Citizen Science: How Anyone Can Contribute to Scientific Discovery

Kathryn Hulick



Nikon

mini



© 2020 ReferencePoint Press, Inc. Printed in the United States

For more information, contact:

ReferencePoint Press, Inc. PO Box 27779 San Diego, CA 92198 www.ReferencePointPress.com

ALL RIGHTS RESERVED.

No part of this work covered by the copyright hereon may be reproduced or used in any form or by any means—graphic, electronic, or mechanical, including photocopying, recording, taping, web distribution, or information storage retrieval systems—without the written permission of the publisher.

LIBRARY OF CONGRESS CATALOGING-IN-PUBLICATION DATA

Name: Hulick, Kathryn, author. Title: Citizen Science: How Anyone Can Contribute to Scientific Discovery/by Kathryn Hulick. Description: San Diego, CA: ReferencePoint Press, Inc., 2020. Includes bibliographical references and index. Identifiers: ISBN 9781682827369 (eBook) | ISBN 9781682827352 (hardback) LCCN 2019018535 Subjects: LCSH: Science—juvenile literature.

Contents

Introduction 4 Science for Everyone **Chapter One** 8 **Unexpected Experts Chapter Two** 21 Gathering a Team **Chapter Three** 35 Patterns and Puzzles **Chapter Four** 48 **Empowering People** Source Notes 61 Find a Citizen Science Project 66 **Organizations to Contact** 68 For More Information 70 72 Index 79 **Picture Credits** About the Author 80

Unexpected Experts

Jon Larsen was working as a jazz musician in Norway when he began scooping up dirt and dust from rooftops and roadways. He sifted through thousands upon thousands of tiny grains, peering at the most promising specks under a microscope. He was hoping to find a micrometeorite. These tiny specks fall to Earth from outer space. Professional scientists thought it would be impossible to find them in cities. The problem is that they look very similar to dust specks from car exhaust, pavement, power tools, and other human activities. But Larsen was determined. In 2015, after six years of dirty, painstaking work, he found what he was looking for. "I finally identified one that was different from the rest,"⁵ he says. Matthew Genge, a meteorite expert at Imperial College London, confirmed that Larsen had indeed found a dust speck from outer space. "He ended up making a discovery that professional scientists missed,"6 Genge says. Now, Larsen is a guest researcher at the University of Oslo and has coauthored scientific papers. The space dust he and others gather will help scientists learn more about the universe.

Leaving a Mark on History

Larsen's work eventually became part of mainstream science. But he started out as an amateur with a hobby. Believe it or not, he was scooping up and examining dust for fun. An ordinary person with no scientific degree or training who questions, observes, and records information about animals, plants, insects, rocks, or any other aspect of the world is a citizen scientist. Some people who start out this way eventually gain recognition as mainstream scientists.

For much of human history, there were no universities offering science degrees. Many early inventors, explorers,

and scientists had no formal training. They investigated what interested them and gained expertise through their studies. William Herschel worked as a church organist and music teacher, but in his spare time he built his own telescopes and observed the night sky. In 1781 he discovered the planet Uranus. His sister, Caroline Herschel, often observed as well. She discovered at least eight new comets.

During the eighteenth and nineteenth centuries in Europe, scientific training was very exclusive. Women and people of lower classes were not admitted into most universities or scientific societies. Yet that didn't stop some people from pursuing science. Mary Anning grew up in a poor family in England during this time period. She had a knack for finding fossils and made a living selling what she uncovered. She also studied fossils and made important contributions to geology and paleontology. Michael Faraday also came from a poor family but taught himself physics and chemistry. In 1813 he managed to get a job as an assistant at the Royal Institution in London. Over the following decades, he made major discoveries about electricity and magnetism and invented the electric generator. He eventually worked his way up to become head of the Royal Institution.

Gregor Mendel is famous today as the founder of the field of genetics, which is the study of how offspring inherit characteristics from parents. He crossbred pea plants to figure out how traits such as color and shape get passed on to each new generation. He did this work as a monk at a monastery, since his farming family didn't have the money to send him to a university. Mendel published a paper with the results of his experiments in 1865, but mainstream science didn't discover and recognize his work until 1900, fifteen years after his death.

Hedy Lamarr didn't have any money problems—she was a Hollywood film star. She had no science training, but in her spare time, she invented things. During World War II she wanted to assist with the war effort. So she came up with the idea of guiding torpedoes toward a target with radio waves. To make it difficult



A Norwegian musician set out to find micrometeorites—specks of space dust that fall to Earth. The dust specks he found will help scientists learn more about the universe. In this image, micrometeorites are seen through a scanning electron microscope.

for enemies to interfere with the guidance, the signal would hop through different frequencies. She and her collaborator, Hollywood composer George Antheil, got a patent for the idea, which would later become known as spread spectrum. Today it allows communications technology such as Wi-Fi, Bluetooth, the Global Positioning System (GPS), and more to work without interference.

Passion and Enthusiasm

Today passion and enthusiasm may lead an amateur to become an expert in just about any field, even without a formal scientific education. These amateurs educate themselves along the way, learning mainly from experience. When Jane Goodall first entered the jungle in Tanzania in 1960 to observe chimpanzees, she had no formal training in science, and her only work experience was as a secretary. "I didn't know the first thing about studying chimps so I had no idea what I would find. They had never been studied in the wild before," she says. "I wasn't interested in being a scientist. I wanted to learn about chimpanzees and write books about them, that was all."⁷ She made ground-

breaking discoveries, including the fact that chimpanzees use tools, and she eventually earned a PhD.

Sue Hendrickson never got a high school diploma but has received honorary degrees from several universities for her work in underwater archaeology and paleontology. As a diver, she has explored shipwrecks and recovered artifacts. As a paleontologist (a scientist who studies fossils), she found the world's largest and most complete fossil skeleton of a *Tyrannosau*-

"I didn't know the first thing about studying chimps.... I wasn't interested in being a scientist. I wanted to learn about chimpanzees and write books about them, that was all."⁷

-Jane Goodall, primatologist

rus rex in 1990. The skeleton was named Sue after her and is now a major attraction at the Field Museum of Natural History in Chicago. "I love the thrill when I find something new," says Hendrickson. "I'm like a 4-year-old on an egg hunt—I just want to find stuff; I don't care if it's underwater or on land. I'm addicted to looking for and finding things. That's my true passion in life."⁸

Richard Leakey is another adventurer who never got a formal education. He grew up in Kenya, where his parents worked as paleontologists. Leakey found his first fossil—a jawbone from an extinct giant pig—when he was just six years old. He dropped out of school at age sixteen but found work on paleontological expeditions. By the 1960s he was leading his own expeditions and became the director of the National Museum of Kenya. Over the following decades, his finds—including early human skulls and a nearly complete human skeleton—contributed to scientists' understanding of human evolution. "I'd spent most of my life groveling in the sediments," Leakey says, "so I had a fairly good idea of how to go about finding these things."⁹

These three people came from different backgrounds and time periods, but they shared a passion for their chosen area of research and wound up making important contributions to science. However, this unconventional path from amateur to expert is not easy to tread. Goodall initially faced hostility from the scientific establishment for her unusual research methods. Amateurs often face difficulty in getting scientific institutions and journals to take their work seriously.

Theoretical physics, for example, delves into questions about the nature of the universe that many people enjoy thinking about. Some of these amateurs believe that they have discovered answers to difficult questions and send their work to scientists. "We certainly have a tendency not to pay attention," says Tom Rizzo of Stanford University. For most of the amateur theories, he says, "you don't have to look for very long before you see a mistake that a physics student wouldn't make."¹⁰ Ideas from outside the mainstream are still welcome, but amateurs in theoretical physics or most other scientific disciplines will have to go to much greater lengths to prove themselves than someone with a degree from a reputable institution. While it's certainly possible for amateurs and citizen scientists to make important contributions, anyone interested in science as a career should pursue a formal education.

From the Sky to the Earth

Some areas of scientific inquiry, however, are more open than others to the contributions of hobbyists and enthusiasts. In astronomy, amateurs regularly contribute to discoveries. The sky is vast, and no one knows exactly when or where a new and interesting event might occur. In addition, time on the world's largest telescopes is in high demand. Professionals have to wait in line for time to make observations. Meanwhile, anyone with access to

What Does It Take to Be a Professional Scientist?

Most professional scientists must spend as much as ten years in school getting a PhD. During that time, they learn a great deal of technical knowledge. A formal education is still the most straightforward and accepted way to learn advanced math, physics, statistics, chemistry, biology, and many other subjects. A degree proves to others that a person has spent time and effort developing his or her skills. It also gives a graduate much easier access to jobs and other positions within colleges, universities, laboratories, research centers, and scientific organizations. So if someone has a desire to work full time in science, getting a formal education is the best path to pursue.

Thanks to the Internet, though, education is becoming less formal and more widely accessible. People can now study anything that interests them for free or for very little cost using videos and tutorials or by joining massive open online courses. This means that the world of professional science is becoming more accessible to anyone and everyone who wants to learn.

a backyard telescope may point it in the right direction at just the right time. For example, in 2011 ten-year-old Kathryn Aurora Gray of New Brunswick, Canada, became the youngest person to find a new supernova, which is an exploding star.

Some amateur astronomers have become quite well known for their work. David H. Levy is a science writer and amateur astronomer who has discovered more than twenty comets. In the early 1980s he began working together with the scientist Gene Shoemaker and Gene's wife, Carolyn. In 1993 the trio became famous for their discovery of Shoemaker-Levy 9, a comet on a collision course with the planet Jupiter. Astronomers around the world watched the collision the following year. Don Parker didn't look for new objects but became well-known for his drawings and photographs of Mars and other planets. He worked as a medical doctor but spent his nights watching

Source Notes

Introduction: Science for Everyone

- 1. Quoted in Robinson Meyer, "Canadian Amateurs Discovered a New Type of Aurora," *Atlantic*, March 14, 2018. www.theatlantic.com.
- 2. Quoted in Katherine Xue, "Popular Science," *Harvard Magazine*, January–February 2014. https://harvardmag azine.com.
- 3. Quoted in Meyer, "Canadian Amateurs Discovered a New Type of Aurora."
- 4. Caren Cooper, "Citizen Science: Everybody Counts," TEDxGreensboro, May 15, 2017. www.youtube.com/wa tch?v=G7cQHSqfSzl&feature=youtu.be.

Chapter One: Unexpected Experts

- 5. Jon Larsen, interview with the author, December 3, 2018.
- Quoted in Kathryn Hulick, "On the Lookout for Micro-Missiles from Space," Science News for Students, March 7, 2019. www.sciencenewsforstudents.org.
- Quoted in Esther Addley, "Interview: The Ascent of One Woman," *Guardian* (Manchester), April 2, 2003. www .theguardian.com.
- 8. Quoted in Scholastic, "Q & A with Dinosaur Expert Sue Hendrickson," October 17, 2018. www.scholastic.com.
- 9. Quoted in Virginia Morell, "35 Who Made a Difference: Richard Leakey." *Smithsonian*, November 1, 2005. www .smithsonianmag.com.
- 10. Quoted in Amber Dance, "Outside Science," Symmetry, March–April 2008. www.symmetrymagazine.org.
- 11. Quoted in Dance, "Outside Science."
- 12. Quoted in Sharman Apt Russell, *Diary of a Citizen Scientist: Chasing Tiger Beetles and Other New Ways of Engaging the World*. Corvallis: Oregon State University Press, 2014, p. 25.

Find a Citizen Science Project

New citizen science projects are launching all the time. And ongoing projects run regular events. Below are a few of the websites that help connect people to citizen science projects. Other sources worth checking include NASA, *National Geographic*, and *Scientific American*.

Play Games to Help Science

Citizen Science Games (https://citizensciencegames .com). This website keeps an updated list of citizen science games. It also posts articles and interviews about the intersection between the worlds of science and gaming.

Make Your Own Project

CitSci (www.citsci.org). This website makes it easy for professional or amateur researchers to create their own citizen science projects, recruit volunteers, and collect and analyze data. It also helps connect people to ongoing projects of all kinds.

Join Interactive Science Labs

NOVA Labs (www.pbs.org/wgbh/nova/labs). NOVA Labs offers a range of interactive labs and games that educate students and also engage people in scientific discovery.

Organizations to Contact

Citizen Science Alliance

website: www.citizensciencealliance.org

The Citizen Science Alliance is a group of scientists, software developers, and educators who work together to manage the online-only citizen science projects on the Zooniverse website.

Citizen Science Association

website: www.citizenscience.org

The Citizen Science Association runs the annual CitSci conference, which brings together leaders and learners from the citizen science community. The association also publishes an open-access, peer-reviewed scientific journal, *Citizen Science: Theory and Practice*, that covers research about citizen science.

European Citizen Science Association (ECSA)

website: https://ecsa.citizen-science.net

The ECSA is a nonprofit organization that supports the citizen science movement in Europe by helping projects get off the ground and performing research about citizen science. The organization also runs an online Citizen Science challenge for European students to help them get involved.

Extreme Citizen Science (ExCiteS)

website: www.geog.ucl.ac.uk/research/research-centres /excites

This research group at University College London works to enable communities to start their own citizen science projects to address local environmental issues. The project aims to include any user, regardless of his or her cultural background or literacy level.

For More Information

Books

Loree Griffin Burns, *Citizen Scientists: Be a Part of Scientific Discovery from Your Own Backyard*. New York: Macmillan, 2012.

Caren Cooper, Citizen Science: How Ordinary People Are Changing the Face of Discovery. New York: Overlook, 2016.

Mary Ellen Hannibal, *Citizen Scientist: Searching for Heroes and Hope in an Age of Extinction*. New York: Experiment, 2016.

Susanne Hecker et al., eds., *Citizen Science: Innovation in Open Science, Society and Policy*. London: UCL, 2018.

Greg Landgraf, Citizen Science: Guide for Families: Taking Part in Real Science. Chicago: Huron Street, 2013.

Internet Sources

The Crowd and the Cloud, directed by Geoffrey Haines-Stiles, PBS, 2017. http://crowdandcloud.org.

Aisling Irwin, "No PhDs Needed: How Citizen Science Is Transforming Research," *Nature*, October 23, 2018. www .nature.com.

Dalal Kheder et al., "How Activism Drives Citizen Science," *Tyee*, April 26, 2013. https://thetyee.ca.

Courtland Milloy, "Citizen Scientists Are the New Community Activists," *Washington Post*, April 10, 2018. www.washing tonpost.com.

Guy Raz, "Citizen Science," *TED Radio Hour*, NPR, September 29, 2017. www.npr.org.

70

Index

Note: Boldface page numbers indicate illustrations.

activists environmental, 53-59, 54 marginalized communities, 52, 53-54 medical, 52-53 Aguado, Cathy, 21 AIDS, 46-47, 52-53 Al software, 38-39, 43 Alberta Aurora Chasers, 4 All of Us Research Program, 32-33, 33 ALS, 53 Alzheimer's disease research, 46 Amazon Watch, 56 American Gut Project, 31, 32 animals bats, 42 frogs, 24-25 manatees, 42 orangutans, 42 squirrels, 25 zebras. 42 See also birds; insects; ocean life Anning, Mary, 9 Antheil, George, 10 ash tree diseases, 45-46

Association of Lunar & Planetary Observers, 14 Association of Zoos and Aquariums, 24-25 Astro Drone (computer game), 43 astronomy amount of data collected, 36-37 comets, 13 Galaxy Zoo, 41-42 Higgs Hunters, 42 Kepler space telescope, 36, 39, 40 micrometeorites, 8, 10 Planet Hunters, 39–40 skyglows, 4, 6, 7 Sloan Digital Sky Survey, 41-42 Stardust@home project, 40-42 supernovas, 13 telescopes, 12-13 ATLAS@home, 38 auroras, 4, 6, 7

Baert, Claire, 44 Baker, David, 44 Bat Detective, 42 Beaumont, Chris, 36–37 Beijing, China, 59 Belgium, 59