

**Title:** Guerilla Science: Mixing science with art, music and play in unusual settings.

**Abstract:**

Outreach activities at the interface of science and art present a unique opportunity to connect and engage with “latently interested” publics who do not otherwise take part in science activities like visiting science museums. In this paper, the authors present “Guerilla Science” as one model that supports the hypothesis that well-designed science + art (STEAM) programming in informal settings can broaden participation in, and facilitate engagement with STEM-related topics. This paper describes a range of interactive events featuring scientists and artists and accompanying research into the impact of these events on a public audience.

**Author:** Mark Rosin [1]; Jen Wong [2]; Kari O’Connell [3]; Martin Storksdieck [4], Brianna Keys [5]

1. Mark Rosin (science communicator, mathematician) Pratt Institute, Department of Math & Science-<mark@guerillascience.org>
2. Jen Wong (science communicator, curator) Science Gallery London <jen@guerillascience.org>
3. Kari O’Connell (social scientist), Center for Research on Lifelong STEM Learning, Oregon State University-<kari.oconnell@oregonstate.edu>
4. Martin Storksdieck (social scientist, informal science educator), Center for Research on Lifelong STEM Learning, Oregon State University <storksdieck@oregonstate.edu>
5. Brianna Keys (social scientist), Center for Research on Lifelong STEM Learning, Oregon State University <Brianna.keys@oregonstate.edu>

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Engaging with science successfully, be it in the context of learning or as a citizen in a participatory democracy [1], is, in part, a matter of cultural context, interest, and identity [2]. In particular, in informal settings or out-of-school contexts, or while pursuing voluntary leisure activities, participants have the freedom and agency to choose their level of engagement with topics, ideas, and activities based on their interests and identities [3]. This “informal” [4] or “free choice learning” invariably leads to audience self-selection: public access points to science, like science museums or science media, succeed in reaching (and serving) an already science interested and science engaged audience, but do not necessarily provide avenues for expanding participation in science learning activities beyond the proverbial “converted” or “choir” [5, 6]. This basic characteristic of “free-choice” leaves a significant participation gap for people, especially adults, who are not already interested or engaged in science.

Science education programs that seek to rectify this gap must go “out to the people, thereby reaching a different audience . . . namely these persons, who might not ‘dare’ to enter scientific venues” [7]. Connecting with new publics must be done in a culturally appropriate manner that draws on people’s prior interest and experiences and appreciates their socio-cultural backgrounds and funds of knowledge [8].

One approach towards making science, technology, engineering and/or mathematics (STEM) approachable, desirable and meaningful is to embed or blend STEM into a context that is familiar and valued by audiences, such as fine arts, music, theatre, performance art, or design. The Contextual Model of Learning [9,10] indicates that the physical context matters tremendously in terms of framing a cultural experience. That is, how an experience is “packaged” changes the way it is perceived. Presenting STEM within a different cultural frame (such as art or design), or blending elements of STEM with elements of art or design can open the door for art-interested audiences to engage in science. And while science centers have long been adding occasional STEAM-like experiences into their repertoire, those experiences still do not make the institution overall more inviting to audiences with low affinity to STEM.

In this paper, we - two informal STEAM learning practitioners and three independent social science researchers - present a “Guerilla Science” style model of how this may be achieved.

### **Ethos, goals, and history <1>**

Originating almost a decade after a House of Lords report on Science and Society [11] concluded that science and society must “engage in dialogue aimed at mutual understanding”, Guerilla Science emerged in a new era that embraced what is now referred to as Public Engagement with Science. Unlike Public Understanding of Science, its conceptual predecessor, which was centered on the “deficit model” of communication, Public Engagement with Science initiatives are focused on two-way exchanges and experiences featuring interaction and listening for mutual benefit, and conceptually open to a wider range of outcomes for the participating public.

Guerilla Science creates encounters with science ideas that are embedded in engagement formats

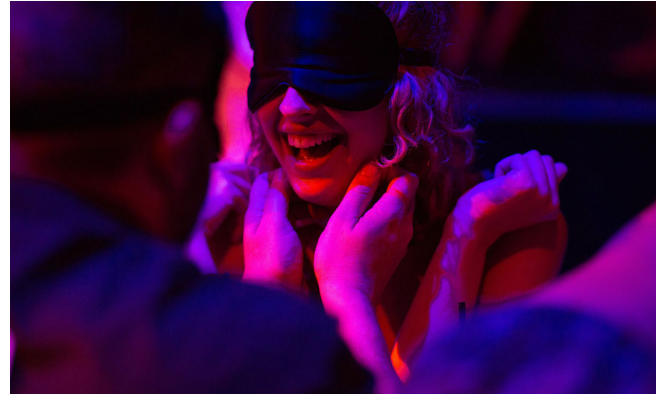
not typically associated by audiences with traditional informal science education. These events take place in the places and spaces where science is least expected, for example music and arts festivals, disused urban spaces, and nightclubs. By including aspects of both scientific and artistic disciplines, the experiences match the venue's contexts and the audience's interests. Guerilla Science's primary audience are adults, who do not see science as "being for them."

The social value of Guerilla Science lies in empowering people with scientific ideas - helping them to see the relevance of science to their lives and in being able to meaningfully use this knowledge. There are three primary ways in which this can happen. First, through supporting individuals and communities to incorporate scientific thinking as one way (amongst many) to make decisions that work for them, e.g., through artful experiences of tasting sweetness in ways that may influence people's health decisions around sugar consumption. Second, through facilitating learning around a range of civic issues that can inspire individuals to become more engaged and informed citizens, e.g., through visceral experiences of ways in which human lifestyles may change as a result of anthropogenic climate change. Third, through exhibiting science as an interesting and important part of human culture with inherent value in its own right, e.g., by exploring the role of touch in eliciting neurochemical responses in a way that reveals the wonder of our bodies and how they function in social interactions.

How these goals are achieved through their events is described in Guerilla Science's Theory of Change:

1. Creating exciting live experiences in spaces where people who do not normally engage with science gather.
2. Connecting with people who do not normally engage with science by crafting experiences that connect to their cultural and learning identities.
3. In connecting to them, support sense-making and investigating practices, and develop a sense that science is relevant and meaningful to their lives.

This Theory of Change assumes an element of "stealth" in the way that scientific aspects of a Guerilla Science experience are foregrounded, to better attract audiences who do not ordinarily engage with STEM topics. However, the degree to which audiences would expect Guerilla Science events or activities to at least partially feature science varies, from where science is barely apparent to where a specific scientific topic is called out (even if embedded into an experience format that is atypical for science engagement). Similarly, the extent to which sense-making and investigating practices are supported varies too. These practices, as well as critiquing, exist as part of a new framework of epistemic practices that exist at the intersection of art and science [12, 13].



Figs 1a & 1b: 1a (left) - *Sensory Speed Dating* host Dr Carlotta Bates, a research scientist who studies sexual attraction. (Image by Mike Massaro.) 1b (right) - Audience members during the touch round of *Sensory Speed Dating* at House of Yes, New York in 2017. (© Marina McClure)

## **Case Studies <2>**

Three examples of Guerilla Science’s work are provided in the following case studies of science rich interactive experiences that borrow elements from art, design, performance, and music and are then deployed in cultural setting not usually associated with science. These events were entitled *Sensory Speed Dating*, *Works on Water*, and *Flavor Feast*. In evaluating the events, we focused on characterizing audience interest, motivations, and satisfaction and takeaways. The specific data collection method depended on context and setting: an online follow-up survey for *Sensory Speed Dating*; short entry and exit interviews and post-event audience feedback forms at *Works on Water*; and feedback forms only at *Flavor Feast*.

### **Sensory Speed Dating <2.1>**

*Sensory Speed Dating* explores the multisensory science of attraction. Originally developed for a music festival context, *Sensory Speed Dating* events now take place in bars and clubs. The event is a form of “happening”, blending the everyday nature of traditional speed dating formats, with scientific content from neuroscience, social psychology and genetics, and elements of cultural history, comedy and food design that situate the audience in a context that is novel for science learning.

Two hosts - a performer and a scientist (whose research area is relevant to attraction, see Fig. 1a), move the audience through different rounds of sensory experiences, all the while exploring the associated science of each experience in accessible language. Guests in rotating pairs take part in several sensory challenges to smell, hear, taste, touch, see and move their way to a greater understanding of the often unconscious processes that drive our behaviour and desires. The challenges cover different areas of scientific research around attraction: including vision, the voice, olfaction, movement, and environmental effects.

For example, when exploring the sense of touch, one member of a pair puts on a blindfold, the other person takes their hands, and moves it to their face or strokes it, gently, for 30 seconds -

Fig. 1b. The pair swap over and share how the sensation of touch affected them - including whether they felt aroused. The conversation between hosts highlights how touch is a vital ingredient to almost every social relationship, referencing historical experiments such as Harry Harlow's rhesus monkey experiments from the 1930s and their relevance to human behaviour today. Harlow showed that rhesus monkeys reared in the absence of maternal touch and warmth were reclusive, had social deficits, and would cling to cloth diapers to try and mimic their mothers' touch. Baby monkeys that grew up without a mother's touch showed signs of psychological damage, including excessive fear and aggressiveness. The same is true in humans: for example, people who hug their partners more often tend to have better physiological well-being, including lower blood pressure, and better psychological well-being, including fewer symptoms of depression. The hosts explore how touch can also exert a powerful effect between strangers, not just romantic partners, referencing studies that show touching someone gently on the arm is enough to elicit more helping behavior.

Sensory Speed Dating has featured neuroscientists and psychologists as participating scientists, comedians and drag queens as the facilitator hosts, and food designers have contributed to the taste round, creating custom made nutmeg and clove spice cookies as an entry into discussing research into the libido-enhancing properties of nutmeg in rats.

### **Works on Water <2.2>**

Guerilla Science partnered with theater company New Georges, 3-Legged Dog/3LD Art & Technology Center, and curatorial group Urban Water Makers on several elements within the *Works on Water* program, a multidisciplinary art, theater, and live experience that explored the relationship between people and water, including (*NOT*) *WATER*, the premiere of a new immersive play developed in response to the devastation of New Orleans by Hurricane Katrina (see Fig. 2a). Initial readings of the script revealed that the play needed more specific examples of water-related crisis outside of North America, and that the playwright wanted to use detailed, accurate information to inspire new scenes. In response, Guerilla Science conducted hours of recorded interviews with scientists on a broad range of anthropogenic climate-change research in different geographic areas. Guerilla Science then provided a dramaturg with a strong science background who worked with the creative team to weave these interviews into narrative threads that informed the final script and performances.

The team also developed four interactive video installations. These were projected into the venue's bathroom sinks, to encourage visitors to connect mindless daily water use with anthropogenic climate change. Guests in the bathroom saw a video of beautiful scenery projected into their sink that, when the faucet was turned on, changed to an unpleasant visual reminder (for example, river pollution in Rio Santiago Lerma, Mexico) of the effects that humans are having on the planet (see Fig. 2b).

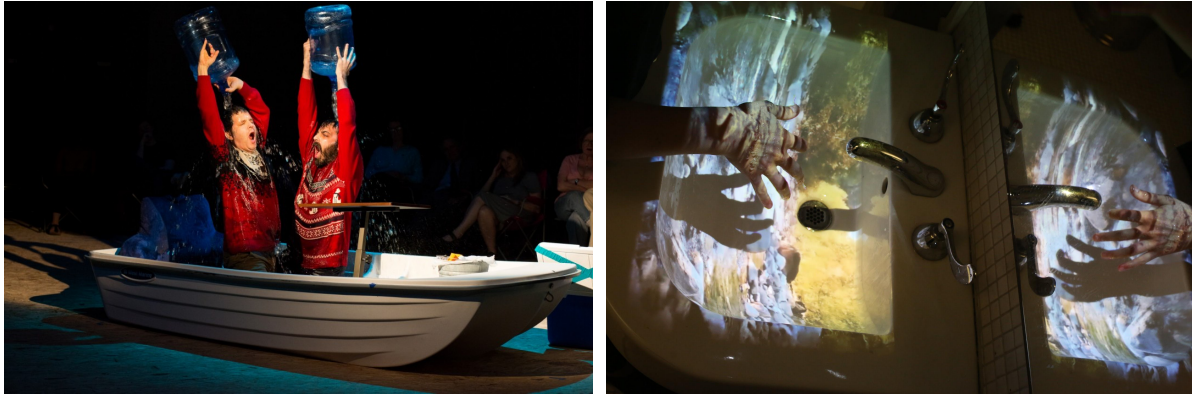


Fig. 2a and 2b: 2a (left) - From the immersive play, *(NOT) Water*, part of *Works on Water*. (© Marina McClure.) 2b (right) - Video installation for *Works on Water*. (© Marina McClure).

### **Flavor Feast at Burning Man <2.3>**

At Burning Man, a seventy-thousand person experiment in community and art that takes place annually in the Nevada desert and ostensibly resembles a festival, Guerilla Science confounded the senses of passers-by with the *Flavor Feast*. Styled as a gaping mouth, the *Flavor Feast* is a series of interactive demonstrations at a pink booth designed to resemble a pop-up store (Fig. 3a). In it, participating scientists and guerilla chefs from one of Burning Man's theme camps [14]- *The Phage* - donned pink aprons and hosted "a pop-up party for the senses".

The overarching take-away for visitors is that flavor perception is dependent on multiple senses, and goes well beyond just our tongues. Our taste buds are important, but our eyes, ears and noses are essential too. To demonstrate the multisensory nature of flavor perception, *Flavor Feast* includes a series of simple edible demos that "trick" the audience's senses. For example, one of the demonstrations involves the use of a "miracle berry" pill - a tablet that hacks your taste buds. The pill contains the protein miraculin, which binds to the tongue's sweet taste buds at a neutral pH but doesn't activate them; at low pH acid causes the protein to change shape and activate the sweet receptors on the tongue, causing normally sour flavors to be perceived as extremely sweet. This demonstration, and others, generated a feeling of joyous discovery in visitors at the wonders of their bodies (Fig. 3b).

### **Audience impact <3>**

Audience survey and interview data gathered from 626 people across the three events described above and one not profiled in this paper (Sweet Shoppe) provided insights into two main research questions about Guerilla Science events:

1. Who participates in Guerilla Science and what are motivations for participation?
2. What do participants take away from their participation?





Fig 3a and 3b: Fig 3a. (left) - Guerilla Science Flavor Feast pop up, Burning Man festival 2017 (Image by Galen Oakes.). Fig 3b (right) - Miracle berry pills cause lemons to taste sweet. An experience that many guests find surprising and exciting. (Image by Galen Oakes.)

The data reveals that the impact of deploying interactive experiences that borrow elements from art, design, performance, and music, infusing the experiences with science content, and installing the experiences in informal settings such as music festivals activates those latently interested in science to engage with science; this is precisely because the context and style of activity helps audiences shift their perspective away from being educated about science to engaging in a cultural experience that happens to have some science content.

The activities are able to attract a wide variety of participants, including audiences who do not normally choose to engage with science [15]. Our empirical studies showed that participants expressed high value for, and interest in science in general. This generic “appreciation” for science is widely shared by almost all people in the United States. However, the participants’ highly positive attitudes toward the value of science did not always translate into a strong social connection to or engagement with science, e.g. through knowing people who work in science-related fields, what is referred to as “science capital” [16]. We label this segment of the population “latently” interested in science: they have positive attitudes toward science in general, but do not necessarily choose to engage with it. We were able to show that Guerilla Science events offer an important opportunity for this “latently” interested public to engage with science learning experiences, and that primary takeaways from these experiences were learning-related.

Key findings from audience research on Guerilla Science events can be summarized as follows [17]:

- Guerilla Science attracts a variety of individuals ranging from those who are highly engaged in to those who at most express generic appreciation for science, but lack a real relationship with science. By engaging with those in the latter category, Guerilla Science offers a unique space or niche to interact with science for those who might not otherwise choose to experience it.

- Guerilla Science attracts participants by making them curious about a topic. Participants also reported being enticed by the type of event, that is, by an expectation for a particular kind of experience. Some, though, are simply joining friends who had wanted to participate.
- Though the motivation to satisfy curiosity is primarily what makes individuals participate in Guerilla Science events, initial primary takeaways are learning-related. When asked what they were taking away from the event, many respondents referenced specific facts they discovered or new experiences that instilled new topic-related knowledge.

Overall, these results suggest that Guerilla Science can expand meaningful engagement with science precisely because it creates experiences at the boundary of art, design, music, or theatre with a wide array of scientific ideas.

### **Final thoughts <4>**

Decades of research on learning have taught us that learners are far more than deficient vessels to be filled with information [18]. Exemplifying the broader field of Public Engagement with Science, Guerilla Science seeks to embody these values by emphasizing connection and two-way conversations rather than unidirectional communication.

Art can help us make meaning of the world, just as science does. Guerilla Science creates experiences that seek to move people with science and scientific ideas in the same way that a piece of music or theater does, not only by connecting forms of art with science, but by making use of common ways in which both include critiquing, meaning-making, and exploratory practices [19]. Guerilla Science therefore creates opportunities for new “latently [scientifically] interested” audiences to encounter, understand, and learn about science in the context of wider culture, for example, at music festivals, through art, and in theater.

This research-practice study has highlighted the value of this approach for engaging those who ordinarily participate at a lower rate in science activities, and for facilitating learning experiences

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## **References and Notes**

- [1] Lewenstein, B., “Views: Public Engagement”, CAISE Blog, 2012 <[informal.science.org/news-views/public-engagement](http://informal.science.org/news-views/public-engagement)>, accessed 1 June 2018
- [2] Falk, J., Dierking, L.,. “*Learning from Museums: Visitor Experiences and the Making of Meaning.*” Lanham, MD: Alta Mira Press. (2000).
- [3] Falk, J. , Storksdieck, M., Dierking, L.. “Investigating public science interest and understanding: Evidence for the importance of free-choice learning”. PUS, 16(4), 455-469. 2007
- [4] Formal learning" refers to learning experiences aimed at formal qualifications, degrees or certificates and is generally designed and controlled by an educator. "Informal learning" (or "free-choice learning") refers to self-directed, self-motivated, and non-assessed learning experiences that are not geared towards achieving defined levels of qualifications. The former is generally associated with schooling, and the latter with out-of-school settings.
- [5] Dawson, E. “Reimagining publics and (non)participation”, J. Sci. Comm.. 1-15, 2018.
- [6] National Research Council. . “Learning science in informal environments: People, places, and pursuits.” Bell, P., Lewenstein, B., Shouse, A.W., & Feder, M.A. (Eds.). Board on Science Education, Washington, DC: N.A.P.. 2009.
- [7] Bultitude. K. & Sardo. A.. “Leisure and Pleasure: Science events in unusual locations”, International Journal of Science Education, 34:18, 2775-2795 (2012)
- [8] See [6].
- [9] Falk, J. & Dierking, L. “The 95% Solution: School is not where most Americans learn most of their science.” *American Scientist*, 98, (2010) 486-493.
- [10] Falk, J. & Storksdieck, M. “ Using the *Contextual Model of Learning* to understand visitor learning from a science center exhibition.” *Science Education* 89: (2005) 744-778.
- [11] House of Lords, “Science and Society, Third Report” 1999-2000 <[publications.parliament.uk/pa/ld199900/ldselect/ldsctech/38/3801.htm](http://publications.parliament.uk/pa/ld199900/ldselect/ldsctech/38/3801.htm)>, accessed 1 June 2018
- [12] Bevan, B. et al. “Purposeful Pursuits: Leveraging the Epistemic Practices of the Arts and Sciences”., in A. J. Stewart et al. (Eds.), *Converting STEM Programs to STEAM Programs*, Springer (2018)
- [13] Bevan, B., Mejiasm, S., Rosin M., Wong, J., “Spectral Crickets: The Epistemics of Art and Science in Education”, Leonardo (submitted), (2019)

[14] Theme camps, made up of Burning Man attendees, are required to contribute to the community through, for example, works of art, a performance, or music.

[15] O’Connell, K., Keys, B., & Storksdieck M., “Getting to Know Guerilla Science Participants.” Technical Report, Corvallis, OR: OSU, (2018) <[stem.oregonstate.edu/sites/stem.oregonstate.edu/files/Guerilla-Science-Final.pdf](http://stem.oregonstate.edu/sites/stem.oregonstate.edu/files/Guerilla-Science-Final.pdf)> accessed 31st July 2018

[16] Archer, L. et al. “ ‘Science capital’: A conceptual, methodological, and empirical argument for extending Bourdieusian notions of capital beyond the arts.” *Journal of Research in Science Teaching*, 52(7) (2015), 922–948.

[17] See [15]

[18] See [6]

[19] See [12]

## **Bibliography**

Mark Rosin is co-founder Guerilla Science and its U.S. director. He is an assistant professor of mathematics at the Pratt Institute, NY.

Jen Wong is co-founder of Guerilla Science and its U.K. director. She is head of programming at Science Gallery London.

Kari O’Connell is a Senior Researcher at Oregon State University’s Center for Research on Lifelong STEM Learning.

Martin Storksdieck is the Director at Oregon State University’s Center for Research on Lifelong STEM Learning and a Professor in the College of Education.

Brianna Keys is a Research Analyst at Oregon State University’s Center for Research on Lifelong STEM Learning.

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