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Making a Case for Citizen Science: All People Can Share in the Experience of Discovery

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Making a Case for Citizen Science

All People Can Share in the Experience of Discovery

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"Hey, kiddo." My father's soft voice startled me out of my sleep, his hand on my shoulder. I rolled over, peering up at him through gummed eyes. Moonlight filtered through my white opaque curtains, casting a shadow on the left side of his face and reflecting in the lenses of his glasses. On my nightstand, the clock blinked 12:06 AM in red block letters. "It's time."

When he left, keeping the door cracked so that a single shaft of yellow light from the hallway crisscrossed my room, I got up slowly and stumbled, still half-asleep, into my closet. I pulled on a hooded sweatshirt and a jean jacket over that. Before I headed downstairs, I tucked my stuffed rabbit under my arm, buttoning the jacket around him so he stayed pressed against my chest.

Downstairs, my dad was waiting by the front door, wearing his winter coat along with his striped pajama bottoms. He handed me a mug of hot cocoa without a word, beckoning me to follow as he moved outside. The concrete of our driveway was frigid, so cold it burned the soles of my feet, but I didn't complain. Instead, I settled on the curb next to my father, following his gaze up to the stars.

"That's Orion," he pointed, without preamble. "You can see his belt, there—look." For many years now that has been the first constellation I pick out of the dark winter sky. "And there," he added, "that's Mercury. It's bright right now. And there's the Big Dipper and the North Star. See? It's called Polaris."

I can't recall how long we sat outside watching the stars. Finally, as I felt myself getting sleepy, transfixed by the vastness of the speckled sky above me, I remember asking him, "How are we ever going to know how many stars there are? There aren't enough astronauts to count them all."

My dad laughed at that, wrapping an arm around my slim, bony shoulders. "That's probably true. But I bet there are lots of fathers around the world doing this with their kids right now, like we are. Maybe we can help the astronauts out."

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Now, ten years later, as it turns out, my dad wasn't too far off. Today, if you have a few spare minutes, you can help NASA scientists classify galaxies based on morphology through Galaxy Zoo or identify stellar-wind bubbles in the Milky Way via The Milky Way Project. If outer space isn't your thing, you can spend time folding proteins into their lowest energy conformations in a game called Foldit, created by the University of Washington, or join nearly 200,000 players from around the world in the online puzzle game EyeWire in order to aid researchers at the Massachusetts Institute of Technology as they work to map neurons in the retina. This is all thanks to the recent explosion in citizen science projects.

A term coined in the 1990s, 'citizen science' has two widely accepted definitions. The first, accepted into the Oxford English Dictionary in 2014, was adopted by the Cornell Lab of Ornithology in 1995 after researchers began searching for a name to refer to their projects that depended on large numbers of participants—the majority of them non-scientists—collecting data on birds. The definition equated citizen science with participation of the general public in scientific research, where citizens collaborate with professional scientists to collect or analyze vast quantities of data.

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The second definition of the term arose from the 1995 publication of a book by Alan Irwin, a professor of organization at Copenhagen Business School. The book, Citizen Science: A Study of People, Expertise, and Sustainable Development, discusses citizen science as an avenue for democratizing science. By building an active "scientific citizenship," the public can be more meaningfully educated and involved in the policy-making and discourse surrounding scientific topics, especially those regarding human and environmental health. Irwin's call for a democratization of science centers is based upon his belief that the troubling rise of climate change should be tackled with vigor by both scientists and citizens alike.

All around the world over the past 20 years, several thousand citizen science projects have engaged millions of participants in gathering and processing data. These projects tend to center on answering particular scientific questions, in line with the Cornell Lab's conception of citizen science. However, at least in the United States, a significant portion of funding for these projects typically comes from the Advancement in Informal STEM Learning program of the National Science Foundation. As such, science education and science accessibility have become important goals of many projects, much as Irwin anticipated.

Particularly in the current political atmosphere—one in which the survival of the Environmental Protection Agency is under siege, as just one of many examples—science, technology, engineering, and math (STEM) accessibility and public engagement in the sciences are more crucial than ever. Citizen science has an important role to play in engaging communities to demand policy that improves human and environmental well-being, as well as encouraging folk to take an active and meaningful interest in the ways in which the world works. It carries the potential to change public attitudes and opinions of science through empowering individuals without formal STEM training to better understand and more critically evaluate the scientific claims they may be confronted with over the course of their daily lives. Citizen science provides a unique

opportunity to transform the institutional, exclusionary, and bureaucratic scientific process into a participatory, deliberative, and human one.

Of course, many questions arise for professional scientists in pursuit of these types of projects: what are the most effective ways to genuinely engage the general public in citizen science without compromising scientific rigor and accuracy? What are the best implementations of citizen science in terms of furthering both scientific research and science education and accessibility? What are the challenges that may arise in the pursuit of a more globally collaborative scientific process?

True to scientific form, an open access journal called Citizen Science: Theory and Practice was started by the Citizen Science Association and Ubiquity Press in May 2016. It is dedicated to answering these and other questions regarding the assumptions, practices, outcomes, costs, benefits, challenges, and overall impact of citizen science within both the scientific community and society at large. The journal has taken on a variety of topics, ranging from strategies for increasing the credibility and scientific rigor of data gathered through citizen science to the evaluation of best practices for enlisting and retaining citizen participants. Continued engagement by the scientific community with these and other issues surrounding the practice and goals of citizen science are crucial, since citizen science, despite obvious power as both a research method and a tool for communication, is not without its limitations.

For example, in 2012, Graber and Graber published an article in the Journal of Medical Ethics in response to the success of the protein-folding game Foldit. They made a case for the potential ethical concerns of citizen science, especially in projects that reward players with scores and social capital, motivations which they suggest pose risks for the economic, social, or mental health status of participants. Graber and Graber argue that citizen science projects are, by definition, experiments involving human subjects. In that vein, many of these individuals may not fully understand the methods, goals, and ramifications of the projects in which they are participating, which breaks with the value of informed consent in medical and research ethics. As such, the authors recommend that all citizen science projects be run past an institutional review board (IRB). IRBs, committees dedicated to approving and monitoring any kind of research involving humans, are standard practice in the US and could be used to offset the potential harm done to participants involved in citizen science projects.

Nevertheless, as it stands, the potential of citizen science for bridging gaps and forging connections between the scientific community and the general public outweighs the drawbacks. Citizen science cultivates the possibility of engagement with members of diverse communities who might otherwise be excluded from such collaboration due to institutional inequality and oppression. Improved scientific literacy and accessibility are critical for shaping sound public policy and encouraging folk to take a genuine and well-informed interest in their own health, the wellbeing of their environment, and the general stitching of the universe. To the average person, the physics of protein-folding may seem like a niche interest even for a scientist, but understanding that games like Foldit could lead to medical breakthroughs or drug discovery may contextualize for folk the importance of the game they play as they ride to work each morning on the Metro.

Simultaneously, members of the scientific community must constantly interrogate their own motives and the efficacy of their practices, moving to cultivate more inclusive and accessible approaches to scientific dialogue and deliberation as they design and implement citizen science projects. Project developers must make a serious effort to contextualize their investigations by integrating both general knowledge and scientific expertise, empowering citizen participants to become engaged members in the process of creating and executing projects. In order for citizen science to be successful, there must be space for unconventional scientific practice. Scientific institutions ought to be pushed to reevaluate their conceptions of

"expert knowledge," challenged to question whose knowledge is viewed as valid and respected within the scientific community and the historical and structural reasons for that. Academia and industry prize years of rigorous scientific training that are simply not obtainable for low-income folk, as well as are systematically denied to women, queer and trans people, and people of color. As such, a sustainable model of citizen science will depend

as are systematically denied to women, queer and trans people, and people of color. As such, a sustainable model of citizen science will depend on serious considerations of trust and equity, as the community of trained science professionals learns to accept the validity of scientific work that comes from beyond the ivory tower. Citizen science has incredible potential to further scientific research and innovation, but with its application comes great responsibility.

Since that night under the stars with my father, my scientific interests have moved away from the interstellar. Still, I have never forgotten my dad's reminder that this planet and the ones beyond — and the forces that govern it all — belong to each of us. Professional scientists or not, we all have a role to play in uncovering their mysteries.