Interpreting Science

at Museums and Historic Sites

Edited by Debra A. Reid, Karen-Beth G. Scholthof, and David D. Vail

INTERPRETING HISTORY SERIES

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CHAPTER 18

Integrating Art and Science to Effectively Share Knowledge

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PICTURE THIS. You're in an education room in a museum. The room is well-appointed, with plenty of lighting, comfortable seating, and handy work surfaces. The room is also clearly well-stocked with materials of all sorts. But, it does not have any windows. And the facilitator says, "Sketch a tree." That is your only instruction. Someone asks, "What kind of tree?" Another, "How big?" The facilitator only responds, "That's up to you. Just sketch a tree. Don't overthink it." There are no trees to look at, so you scribble down a tree from memory. It looks like a triangle, a stereotypical conifer. You notice that your neighbor has drawn something that could be a fruit tree, or a poofy cloud on a post. You both agree: You have no idea how to draw. Hopefully the facilitator doesn't expect much!

And then the facilitator says, "Okay! Now, sketch a specific tree that was special to you as a child or is special now." Big gulp. You have exactly the tree in mind. Perhaps you grew up near a forest. Perhaps you grew up in an urban environment, and there was just one, iconic tree in your neighborhood. Maybe you recently planted a tree to commemorate someone's birth or death. Whatever the case, you can see this tree vividly in your mind's eye. But getting it down on paper?!?

You can't just duck out, so you labor over what the trunk looks like, how the branches are shaped, what kind of leaves the tree has. And far too soon—you haven't come close to drawing the whole tree—the facilitator asks everyone to pause. You are then prompted to talk with your neighbor about the tree you sketched. Most of your conversation is about the memories you each have of these trees, why you care about the tree, and if you've seen it recently. And, you apologize to each other: for the amateur nature of your drawings, for omitting all sorts of details, especially the ones you can't quite remember. How the branches

connect to the trunk. The actual shape of the canopy of the tree. What sorts of scars or marks were on the trunk. Whether any other animals (besides you) seemed to value the tree or use it for food or shelter.

You're still not quite sure what the facilitator is up to, but you enjoy thinking about your special tree for a few minutes. You might have preferred to just reminisce or write notes about it, though. Drawing is hard, and you wouldn't want anyone to see your sketch. It looks like a little kid drew it! Why did you need to draw anyway?

The facilitator seems to anticipate your questions. "Now, it's time to write some notes. Add some context and details to your sketch. Use words to clarify things that didn't come through in your sketch." And, your memories hit the paper in a flood—the color of the leaves or needles at different times of year. The sound of the wind going through in the winter. How you used to interact with the tree. Where parts of the tree "should" be but don't actually look that way in your sketch.

"And now, write down at least one question you have." The facilitator continues, "What's missing? What can't you remember? What would you have to go back to that tree and look at closely, in order to depict it accurately?" And your list swells: no idea what the buds looked like. Did it flower? How big was it, really, compared to memory? Is it still there?

The facilitator asks you to discuss what was similar and what was different about what you made for "draw a tree" versus "draw a specific, special tree." There's a hush, and then everyone starts calling out things like "cloud tree," "It's a cartoon," and "The specific tree is way more detailed."

"Yes, exactly," says the facilitator. And they remind you of something obvious that feels somehow profound: A blank page is blank. And it clicks—your expectations influence both your memories and your new experiences or efforts to learn something new. Your expectations are perhaps more influential than the reality you actually encounter. That's why looking for memory or accuracy or fact on a blank page can be frustrating. And yet, this frustration is avoidable if you are attentive and observant, if you are open to noticing and learning from your surroundings and experiences. It is possible to try something new without "failing" if you moderate your expectations and acknowledge you have arrived with preconceptions.

When the facilitator next prompts you to go out into the museum, with its interactive exhibits and indoor and outdoor displays, you're intrigued. You're actually willing, now, to try to sketch things that catch your attention. And, you've been primed—by sketching your tree from memory—to double-check your perceptions of the museum exhibits. You can use your sketches and notes to keep you tuned in to what's really there, not just what you anticipate you'll see.

As this example[1] shows, what museum and historical site visitors experience is contingent. Our interpretation, memory, conclusions, and even learning hinge on our prior knowledge, social pressures, and even convenience.[2] In reality, human nature is at odds with many of the goals of museums and historical facilities and the ways of knowing that are conveyed through such institutions. These are places, materials, and ideas that are intended to simultaneously entertain and educate. And yet, most of us are unaware of how our biases, expectations, and social positioning influence how we interact[3] with settings like museums.

This paradox is especially acute in settings where science is a central theme or subject. Most science, in the United States at least, is conveyed in a manner rooted in three

assumptions: (1) science is objective,[4] (2) this objectivity is not just desirable, it is paramount,[5] and (3) science is a universal social good. And yet, history contradicts these assumptions with deep and mounting evidence that Euro-colonial science has been exploitative, damaging, and exclusionary across cultures, regions, socio-economic circumstances, and time frames.[6]

Only a few examples are needed to emphasize the lack of objectivity in, and exclusionary nature of, science. Indeed, science history and current practices are far too often characterized by exploitation, appropriation, and suppression. Examples include explicit situations such as when Johns Hopkins researchers exploited Henrietta Lacks, a Black woman who died from a devastating, aggressive cancer for which she sought treatment at Johns Hopkins. Researchers there harvested some of the cancer cells from her without permission.[7] They propagated the cells into the HeLa cell line now worth billions of dollars; a resource, which numerous courts have ruled is *not* the property of her family, but of the biomedical companies who commodified her illness. Other examples are more nuanced and explicitly intersect with the arts. For example: Maria Sibylla Merian appropriated knowledge from her slaves in Suriname to "discover"[8] and elegantly illustrate insect metamorphosis and the concept of ecology. And, the Vatican suppressed Galileo's illustrations and dissemination of his realization that the Earth actually revolves around the Sun by threatening him with torture and death (ultimately scaled back to lifelong house arrest). These examples make it clear: both art and science were historically dominated by Eurocentric attitudes that were frequently dismissive, exclusionary, and worse.

As we dig deeper into the whitewashing of science and art, it's a fairly grim and intense history; one that may not be appropriate or authorized for all museums and historical settings. Further, we face a conundrum if we focus on the major flaws of science and modern calls for accountability. That is: museums, historical sites, scientists, and advocates for evidence-based decision-making are struggling to compete with short attention spans, alternative "facts," and massive amounts of information hitting people every day.[9]

In such circumstances, leveraging the provocative and contemplative power of arts practices can allow for more nuanced engagement with the positives and negatives of modern science and science history, *if* we hold space for diverse ways of knowing (e.g., Indigenous science). The arts can invite visitors to productively reckon with the benefits and necessities of a paradigm shift. Indeed, today we are seeing scientists attempt more candid, responsive, inclusive, and socially engaged approaches to conducting science.[10] Arts practices can help us consider and value approaches such as co-production, collaboration, and consultation.[11] Arts integration can even form the basis of efforts to integrate multiple ways of knowing into bodies of evidence and research methods that are mutually beneficial.

One such approach is to use drawing as a relationship-building and knowledge-sharing tool. Dr. Jean Polfus and collaborators resorted to drawing in an attempt to find common ground with Dene elders and hunters in Canada's Northwest Territories.[12] Ultimately, drawing and storytelling facilitated the development of Indigenous-driven research methods that respected local taboos, centered Indigenous knowledge, and made possible the collection of important genetic data about caribou biodiversity.[13] Given the diverse histories and affinities of people who engage with museums and historical sites, similar reciprocal processes can be valuable at these locations.[14]

For a museum-based example of arts-informed knowledge exchange, we can consider the ArT STaRTs (Artful Thinking Science Teacher Resource Trainings) program that I codeveloped at the University of Wyoming in collaboration with the UW Art Museum and the UW Science Initiative's Learning Actively Mentoring Program (focused on enhancing science teaching in higher education). As previously noted, an increasingly polarized media and political environment can negatively impact public perceptions of science[15] and bring increased scrutiny to how people fund and do science. Through ArT STaRTs, we are investigating the utility of public scrutiny of art, particularly public art, to serve as a metaphor and lens for science educators and scientists working to make science more accessible and inclusive.

Art-science integration (aka STEAM) is widely touted as a powerful means of enhancing how people engage with and learn science.[16] Similarly, art-science integration is often seen as a compelling way to enhance scientists' creativity. And indeed, "creativity is crucial to the capacity to do science well, to communicate it in compelling ways, and to enhance learning."[17]

It is counterproductive, however, to use "told, not taught" approaches when integrating arts-based practices in classrooms.[18] As previously discussed, the way we teach science can result in people feeling like they do not belong in science, or that science doesn't care about them. Arts experiences can go similarly poorly without deliberate facilitation. Thus, ArT STaRTs workshops aim to build science educators' awareness of both the opportunities and potential challenges (access, sense of belonging and self-agency, etc.) facing learners in art, science, and integrated environments.

At the same time, we are studying the outcomes of these trainings, because there is a documented need for meaningful assessment of art-science integration training efforts,

Figure 18.1. ArT STaRTs program at University of Wyoming. In the author's codeveloped ArT STaRTs program, STEM faculty discuss connections between artworks and the science subjects they teach. Here, an evolutionary geneticist describes how a mixed-media painting relates to her undergraduate evolution course. Photograph by Bethann Garramon Merkle © 2023.

Figure 18.2. Chemistry of resin sculpting transforms arts educators' understanding of genetic phylogenies, replication, and biodiversity. An arts educator participates in a summer Art-Science Institute co-developed by the author. Here, she learns about chemical processes necessary to create resin sculptures which are part of a project to construct three-dimensional phylogenetic trees of cichlid fishes. Photograph by Bethann Garramon Merkle © 2023.

particularly beyond K–12 classrooms.[19] Such integration is a developing field of research, and it can be a powerful means of implementing the "Broader Impacts" expectations that federal funders increasingly require.[20] Ideally, museums and historic sites using art-science integration approaches will also contribute to efforts to understand and assess the efficacy of such work. Possibilities for doing so include (1) developing robust assessment and evaluation programs internally and then sharing results externally and (2) consulting or partnering with researchers investigating these questions.

The synergies of art-science integration efforts are actually not surprising, though surprise seems to be a common reaction. In reality, art-making and scientific investigation share a kinship[21] of creativity, curiosity, close observation, and questioning. These aspects of inquiry are coupled, in art and science, with description and interpretation that are essential to the advancement of technology, industry, the economy, and indeed, society's self-concept. Furthermore, creativity can be both practiced and enhanced to strengthen science professionals' capacity in academic, industry, and civic spheres.[22] Indeed, agreed-upon definitions of creativity identify it as one's ability to generate ideas that are both novel and usable—a

capacity that we must aim for in educational and civic settings. STEAM initiatives aiming to enhance these capacities are increasingly common and thus can provide us with wide-ranging, robust models[23] for implementation and assessment. When melded together, sociocultural, scientific, and arts considerations can result in transformative practice in both art and science.[24] Settings such as museums and historical sites are ideal for drawing people into complex, fully integrated art-science experiences that authentically model the complementary and additive nature of the arts and sciences.

Notes

1. This facilitation sequence is a central part of the drawing trainings and educator coaching conducted regularly by the author. See Bethann G. Merkle, Brian R. Barber, and Matthew D. Carling, "Drawn to Natural History: Enhancing Field Courses with Drawing and Field Journal Instruction," *Natural Sciences Education* 49 (2020): e200019 for a detailed discussion of this approach.
2. For example, see Jonas T. Kaplan, Sarah I. Gimbel, and Sam Harris, "Neural Correlates of Maintaining One's Political Beliefs in the Face of Counterevidence," *Scientific Reports* 6 (2016): 39589.
3. See George Lakoff and Mark Johnson, *Metaphors We Live By*, second ed. (Chicago: University of Chicago Press, 2003); and Daniel Kahneman, *Thinking, Fast and Slow* (New York: Farrar, Straus and Giroux, 2013) for an extended discussion.
4. Adrian Treves, "Scientific Ethics and the Illusion of Naïve Objectivity," *Frontiers in Ecology and the Environment* 17 (2019): 363.
5. Dean K. Simonton, *Creativity in Science: Chance, Logic, Genius, and Zeitgeist* (Cambridge: Cambridge University Press, 2004).
6. For example, Bethann Garramon Merkle, Evelyn Valdez-Ward, Priya Shukla, and Skylar R. Bayer, "Sharing Science through Shared Values, Goals, and Stories: An Evidence-Based Approach to Making Science Matter," *Human-Wildlife Interactions* 15 (2022): 598–614; Liisa Husu, "Gate-Keeping, Gender Equality and Scientific Excellence," in *Gender and Excellence in the Making* (Luxembourg: European Commission Publications Office, 2004): 69–76, https://op.europa.eu/s/xD90; Samniqueka J. Halsey, Lynette R. Stickland, Maya Scott-Richardson, Tolulope Perrin-Stowe, and Lynnicia Massenburg, "Elevate, Don't Assimilate, to Revolutionize the Experience of Scientists Who Are Black, Indigenous and People of Colour," *Nature Ecology and Evolution* 4 (2020): 1291–93; and Rocío Deanna et al., "Community Voices: The Importance of Diverse Networks in Academic Mentoring," *Nature Communications* 13 (2022): 1681.
7. Rebecca Skloot, *The Immortal Life of Henrietta Lacks* (New York: Crown, Penguin Random House, 2010).
8. Elizabeth Polcha, "Breeding Insects and Reproducing White Supremacy in Maria Sibylla Merian's Ecology of Dispossession," *Lady Science* (June 20, 2019), https://www.ladyscience.com/breeding-insects-and-reproducing-white-supremacy/no57.
9. Merkle et al., "Sharing Science."
10. For example, see Katherine Canfield and Sunshine Menezes, *The State of Inclusive Science Communication: A Landscape Study* (Kingston: Metcalf Institute, University of Rhode Island, 2020); Julie Risien and Martin Storksdieck, "Unveiling Impact Identities: A Path for

Connecting Science and Society," *Integrative and Comparative Biology* 58 (2018): 58–66; and Jean L. Polfus, Deborah Simmons, Michael Neyelle, Walter Bayha, Frederick Andrew, Leon Andrew, Bethann G. Merkle, Keren Rice, and Micheline Manseau, "Creative Convergence: Exploring Bicultural Diversity through Art," *Ecology and Society* 22 (2017): 4.

11. Polfus et al., "Creative Convergence."
12. Bethann G. Merkle, "Drawn to Caribou," *American Scientist* 104 (2016): 16–18.
13. Polfus et al., "Creative Convergence."
14. For example, see Katie Christensen, Bethann G. Merkle, and Brenna Marsicek, "Integrating Art, Science, and Community Engagement: The University of Wyoming Art Museum's Ballengée Project," *Informal Learning Review* 148, no. 1 (2018): 21–27.
15. Jay D. Hmielowski, Lauren Feldman, Teresa A. Myers, Anthony Leiserowitz, and Edward Maibach, "An Attack on Science? Media Use, Trust in Scientists, and Perception of Global Warming," *Public Understanding of Science* 23 (2014): 866–83; Matthew C. Nisbet et al., "Knowledge, Reservations, or Promise? A Media Effects Model for Public Perceptions of Science and Technology," *Communication Research* 29, no. 5 (2002): 584–608.
16. National Academies of Sciences, Engineering, and Medicine, *The Integration of the Humanities and Arts with Sciences, Engineering, and Medicine in Higher Education: Branches from the Same Tree* (Washington, DC: National Academies Press, 2018).
17. Stephanie R. Januchowski-Hartley, Natalie Sopinka, Bethann G. Merkle, Christina Lux, Anna Zivian, Patrick Goff, and Samantha Oester, "Poetry as a Creative Practice to Enhance Engagement and Learning in Conservation Science," *BioScience* 68 (2018): 905.
18. Bethann G. Merkle, "Drawn to Science," *Nature* 562 (2018): S8–S9.
19. National Academies of Sciences, Engineering, and Medicine, *The Integration of the Humanities and Art with Sciences.*
20. National Science Foundation, "Perspectives on Broader Impacts," NSF 15-008, 2014, https://nsf-gov-resources.nsf.gov/2022-09/Broader_Impacts_0.pdf.
21. For example, see Januchowski-Hartley et al., "Poetry as a Creative Practice," 905–11; Merkle, "Drawn to Science;" Christensen, Merkle, and Marsicek, "Integrating Art;" and J. H. van't Hoff, *Imagination in Science*, trans. and intro. G. F. Springer (Amsterdam: Springer, 1879; New York: Springer-Verlag, 1967), 1–18.
22. Januchowski-Hartley et al., "Poetry as a Creative Practice."
23. For example, see Niki A. Rust, Lucia Rehackova, Francis Naab, Amber Abrams, Courtney Hughes, Bethann Garramon Merkle, Beth Clark, and Sophie Tindale, "What Does the UK Public Want Farmland to Look Like?" *Land Use Policy* 106 (2021): 105445; Christensen, Merkle, and Marsice, "Integrating Art"; Amy Duma and Lynne Silverstein, "A View into a Decade of Arts Integration," *Journal for Learning through the Arts* 10, no. 1 (2014): 1–18; and Aaron M. Ellison et al., "Art/Science Collaborations: New Explorations of Ecological Systems, Values, and their Feedbacks," *Bulletin of the Ecological Society of America* 99 (2018): 180–91.
24. For example, Polfus et al., "Creative Convergence;" Christensen et al., "Integrating Art, Science, and Community Engagement;" Januchowski-Hartley et al., "Poetry as a Creative Practice;" and Rust et al., "What Does the UK Public Want."