states. Most science festivals focused their efforts on specific metropolitan areas (e.g. the Las Vegas Science & Technology Festival or the Dayton Regional

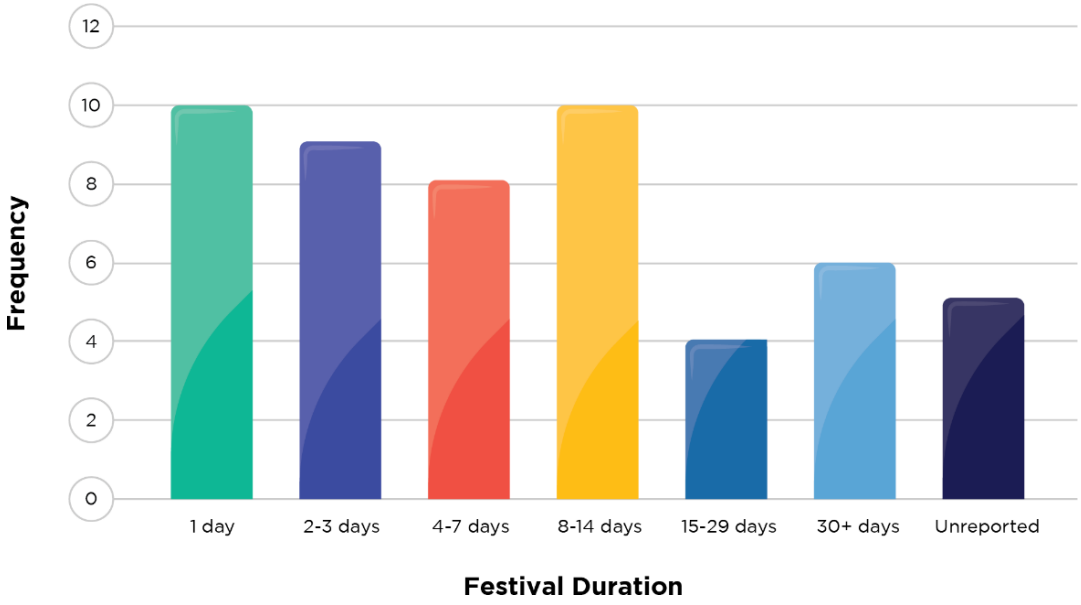

Figure 2. Duration of science festivals.

Science Festival). The Science Learning Tent at Arlee, by contrast to some of the larger festivals, was hosted at a tent during the town's fourth of July celebration.

One of the more consistent traits of the science festivals was theming, though some differences remain. Twenty-five of the 55 member festivals primarily used the STEM (Science, Technology, Engineering, and Mathematics) acronym to describe their festivals. Fourteen of the member festivals expanded their outreach to include arts-based programming and branded themselves as STEAM (Science, Technology, Engineering, Arts, and Mathematics) efforts. Other festivals assumed more narrow foci. For example, activities at the Sitka WhaleFest focused largely on marine biology while the Rogue Valley Mini Maker Faire emphasized engineering and art.

Part of the appeal of science festivals is the wide variety of formats available for visitors to engage with scientific content [Fogg-Rogers et al., 2015]. Science festivals often include public talks, tours, open-houses, large-scale science expos, workshops, science competitions, live shows, and other interactive activities [Boyette and Ramsey, 2019; Boyette and Young, 2014; Fikus, 2005; Fogg-Rogers et al., 2015]. Larger festivals may utilize all of these formats, while smaller festivals may only feature events in one or two formats. Formats are often chosen with a specific audience demographic in mind. For example, the Chicago Science Fest — in addition to other activities — hosted many public science lectures designed to engage adult festival attendees. The main attraction at the Jacksonville Science Festival, on the other hand, was a large-scale expo featuring hands-on activities and demonstrations for K-12 students.

The findings from this phase of the analysis illustrate just how different science festivals are from one another with respect to size, duration, geographic reach, theming, and programming. These differences pose several challenges for researchers. For instance, how are we to make sense of the literature on science festivals when the festivals being studied are often insufficiently described or not described at all? To what extent can data from a one-day maker fair in Ashland,

Oregon be used to inform or improve the practices of a month-long, statewide science festival in Maryland? Is there utility in referring to all the activities described here and in the literature as "science festivals" or is there a need to categorize them based on audience demographics, formatting, or other characteristics? It is beyond the scope of this paper to answer these questions. However, we encourage researchers and practitioners alike to think carefully about the language they use to describe these efforts. In defining and describing science festivals, some level of generality is needed to ensure that research generates useful applications for practitioners. Even so, we must not lose sight of the contextual factors that make each festival unique.

Finding common ground

Though science festivals differ dramatically in a number of important ways, there may exist some commonalities between them. In previous work, Bultitude, McDonald and Custead [2011] systematically reviewed surveys and web sites to identify four shared characteristics of science festivals: a focus on celebrating science, an intention to engage non-specialists with scientific content, a finite duration with a tendency to reoccur on a yearly or bi-yearly basis, and an overarching theme or branding that connects a festival's offerings. This typology has been frequently cited in the science festival literature and remains largely useful even in the rapidly evolving landscape of the science festival community.

Here, we hope to utilize our findings from science festival web sites, annual reports and social media pages to identify other potential commonalities between science festivals. From our thematic analysis of these data, three recurring patterns emerged. First, we note that the purpose of science festivals often extends beyond the mere celebration of science in two important ways: by increasing public awareness of science in our everyday lives and by inspiring children to pursue careers in science. Second, we show that festival organizers heavily prioritize the interactive or hands-on nature of their visitor experiences. Third, we identify the ways in which collaborations between informal science institutions, universities, businesses, community groups, and other STEM organizations are essential to the success of science festivals. The findings outlined here may prove useful in distinguishing science festivals from other public science engagement endeavors. For each of these findings, we have extracted sample quotations from the data to further illustrate the arguments being made [Braun and Clarke, 2006].

Finding common ground: expected outcomes for science festival visitors

While most science festival organizers would likely argue that the celebration of science is an important outcome for their festivals, they might also argue that their festivals also serve more practical goals. In our analysis of festival web sites, annual reports and social media pages, we identified two such goals: increasing public awareness of science in everyday life and encouraging young children to pursue careers in science.

Thirty-five out of the 55 festivals analyzed featured language suggesting that increasing public awareness of science in everyday life was a priority. Such language tended to appear in statements related to festivals' specific missions and goals. In most cases, the goal of raising awareness is explicit. The following

quotations serve as illustrative cases in which festival organizers explicitly emphasize the goal of increasing public awareness of science. Each of these quotations was extracted from festivals' mission statements (passages of interest are underlined for this article):

- "Generate interest in, understanding of, and public discourse on STEM among youth and adults." [Atlanta Science Festival, 2021]
- "Nurture an appreciation of science in our daily lives by connecting a community of citizens of all ages, scientists, science organizations, and businesses." [Siskiyou Science Festival, 2018]
- "A multifaceted, multicultural event, the Festival makes science accessible, interactive and fun, highlighting the impact of STEAM in all our lives." [Cambridge Science Festival, 2021]

In some cases, the goal of raising awareness referenced a more specific kind of awareness — namely, the awareness that science has the potential to impact our lives by addressing societal challenges. Language referencing this idea tended to include words like "impact", "society", and/or "community". For festivals emphasizing science awareness in this way, the focus lies not in the impacts of science on individual lives, but rather its impacts on society as a whole. The following sample quotations reveal festival organizers' specific motivations for raising public awareness of science:

- "Embracing STEM as a foundation in everyday life and education will propel us into a future of unlimited possibilities and community success." [Dayton Regional Science Festival, 2017]
- "Science is vital for even the most basic aspects of modern society…" [St. Petersburg Science Festival, 2021]

Some festival web sites made a more personal appeal to potential visitors. These festivals did not emphasize the impact of science on society but rather its impact on the lives of individuals. In such cases, the goal of increasing public awareness of science was akin to helping visitors recognize that science can be personally meaningful. The following extracts from the Virginia Tech Science Festival and Indian River Lagoon Festival mission statements illustrate this point:

- "…We hope the festival inspires you to see science as accessible and relevant to you." [Virginia Tech, 2020]
- "Helping people realize that science is relevant, interesting, fun and an important part of their lives…" [Indian River Lagoon Science Festival, 2020]

While 20 of the 55 festivals analyzed here did not explicitly reference public awareness of science, one could reasonably conclude from the data presented that science festivals are often designed — explicitly or implicitly — with the purpose of teaching visitors about the relevance of science to their everyday lives or to

society as a whole. Indeed, a review of the literature indicates that science festivals can have a quantifiable impact on visitors' knowledge of scientific content and their adoption of evidence-based behaviors — e.g. behaviors that promote sustainability [Adhikari et al., 2019; Boyette and Ramsey, 2019; Pennisi and Lackey, n.d.]. In this regard, science festivals have considerable potential to cultivate scientifically literate, reflective citizens.

A second finding from this analysis demonstrated that science festivals often aim to inspire young children to pursue careers in STEM. Thirty-one of the 55 festival web sites analyzed here included language that explicitly articulated this goal. In these 31 cases, phrases such as "cultivate next generation of scientists" and "encourage young children to pursue careers in STEM" were commonly found in festival mission statements. The following quotations highlight three examples of cases where the goal of inspiring young children to pursue careers in STEM is explicitly articulated (passages of emphasis are underlined for this article):

- "Support pathways for educational advancement in STEM from cradle to career." [Atlanta Science Festival, 2021]
- "Engage young people in the fun, excitement and awe of science to inspire them to careers in science, technology, and engineering." [Bay Area Science Festival, 2021]
- "…to cultivate curiosity and communicate the power of knowledge and creativity to change our world view; to promote innovation and to cultivate the next generation of global citizens." [Wisconsin Science Festival, 2021]

Festivals' overwhelming emphasis on this goal is likely a response to calls for a larger STEM workforce in addressing important economic, social, and environmental needs [National Research Council, 2012]. A previous analysis demonstrated that out of 38 science festivals, 36 reported that families with children were a target demographic [Bultitude, McDonald and Custead, 2011]. Research on informal STEM learning opportunities demonstrates that such experiences are influential in guiding young learners toward STEM career paths [Baran et al., 2019]. Other studies of science festivals indicate that visitors report greater awareness of STEM career opportunities [Boyette and Ramsey, 2019]. It is important to note that even when the goal of inspiring young children to pursue careers in STEM was not explicitly articulated in a festival's web site, social media, or annual report, these data sources prominently featured imagery depicting children engaging in scientific activities.

In summary, the language of science festival web sites suggests that organizers often share two goals. First, science festivals are typically designed with the intent to improve public awareness of science in everyday life. This finding is consistent with findings from a previous study on science communication events in Europe which indicated that improving public awareness of science was a common goal of event organizers [Fikus, 2005]. Second, many science festivals aim to encourage young children to pursue careers in STEM — a goal which they are well-suited to achieve [Baran et al., 2019; Boyette and Ramsey, 2019]. Other potential goals of science festivals include positive learning outcomes for visitors, community-building, enjoyability, equity in informal learning environments, the

promotion of environmentally conscious behaviors and the celebration of science. Though these goals were articulated with less frequency, they constitute important foci for future analysis.

Given the diverse nature of science festivals and the degree to which they employ "meaningful cultural norms to make events resonate with local audiences" [Wiehe, 2014] — it is very possible to have two or more science festivals with very similar stated goals to utilize very different activities, formats, styles and venues. One potential avenue for future research, then, would be to enumerate the ways in which a festival's goals might inform the design of its programming. Researchers might also be interested in the degree to which the goals of festival organizers align with the goals of their public audiences. Previous research indicates that visitors to science festivals bring a wide range of values and expectations with them [Jensen and Buckley, 2014]. Whether or not these values are consistent with the values of festival organizers remains unclear.

Finding common ground: the interactive nature of science festivals

To achieve their goals, festivals engage public audiences with science content in a wide variety of formats, including lectures, discussions, shows, hands-on activities, and more [Bultitude, McDonald and Custead, 2011; Nielsen, Gathings and Peterman, 2019]. However, this analysis will show that an overwhelming majority of science festivals rely on programs that are hands-on or otherwise interactive in nature.

Of the 55 festivals analyzed here, 42 explicitly featured language advertising hands-on or interactive programming. Of the 13 remaining festivals, 11 featured images of public audience members actively participating in a science activity or demonstration. Consider the following ways in which science festivals emphasize hands-on or interactive programming (passages of interest are underlined for this article):

- "…At most events you'll be participating, creating, and interacting. This is not show and tell… it's show and do!" [Cambridge Science Festival, 2021]
- "Celebrate Science Indiana features interactive events and activities, and, whenever possible, it will provide take-home information, activities, or innovative ideas for further investigation." [Celebrate Science Indiana, 2020a]
- "With over 40 hands on science booths from our own community of science, engineering and technology innovators…" [Jackson Hole WILD Science Fest, 2017]
- "Provide a rare opportunity for people of all ages to experience STEAM live and discover new concepts through hands-on experiences and face-to-face interactions with faculty, staff, and students." [MSU Science Festival, 2021]

The frequency with which science festival web sites advertise hands-on and interactive programming suggests a common thread underlying these festivals. The findings here align with those of Bultitude, McDonald and Custead [2011], which found that 100% of science festivals featured hands-on programming (n=51).

Indeed, hands-on experiences are frequently described as the most popular science festival attractions [Chen, 2014].

Importantly, research on science learning indicates that hands-on learning experiences are critical to improving learners' scientific knowledge, their attitudes toward science, and their desires to pursue STEM careers [National Research Council, 2012]. Other interactive activities, such as opportunities to interact with practicing scientists, have significant impacts on how much visitors learn at science festivals and the extent to which they report enjoying their experiences [Boyette and Ramsey, 2019]. To their credit, science festival organizers seem to have universally recognized the importance of allowing visitors to learn science content via active participation.

Finding common ground: the collaborative nature of science festivals

In their efforts to engage tens of thousands of visitors across the country every year, members of the broader science festival community rely heavily on collaborations between informal science institutions, universities, businesses, community groups, and other STEM organizations [Wiehe, 2014; Science Festival Alliance, 2018]. A social network analysis of the North Carolina Science Festival demonstrated how this annual celebration plays a critical role in strengthening the state's STEM learning environment and infrastructure by bringing events to new communities and building relationships between cooperating groups that persist well after the festival itself has ended [Bevc, Young and Peterman, 2016]. A similar social network analysis of the Edinburgh Science Festival revealed the complex and interdependent nature of those who staff and organize such efforts [Jarman, 2016]. Without collaborative partners, science festivals are not likely to sustain the impacts they have on the communities they serve. Additionally, these relationships are often leveraged for other initiatives that benefit these communities in the long term.

Returning once more to science festival web sites, annual reports and social media pages, it becomes evident that festival organizers are keenly aware of the importance of collaborative networks. Of the 55 festivals analyzed for this article, 42 either explicitly mention the importance of inter-organizational collaborations — typically in mission statements or other language related to festival goals — or acknowledge 10 or more collaborative partners. In some cases, particularly for festivals serving large geographic regions, more than 100 collaborating organizations are involved. These organizations provide support to festivals by hosting activities, providing educational resources and staffing, assisting with marketing and publicity, recruiting participants and offering financial support. Consider the following ways in which science festivals explicitly acknowledge the importance of collaborative networks (passages of note are underlined for this article):

- "Festival events feature hands-on activities, tours, tastings, and performances from more than 100 community partners, including school districts, post-secondary institutions, museums, businesses, civic and community groups." [Atlanta Science Festival, 2021]

- "Prominent participants at the event include local and national science-based industries and businesses, federal agencies, educational institutions, and public institutions that have a major emphasis on science or science education, such as the Indiana State Museum and the Indianapolis Children's Museum." [Celebrate Science Indiana, 2020a]
- "We are focused on student preparedness and facilitate collaboration among industry partners, academic institutions, non-profit organizations and the community." [Upstate, 2021a]
- "The MSF works for an entire year recruiting as many organizations as it can to participate in the Festival, such as libraries, museums, public and private schools, colleges, universities, government agencies and private companies." [Maryland STEM Festival, 2021]

While inter-organizational collaboration is vital to the implementation of science festivals, another finding from this analysis shows that festival organizers also value inter-organizational collaboration as an outcome for their festivals. In short, festival organizers hope that by bringing together collaborators from the STEM community, government, business, education, and the broader public, these groups will form lasting partnerships which will ensure that science education outreach is sustained in the long term. In articulating this outcome, science festival web sites, annual reports, and social media pages tend to use phrases such as "building community", "growing networks [of collaborative partners]", and "encouraging collaboration". The following excerpts from the data illustrate how festival organizers operationalize inter-organizational collaboration as an outcome (passages of note are underlined for this article):

- "Encourage partnership and collaboration between the science and technology community and the public." [Bay Area Science Festival, 2021]
- "Create networking opportunities with other scientific, cultural, and educational institutions." [MSU Science Festival, 2021]
- "…respond to these challenges while building new and stronger relationships among the education, business and cultural leaders who will lead that response." [North Carolina Science Festival, 2021b]

In summary, inter-organizational collaboration is vital to the organization and implementation of science festivals. Collaborators may assist festival organizers by providing financial support, recruiting staff, designing educational activities, providing materials, marketing the festival, or meeting any needs not listed here. Moreover, science festival organizers view inter-organizational collaboration as a key outcome of their festivals. In other words, science festivals facilitate network- and community-building between collaborative partners who place similar emphasis on sustaining STEM education outreach in the long term.

Limitations

This qualitative analysis of science festival web sites sheds light on the way festival organizers conceptualize their efforts. However, in some cases, web sites and social media pages provided minimal information about their festivals. Moreover, the

number of festivals analyzed here (n=55) is not sufficient for statistical analyses beyond descriptive statistics.

Another limitation of this work lies in its geographic scope. All but one of the festivals identified in this analysis are located in the United States. Given the differences in cultural practices, it is possible that science festivals outside of the United States have features that make them distinct. Future research will be critical in elucidating these features.

Conclusions

In this article, we reviewed the literature surrounding the impacts of science festivals on public audiences. However, we express caution regarding the generalizability and replicability of those studies as the majority of them lacked sufficient descriptive information about the festivals being studied. We show that science festivals vary greatly with regard to their size, duration, geographic reach, theming, and programming. We also show that many science festivals share four characteristics in common: An intent to increase public awareness of science, an intent to encourage young children to pursue careers in STEM, widespread use of hands-on or otherwise interactive activities, and a reliance on inter-organizational collaboration.

Science festival research is still in its infancy and much more work is needed to better understand the effects that these festivals have on public audiences and festival staff. In particular, are festivals having the impacts that organizers intend? To what extent do the goals of festival organizers align with those of festival attendees? In the era of COVID-19, how can the hands-on, interactive content of science festivals be transferred to virtual settings? The answers to these questions will prove fundamental to the way science festivals evolve to meet the demands of a rapidly changing world.

References

Adhikari, B., Hlaing, P. H., Robinson, M. T., Ruecker, A., Tan, N. H., Jatupornpimol, N., Chanviriyavuth, R. and Cheah, P. Y. (2019). 'Evaluation of the Pint of Science festival in Thailand'. *PLOS ONE* 14 (7). Ed. by J. A. Conejero, e0219983. https://doi.org/10.1371/journal.pone.0219983.

Arkansas Science Festival (2020). *Arkansas Science Festival Mission Statement*. URL: https://arkansassciencefestival.org/mission.

Atlanta Science Festival (2021). *Atlanta Science Festival Mission & Goals*. URL: https://atlantasciencefestival.org/about/mission-and-goals/.

Baran, E., Bilici, S. C., Mesutoglu, C. and Ocak, C. (2019). 'The impact of an out-of-school STEM education program on students' attitudes toward STEM and STEM careers'. *School Science and Mathematics* 119 (4), pp. 223–235. https://doi.org/10.1111/ssm.12330.

Bay Area Science Festival (2021). *What is the Bay Area Science Festival?* URL: https://www.bayareasciencefestival.org/about-us/what-is-basf/.

Bevc, C., Young, D. and Peterman, K. (2016). 'Using social network analysis to document science festival partnerships'. *JCOM* 15 (05), A04. https://doi.org/10.22323/2.15050204.

Boyette, T. and Young, D. (2014). 'Adding value by celebrating science'. *Informal Learning Review* 125.

Boyette, T. and Ramsey, J. (2019). 'Does the messenger matter? Studying the impacts of scientists and engineers interacting with public audiences at science festival events'. *JCOM* 18 (02), A02. https://doi.org/10.22323/2.18020202.
Braun, V. and Clarke, V. (2006). 'Using thematic analysis in psychology'. *Qualitative Research in Psychology* 3 (2), pp. 77–101. https://doi.org/10.1191/1478088706qp063oa.
Bultitude, K., McDonald, D. and Custead, S. (2011). 'The Rise and Rise of Science Festivals: an international review of organised events to celebrate science'. *International Journal of Science Education, Part B* 1 (2), pp. 165–188. https://doi.org/10.1080/21548455.2011.588851.
Cambridge Science Festival (2021). *What is the Cambridge Science Festival?* URL: https://cambridgesciencefestival.org/about-us/.
Canovan, C. (2019). '"Going to these events truly opens your eyes". Perceptions of science and science careers following a family visit to a science festival'. *JCOM* 18 (02), A01. https://doi.org/10.22323/2.18020201.
Celebrate Science Indiana (2020a). *About Celebrate Science Indiana*. URL: https://celebratescienceindiana.org/about-csi/.
— (2020b). *Our Goals*. URL: https://celebratescienceindiana.org/mission/.
Charleston STEM Festival (2021). *Where it all Started*. URL: http://www.charlestonstemfest.org/about.html.
Chen, G. (2014). 'National Science Festival of Thailand: historical roots, current activities and future plans of the National Science Fair'. *JCOM* 13 (04), C04. https://doi.org/10.22323/2.13040304.
Chicago Science Festival (2019). *Festival Description*. URL: https://sciencefestivals.org/festival/chicago-science-festival/.
City of STEM (2021). *What is City of STEM*. URL: https://cityofstem.org/about.
Colorado Springs Cool Science Festival (2018). *Festival Description*. URL: https://sciencefestivals.org/festival/colorado-springs-science-festival/.
Crettaz von Roten, F. (2011). 'In search of a new public for scientific exhibitions or festivals: the lead of casual visitors'. *JCOM* 10 (01), A02. https://doi.org/10.22323/2.10010202.
Davies, S. R. (2019a). 'Science communication as emotion work: negotiating curiosity and wonder at a science festival'. *Science as Culture*, pp. 1–24. https://doi.org/10.1080/09505431.2019.1597035.
— (2019b). 'Science communication is not an end in itself: (dis)assembling the science festival'. *International Journal of Science Education, Part B* 9 (1), pp. 40–53. https://doi.org/10.1080/21548455.2018.1540898.
Davies, W. K. D. (2015). 'Festive Cities: Multi-Dimensional Perspectives'. In: Theme Cities: Solutions for Urban Problems. Springer Netherlands, pp. 533–561. https://doi.org/10.1007/978-94-017-9655-2_14.
Dayton Regional Science Festival (2017). *Festival Description*. URL: https://sciencefestivals.org/festival/dayton-regional-science-festival/.
Fikus, M. (2005). 'Audiences'. In: The white book: science communication events in Europe. European Science Communication Events Association, pp. 31–70.
Fogg-Rogers, L., Bay, J. L., Burgess, H. and Purdy, S. C. (2015). '"Knowledge is power": a mixed-methods study exploring adult audience preferences for engagement and learning formats over 3 years of a health science festival'. *Science Communication* 37 (4), pp. 419–451. https://doi.org/10.1177/1075547015585006.

Idema, J. and Patrick, P. G. (2019). 'Experiential learning theory: identifying the impact of an Ocean Science Festival on family members and defining characteristics of successful activities'. *International Journal of Science Education, Part B* 9 (3), pp. 214–232. https://doi.org/10.1080/21548455.2019.1614238.

Indian River Lagoon Science Festival (2020). *Our Mission*. URL: https://irlsciencefest.org/about-us/.

Jackson Hole WILD Science Fest (2017). *WILD Science*. URL: http://jhcenterforthearts.org/calendar/events/wild-science.

Jacksonville Science Festival (2021). *The Festival: What is Jacksonville Science Festival (JSF) at a Glance?* URL: http://www.jacksonvillesciencefestival.org/.

Jarman, D. (2016). 'The Strength of Festival Ties: Social Network Analysis and the 2014 Edinburgh International Science Festival'. In: Critical Event Studies. Palgrave Macmillan UK, pp. 277–308. https://doi.org/10.1057/978-1-137-52386-0_14.

Jensen, E. and Buckley, N. (2014). 'Why people attend science festivals: interests, motivations and self-reported benefits of public engagement with research'. *Public Understanding of Science* 23 (5), pp. 557–573.

Kennedy, E. B., Jensen, E. A. and Verbeke, M. (2018). 'Preaching to the scientifically converted: evaluating inclusivity in science festival audiences'. *International Journal of Science Education, Part B* 8 (1), pp. 14–21. https://doi.org/10.1080/21548455.2017.1371356.

Maine Science Festival (2021). *Festival Description*. URL: https://sciencefestivals.org/festival/maine-science-festival/.

Maryland STEM Festival (2021). *About*. URL: https://marylandstemfestival.org/about.

MSU Science Festival (2021). *Our Mission*. URL: https://sciencefestival.msu.edu/about/our-mission.

National Research Council (2012). A framework for K-12 science education: practices, crosscutting concepts and core ideas. Committee on a Conceptual Framework for New K-12 Science Education Standards. Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC, U.S.A.: National Academy Press. https://doi.org/10.17226/13165.

Nielsen, K., Gathings, M. J. and Peterman, K. (2019). 'New, Not Different: Data-Driven Perspectives on Science Festival Audiences'. *Science Communication* 41 (2), pp. 254–264. https://doi.org/10.1177/1075547019832312.

North Carolina Science Festival (2021a). *About*. URL: https://www.ncsciencefestival.org/about.

— (2021b). *Festival Mission*. URL: https://www.ncsciencefestival.org/about/festival-mission.

Pennisi, L. and Lackey, N. Q. (n.d.). 'A multiyear evaluation of the NaturePalooza Science Festival'. *Journal of Extension* 56 (7), 8. URL: https://tigerprints.clemson.edu/joe/vol56/iss7/8.

Randolph College Science Festival (2020). *SciFest Schedule: 2020*. URL: http://randolphscience.org/scifest/.

Rose, K. M., Korzekwa, K., Brossard, D., Scheufele, D. A. and Heisler, L. (2017). 'Engaging the public at a science festival: findings from a panel on human gene editing'. *Science Communication* 39 (2), pp. 250–277. https://doi.org/10.1177/1075547017697981.

Science Festival Alliance (2013). *2012 annual report of the Science Festival Alliance*. URL: http://sciencefestivals.org/resource/2012-science-festival-alliance-annual-report/.
— (2018). *2017 annual report of the Science Festival Alliance*. URL: https://sciencefestivals.org/wp-content/uploads/2017-SFA-Annual-Report-Lo-Res.pdf.
Siskiyou Science Festival (2018). *Siskiyou Science Festival Vision*. URL: https://sciencefestivals.org/festival/siskiyou-science-festival-2/.
St. Petersburg Science Festival (2021). *Why a Science Festival?* URL: https://stpetescifest.org/about/.
Su, L. Y.-F., Scheufele, D. A., Bell, L., Brossard, D. and Xenos, M. A. (2017). 'Information-Sharing and Community-Building: Exploring the Use of Twitter in Science Public Relations'. *Science Communication* 39 (5), pp. 569–597. https://doi.org/10.1177/1075547017734226.
Tennessee STEAM Festival (2020). *Tennessee STEAM Festival: What is it?* URL: https://www.tnsteam.org/what-is-it.
Upstate (2021a). *About Us*. URL: https://www.imaginesteamsc.org/upstate/learn-more/about-us/.
— (2021b). *Our History*. URL: https://www.imaginesteamsc.org/upstate/learn-more/our-history/.
van Beynen, K. and Burress, T. (2018). 'Debris, diatoms, and dolphins: tracking child engagement at a public science festival'. *International Journal of Science Education, Part B* 8 (4), pp. 355–365. https://doi.org/10.1080/21548455.2018.1506189.
Virginia Tech (2020). *Virginia Tech Science Festival*.
Wiehe, B. (2014). 'When science makes us who we are: known and speculative impacts of science festivals'. *JCOM* 13 (04), C02. URL: http://jcom.sissa.it/archive/13/04/JCOM_1304_2014_C01/JCOM_1304_2014_C02.
Wisconsin Science Festival (2021). *About Wisconsin Science Festival*. URL: https://www.wisconsinsciencefest.org/about/.

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