reports

OF THE NATIONAL CENTER FOR SCIENCE EDUCATION | SPRING 2019 | VOLUME 39 | NO 2

WHAT DOES THE EVIDENCE SAY?

NCSE Teacher Ambassador Turtle Haste helps her students understand science through inquiry and hands-on learning. *Page 3*

Photo: Heather Summers

EDITOR
Paul Oh
National Center for Science Education
1904 Franklin Street, Suite 600
Oakland CA 94612-2922
phone: (510) 601-7203
e-mail: editor@ncse.com

BOOK REVIEW EDITOR
Glenn Branch

PUBLISHER
Ann Reid

VOL 39, NO 2, SPRING 2019

ISSN 1064-2358 ©2019 by the National Center for Science Education, Inc, a not-for-profit 501(c)(3) organization under US law. *Reports of the National Center for Science Education (RNCSE)* is published by NCSE to promote the understanding of evolutionary and climate science.

NCSE is a nonprofit, tax-exempt corporation affiliated with the American Association for the Advancement of Science and an Associated Group of the National Science Teachers Association.

RNCSE is published 4 times a year.

Address editorial correspondence to editor@ncse.com

Back cover photo:
Sarah Borland Dawson

Write to the publisher regarding address changes, missing issues, purchases of back issues, reprint rights, and related issues.
publisher@ncse.com

Dear NCSE members,

When NCSE first got started, well over 30 years ago now, it was focused squarely on direct attacks on the integrity of science education—specifically, efforts to ban the teaching of evolution or require that it be "balanced" with creationism. As these various efforts failed to pass constitutional muster, opposition tactics evolved (irony alert!) to include watering down the treatment of evolution in state science standards and requiring or allowing teachers to teach "the controversy," "strengths and weaknesses," or "critical thinking" around a shifting set of scientific topics. Evolution remains the most frequent target, with climate change becoming its regular companion in the late 2000s. As it has for all these decades, NCSE continues to monitor local and state legislatures and school boards for such attacks, and mobilize local citizens to fight back.

While preventing these efforts from succeeding remains crucial, NCSE has taken on a more subtle challenge: making sure that all science teachers have the skills and expertise to cover these topics accurately and effectively. But there are over 50,000 public high school biology teachers alone, and surveys show that around 30,000 of them are hedging when it comes to teaching evolution. If you add in middle school science teachers, and high school chemistry, physics, and Earth science teachers (all of whom may discuss topics related to climate change, evolution, or both), the numbers grow into the hundreds of thousands. A throwing up of hands would not seem irrational.

But not when you meet Turtle Haste, profiled on page 3. Turtle is one of our inaugural class of 18 NCSE Teacher Ambassadors—teachers who have agreed to help NCSE develop state-of-the-art lessons aimed at helping students overcome their misconceptions about evolution and climate change by engaging directly with evidence. In 2019, we will add another 24–30 Teacher Ambassadors, with some focused on developing lessons to help students grasp the nature of science, as Brad Hoge discusses in his update on page 10.

By the end of 2019, NCSE will be supporting nearly 50 teachers in their efforts to spread great lessons and great teaching practices in places where evolution and climate change are particularly contentious. That may not seem like many. But our program is carefully designed to ensure that the Teacher Ambassadors are ready, willing, and able to spread the word among their colleagues. So if each of them recruits just 20 of their peers, that's one thousand teachers doing a better job, year after year. Tens of thousands of students overcoming misconceptions and learning science as science is actually practiced. We'll still have a long way to go, but it will be an amazing start.

As always, thank you for your support of NCSE.

Ann Reid is the executive director of NCSE.
reid@ncse.com

What Does the Evidence Say?

A bag of paper bones.

That's what instantly comes to Turtle Haste's mind when asked to describe a pivotal moment in her long and distinguished career as a science educator.

She was a graduate student at Oregon State University, studying with Norman Lederman—"Mr. Inquiry," Haste calls him—when she and her classmates were presented with the bag. Lederman told them that they needed to assemble the paper cut-outs of bones from the bag into the correct animal skeleton.

"How do you figure out what are the arms? What are the legs? Where the backbone stops and becomes the shoulders?" Haste recalls asking herself.

She was forced to rely on her understanding of bone function, and what she already knew about animal anatomy. Through the process of recreating an animal from a bag of bones, Haste confirmed for herself the power of hands-on, inquiry-based learning experiences. By posing questions, and using evidence to form answers, she discovered the importance of active learning and its capacity to help anyone, especially young people in a science classroom, make cognitive connections.

Recently, Haste engaged in that same activity. This time, though, she was the teacher, with her New Mexico middle school students, and she used actual fossils instead of paper cut-outs of bones.

"None of them got the fossils right," Haste recalls, "and that's okay." The students soon realized that what they were doing was exactly what paleontologists and physical anthropologists do. "They got to see: here's something that looks like a bird's leg, here's something that looks like a dog's jaw, here's something that looks like it could have come from me," says Haste. By the end of the activity, her students saw themselves as scientists, examining evidence and making arguments. And, she adds, "they realized that these examples from the past are connected to today."

Photo: Jen Mendolia

Evidence is a word that comes up often when talking with Haste. "It's not whether you're right or wrong," Haste continually tells her students. "It's 'What does the evidence say?'" The importance of evidence is what she continually points her students toward in all their work, particularly when it comes to climate change and evolution. With these often socially controversial topics, Haste believes it is critical for students to engage directly with evidence to cut through misconceptions and misinformation.

A newly minted NCSE Teacher Ambassador, Haste is too modest to call herself a master teacher. Yet she has the awards and accolades to put her at the top of her profession. In 2017, Haste, who teaches middle school science at Desert Ridge Middle School in Albuquerque, New Mexico, was chosen by the National Association of Geoscience Teachers as New Mexico's Outstanding Earth Science Teacher. She's also a NASA Endeavor Fellow, a National Oceanic and Atmospheric Administration (NOAA) Planet Steward, and a National Board for

Professional Teaching Standards Certified Teacher. Always looking to improve her teaching, Haste has even traveled the world with the NOAA Teacher at Sea program and the Fulbright Teachers for Global Classrooms program.

In 2017, when the New Mexico Public Education Department tried to weaken the treatment of climate change and evolution in a proposed set of new state science standards, Haste joined the campaign to resist its misguided effort. "I've never seen science teachers so impassioned about what they would be teaching, and why it was important," Haste recalls. Through public hearings, letters to the editor, and protests, the community of science teachers and concerned citizens finally convinced the department to reverse course and adopt the Next Generation Science Standards in their original form.

As an NCSE Teacher Ambassador, Haste is one of 28 highly skilled teachers from around the country who are developing climate change, evolution, and nature of science units for use by colleagues and peers who are uncertain how to teach these topics. The Teacher Ambassadors are also leading professional development on the units, locally and regionally. And they are acting as mentors, supporting science teachers to acquire content knowledge and new pedagogical techniques while also navigating the challenging cultural landscapes they may face in their schools and communities.

"During my first years in the classroom, I experienced a lot of confrontations until I figured out how to not be the person perceived as a threat because of science. I know that if I had had a mentor, I probably would not have had as many issues," Haste says, explaining why she signed on to become an NCSE Teacher Ambassador. "I don't want anyone to feel alone in this practice. We need competent science teachers. And you can't be that if you feel threatened by parents. Or by the community. Or by your boss. So we all need to work together."

PLACE & TIME
The Galápagos as a World Heritage Site

The Galápagos was among the first group of UNESCO World Heritage Sites in 1978. Photo: Randy Moore

In 1978, the Galápagos Islands became one of the first four natural sites to be made a United Nations Educational, Scientific, and Cultural Organization (UNESCO) World Heritage Site. UNESCO considers it in the interest of the international community to preserve sites that meet strict criteria and are of importance to the world as World Heritage Sites. The Galápagos fulfills the criterion "to contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance." This designation had important implications for the conservation of the Galápagos, for UNESCO World Heritage Sites are watched by the world.

Photo: Jen Mandolia

Haste continues to have a few students each year who question accepted science when it comes to climate change and evolution. The topics are particularly challenging for her middle school students, she says, because of their youth and limited life experience. In addition, she has students in her class with a variety of spiritual worldviews: Navajo, Cochiti, Apache, Roman Catholic—the list goes on. By affirming her students' right to have their own views and perspectives, Haste helps them understand that science and their belief systems don't have to be mutually exclusive. But when it comes to the science, Haste returns to the scientific pillar so critically important during Norman Lederman's course: evidence.

"If a kid says, 'I don't believe that,' I say, 'What's the part you don't believe?' And then, ultimately: 'What's your evidence?' "

Paul Oh NCSE's Director of Communications. oh@ncse.com

UNESCO World Heritage Sites comprise the most famous and recognizable list of protected places in the world. Many sources claim that the Galápagos were the first UNESCO World Heritage Site, presumably because they were designated "UNESCO Reference no. 1" in UNESCO's records. However, this designation refers to the fact that the Galápagos was the first site nominated for consideration by UNESCO. In fact, there was no first individual UNESCO World Heritage Site, but rather a first group of 12 such sites (approved by UNESCO at its meeting in Washington DC in September 1978), of which the Galápagos was one. Most of the more than 30 other sites initially nominated for the designation were rejected, and the official minutes of the UNESCO meeting list Galápagos third in the alphabetized announced group of approved sites. As of 2018, there were 1,073 World Heritage Sites, of which 206 (19%) were sites of natural importance. Five World Heritage Sites, including the Galápagos, are in Ecuador.

The UNESCO plaque located in the Galápagos along the road to the Charles Darwin Research Station (GPS: S00 44.493, W090 18.403) reads as follows:

> Galápagos Islands declared a natural heritage for humanity by the intergovernmental World Heritage Committee in its second meeting held in Washington on September 8 of 1.978 General Fernando Dobronsky Minister for Education and Culture Amadou Mahtar M'Bow Director General of UNESCO Santa Cruz. 28 de Julio de 1.979

In 2007, the Galápagos was declared a World Heritage Site in Danger. This designation remained in effect until 2009, when the Ecuadorian government showed that the critical issues—mostly related to human activities—that had harmed the Galápagos in recent decades were being addressed.

Randy Moore is the H. T. Morse–Alumni Professor of Biology at the University of Minnesota, Twin Cities. His most recent book is *Galápagos Revealed: Finding the Places that Most People Miss* (Galapagos Conservancy, 2019). Rmoore@umn.edu

RanDom Samples with William F. McComas

Photo courtesy of William F. McComas

Longtime NCSE member William F. McComas is the inaugural holder of the Parks Family Endowed Professorship in Science Education at the University of Arkansas following service as a secondary biology teacher in suburban Philadelphia and as a professor at the University of Southern California. He is interested in the intersection of philosophy of science and science instruction, the enhancement of laboratory teaching, informal science learning, evolution education, and science for gifted learners. His latest book is the edited *The Nature of Science in Science Instruction: Rationales and Strategies* (Springer, 2019). McComas currently serves as the editor of *The American Biology Teacher*. He has been honored for his work in evolution education, research in biology teaching, innovations in college science teaching, and mentorship. McComas is a Fellow of the American Association for the Advancement of Science, and was recently named a Distinguished Professor at the University of Arkansas. We wanted to touch base with him about the nature of science especially. Our exchange has been edited for sense and length.

Paul Oh: You've recently edited a book on the nature of science, and you're acting as an advisor for NCSE's upcoming nature of science workshop. What gets you excited about this topic?

William F. McComas: The book, *The Nature of Science in Science Instruction: Rationales and Strategies* (2019), is a synthesis of many decades of thinking from a range of scholars about what aspects of the nature and philosophy of science should be included in science instruction. Perhaps even more important, the book includes scores of strategies for how to teach aspects of nature of science in various settings. I am delighted to have brought together 65 authors who have contributed to 38 chapters; I see my role as synthesizer-in-chief, because this book is useful because of this collaboration.

I have always been passionate about the nature of science because of its fundamental importance in plans for science teaching. What could be more important to science learners than topics such as understanding how knowledge is generated in science, what counts as data, how scientists function as a community, and why we should have confidence in science as a way of knowing? I am particularly excited now because we seem to be turning a corner in our long quest to get topics related to nature of science into the mainstream science curriculum at all levels. The new Next Generation Science Standards (NGSS) include many issues related to nature of science featured throughout. My only frustration is that, for some reason, the authors of the NGSS decided that we should focus on content, science and engineering practices, and crosscutting concepts as the three dimensions of science learning, when they should have simply pushed that label to its logical conclusion and called for four-dimensional science learning, including the nature of science as the fourth D. The nature of science content recommended in the NGSS should be more widely acknowledged—but it's there!

My support for nature of science goes farther in that I am convinced that many issues such as climate change and evolution denial might (he says hopefully) be less widespread if only the average person—and legislator—knew how science functions and understood the role played by evidence in establishing the patterns seen in the natural world. These patterns, by the way, are developed into models that allow prediction, as in the case of climate change. So, I would conclude by saying again that nature of science content must be part of any complete science learning experience for all future citizens in general and policymakers specifically. Our graduates can remind themselves of many scientific facts with a quick online search, but an understanding of the scientific process itself is necessary to inform decision-making.

PO: Tell us a little bit about the Darwin course you're teaching this semester.

WFM: This class, which I have been facilitating at the University of Arkansas, is one of my more gratifying instructional experiences. I have a deep personal interest in Darwin and the development of evolutionary thought. About 10 years ago, with support from our Honors College, I put out a call across campus for anyone who wanted to contribute to a semester-long seminar, and I was delighted by the incredible response. Colleagues from biology, anthropology, the law school, political science, the history and philosophy departments, and even from English offered to share a few lessons targeting how their fields are impacted by evolution. We have run this class four times, it fills up immediately, and I have never had a problem getting colleagues to participate. In fact, even those not

teaching in the class regularly have asked to sit in for the semester. The students have been very responsive to learning about Darwin and evolution in this fashion and often tell me that they have never had an opportunity to think about a topic and its links to so many discrete fields. It is clear that the most complete (and perhaps best) way to learn about a complex topic is to approach it from as many perspectives as possible while considering the implications of those connections widely. The Darwin course certainly provides an example of this sort of interdisciplinary learning experience.

PO: You're a longtime NCSE member. Why did you join and what's kept you engaged?

WFM: I can't remember a time when I wasn't a member of NCSE—I may have joined when I was a high school biology teacher more than 25 years ago. The answer to this question is easy and it's professional and personal. As a science educator, I support many organizations whose work is important within the context of science teaching and learning, and a group targeting challenging issues like evolution and climate change understanding is certainly one I support. My other major reason for NCSE membership is personal. I have always been fascinated by Darwin, so I am always interested in learning anything new about him, his work, the implications of his discoveries and, most importantly, the challenges of understanding and accepting evolution. I am very fortunate to be able to combine elements of my work with a strong personal curiosity. Simply put, NCSE is engaged in work that I find important and interesting and I appreciate the opportunity to be a part of a community that feels the same way. Thus, for me, membership in NCSE seems almost unavoidable!

—PAUL OH

Karl W. Flessa of the University of Arizona, **Jody Hey** of Temple University, **John Archie Pollock** of Duquesne University, **Samuel Michael Scheiner** of the National Science Foundation, **Gregory W. Swift** of the Los Alamos National Laboratory, and **Jan A. Witkowski** of Cold Spring Harbor Laboratory were all elected as Fellows of the American Association for the Advancement of Science in 2018. Congratulations to all. (And let the NCSE office know if we overlooked your name on AAAS's list!)

NCSE is pleased to congratulate **Michael E. Mann** who along with Warren M. Washington was named the co-recipient of the 2019 Tyler Prize for Environmental Achievement—often described as the Nobel Prize for the environment. **Naomi Oreskes**, a member of NCSE's board of directors, described Mann as "not just a great scientist, but also a hero." Mann and Washington will share a $200,000 prize, which will be awarded at a private ceremony in San Francisco on May 3, 2019. Mann is Distinguished Professor of Atmospheric Science at Penn State University, with joint appointments in the Department of Geosciences and the Earth and Environmental Systems Institute. He is also director of the Penn State Earth System Science Center. Mann received NCSE's Friend of the Planet Award in 2014 and was interviewed by Peter Buckland in *RNCSE* 36:1 in 2016. He is scheduled to join NCSE's board of directors in April 2019.

Photo: Joshua Yospyn

Photo: Susan Gerbic

NCSE's founding executive director **Eugenie C. Scott** received the John and Mary Lou Pojeta Service Award from the Paleontological Society at a banquet during its annual meeting held in Indianapolis on November 4, 2018. The Pojeta award was established to recognize exceptional professional or public service by individuals or groups in the field of paleontology above and beyond that of existing formal roles or responsibilities. At the same banquet, **Anna K. Behrensmeyer** of the Smithsonian Institution's National Museum of Natural History received the Paleontological Society Medal, the most prestigious honor bestowed by the society.

—GLENN BRANCH

UPDATES

ncse.com/updates

Are there threats to effective science education near you? Do you have a story of success or cause for celebration to share? E-mail any member of staff or info@ncse.com.

ALABAMA, LENOX

The flamboyant young-earth creationist Kent Hovind was back in the news in September 2018 with the opening of a new version of Dinosaur Adventure Land in rural Alabama. "For Hovind and his supporters, it's a ministry," wrote Anna Claire Vollers at al.com. "To his detractors, it's a dinosaur-themed tax shelter." The original version, in Pensacola, Florida, closed in 2009, while Hovind was serving time in a federal prison for failing to pay taxes, structuring cash transactions, and obstructing federal agents.

ARIZONA

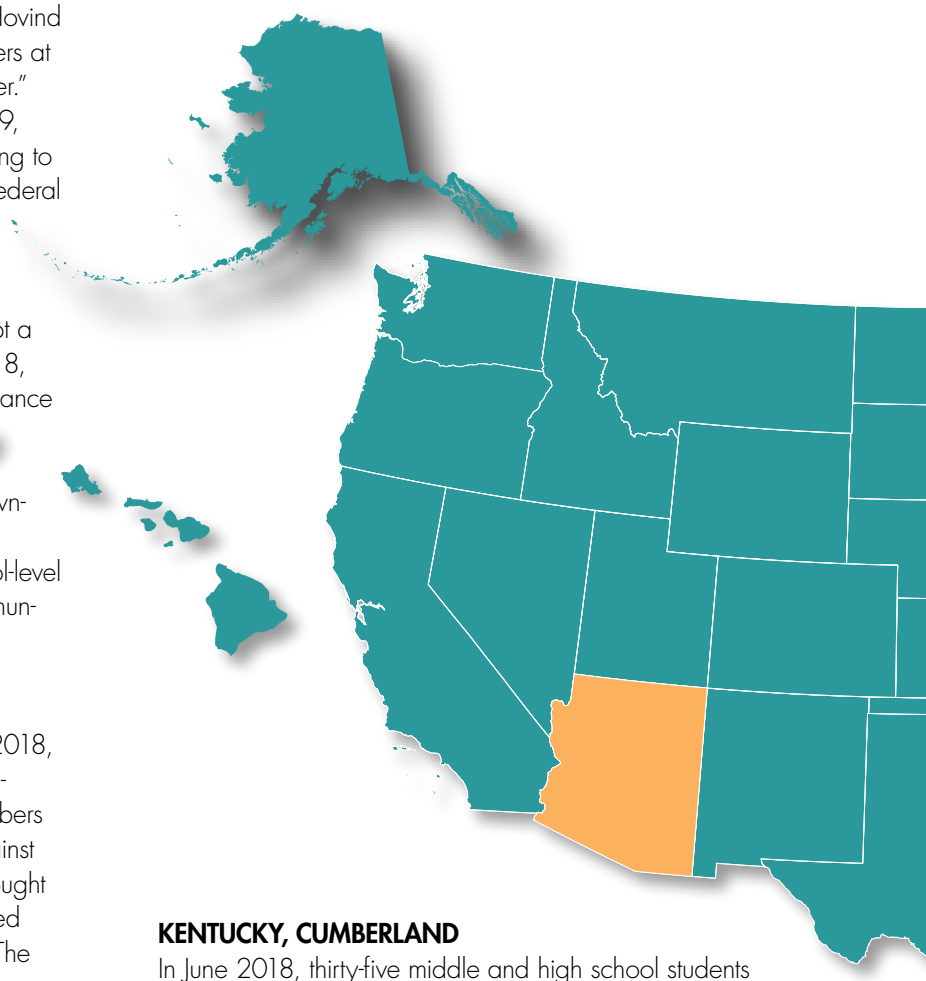
The Arizona state board of education voted 6–4 to adopt a new set of state science standards at its October 22, 2018, meeting. These standards were recently revised in accordance with recommendations from the Arizona Science Teachers Association to restore the concepts of speciation and common ancestry, earlier removed or downplayed at the behest of the state Superintendent of Public Instruction, Diane Douglas. Also restored were high school-level standards about climate change. There was reportedly "thunderous applause" at the vote.

FLORIDA, MARTIN COUNTY

The Martin County School Board voted 3–2 on June 5, 2018, to adopt a new batch of science textbooks despite objections to their (accurate) treatment of evolution. Board members Rebecca Negron and Michael DiTerlizzi, who voted against adoption, were vocally sympathetic to the objections, brought pursuant to a new law, enacted in 2017, apparently aimed at empowering creationists and climate change deniers. The board was forced to expend thousands of dollars and scores of hours on the proceedings.

FLORIDA, MIAMI

During the summer of 2018, a high school-level lesson plan promoting the pseudoscientific idea that "the Americas were visited by African peoples and other non-Europeans prior to the age of Columbus" was spotted on the Miami-Dade County Public Schools website by a number of bloggers specializing in archaeology. As part of the lesson, students were instructed to write letters to textbook publishers, urging "better coverage of non-European explorations of America." The lesson plan was silently removed by August 1, 2018.



KENTUCKY, CUMBERLAND

In June 2018, thirty-five middle and high school students participated in a summer program at Southeast Kentucky Community and Technical College aimed at preparing them for college-level academic work—and were taken to visit, among other things, Answers in Genesis's Creation "Museum" and Ark Encounter, by way of "cultural enrichment," according to a report in the *Middlesboro Daily News*. NCSE sent a letter to the program's interim director explaining the inappropriateness of the visit and recommending against a repetition.

NEW JERSEY, LAKEWOOD TOWNSHIP

In September 2018, the *Asbury Park Press* reported that private schools affiliated with Orthodox Judaism in the township received state funds to purchase textbooks, of which a few had "clear religious themes." Mentioned was Yaakov Lubin's middle-school textbook *Fundamentals of Life Science* (2018), which promises to confer "a greater appreciation of the greatness of Hashem [God] and His magnificent creations." A spokesperson for the New Jersey Department of Education told the newspaper that the department was investigating.

TENNESSEE, WARTRACE

A teacher at Cascade Middle School, part of the Bedford County Schools, was accused of playing a young-earth creationist video to his science class and otherwise infusing his classroom instruction "with religious doctrine, unscientific materials, and outright misinformation." Acting on behalf of the parent of a child in the class, the American Humanist Association sent a September 12, 2018, letter to the district explaining the legal issues and calling for appropriate action; the district agreed to take steps.

BRAZIL, MINAS GERAIS

A textbook used to prepare state teachers for competitive examinations accuses evolutionary biologists of "imposing their answers and censoring any explanation that does not respect Darwin," and insists that "[t]rue science does not contradict the Bible," reported *O Tempo* in April 2018. The textbook's publisher, Grupo Nova, defended the treatment by saying that it sought to present evolution from a variety of perspectives. The state department of education emphasized that it was not responsible for the textbook's content.

NEW ZEALAND, AUCKLAND

A former student at a private school reported that creationism was taught as scientifically credible there, although the principal denies it. A government spokesperson noted that private schools are allowed to present creationism as scientifically credible. The report is nationally significant because the former student's teacher was the sister of the leader of the center-right National Party and the wife of a National Party member of parliament, and the party hopes to reintroduce a charter school program.

TURKEY

Adnan Oktar, the controversial Islamic creationist who publishes under the name Harun Yahya, was arrested by Turkish police on July 11, 2018, on a long list of criminal charges. It is not Oktar's first brush with the law. In 2008, he was convicted on criminal charges and sentenced to three years in prison, although his conviction was overturned on appeal in 2010. Signs that Oktar and his organization are out of favor with the Erdoğan administration were evident earlier in 2018.

What Do You Get When You Cross Evolution with

You might guess the National Center for Science Education. You wouldn't be wrong. But you also get the perfect opportunity to teach about the nature of science.

Why the nature of science?

When the first group of NCSE Teacher Ambassadors for climate change convened to develop lessons last year, they asked me to let them include a lesson on the nature of science. Similarly, our first cohort of Teacher Ambassadors for evolution went on and on about how what we were really teaching was the nature of science. Why were both groups so eager to discuss the nature of science with their students? And why are climate change and evolution such good content areas in which to address the nature of science?

The answer is twofold: both evolution and climate change allow teachers to model how scientists collect, analyze, and argue about data, and they model two different ways of doing science. Evolution allows students to make predictions from theory and then test their predications against evidence. Climate change allows students to mine big datasets for patterns that produce predictions and then test their predictions against real-world data. In both approaches, students can explore real evidence through hands-on lessons that let them form an understanding not just of the content they are studying, but also of how the evidence was collected and how it supports the conclusions. This emphasizes that the scientific process is not a cookbook exercise, but rather that there are multiple ways to do science.

As a result, NCSE is adding a cohort of Teacher Ambassadors for the nature of science who will meet for the first time in the summer of 2019. We're doing so because we see the need for lessons teachers can use to set the table for the teaching of evolution and climate change. Teachers often cover the nature of science at the beginning of a course but then don't discuss it again. This disconnects the process of science from the evidence it provides since most of the content students are learning was collected in the past. It makes science static and dull, and simply a collection of old knowledge, rather than a dynamic means of discovery. It also allows the lessons about the nature of science to be filed away and forgotten. But both evolution and climate change offer the opportunity for teachers to continue focusing on how science works to produce knowledge and provide explanation. This is particularly important since both climate change and evolution are often challenged because students don't understand where the evidence comes from and why it can be trusted.

both evolution and climate change scientists collect, analyze, and argue different ways of doing science …

Evolution and the nature of science

Attacks on the teaching of evolution often claim that it is "only a theory," suggesting that evolution is just one possible guess as to how biodiversity has come about.

Climate Change?

allow teachers to model how about data, and they model two predicting and mining data.

In reality, the statement that life has evolved is factual and supported by overwhelming evidence. And in science, it's all about the evidence. Data from observation and experiment tell the story, and conclusions are constrained by the careful scientific analysis of all evidence collected. When scientists reach consensus about conclusions drawn from data, it is typically the result of years of exploration, analysis, and argument.

Scientists are skeptical by nature. They don't simply accept initial results and conclusions. They challenge each other's methods and logic, they propose additional observations and experiments and analyses, and, most importantly, they repeat observations and experiments numerous times to make sure the data is consistent and analyses are thorough.

The theory of evolution is one of the most thoroughly vetted scientific theories we have. It not only has stood the test of time and intense scientific scrutiny, but also has effectively made predictions that have been confirmed by further exploration. This is the hallmark of a successful theory.

In studying evolution, students can be engaged with evidence across multiple cognitive domains. They can look at data that unfolds right in front of them by studying genetics and ecological adaptation, and they can look at evidence that has unfolded across geologic time. Most importantly, they can see how these two seemingly vastly different perspectives are connected through scientific theory.

Climate change and the nature of science

Climate change lessons provide an opportunity for students to dive into two of the hottest topics in science today: complexity and "big data." Additionally, while there is no single unifying theory underlying the study of climate change, it is a dynamic field of science that utilizes one of the most powerful tools for science: modeling. Whereas evolution provides a better opportunity to walk through a more traditional "scientific method," climate change allows students to explore the process of science "red in tooth and claw." What I mean by this is that climate change science research is exploding with new data every day, and what scientists are learning from their research is becoming increasingly relevant to our everyday lives due to the impact of climate change on our local and global environments. Students can see not only how scientists collect and analyze data, but also how they arrive at consensus through the not always gentle process of peer review.

Looking forward

Sometimes it might seem like it takes a menacing hurricane or a ferocious dinosaur to get students motivated to learn about science. It is also often challenging to find ways to encourage many teachers to spend adequate time and effort on evolution and climate change. But by training teachers about how these topics are connected through the nature of science, we believe we can help them make their teaching more effective so that students appreciate the connections between science process and science knowledge and how science impacts their lives.

Brad Hoge is NCSE's Director of Teacher Support.
hoge@ncse.com

Breaking Down Barriers

Meet NCSE's New Graduate Student Fellows

NCSE's community outreach program aims to break down barriers between scientists and non-scientists, particularly in scientifically underserved communities. We believe the next generation of scientists will need a diverse arsenal of science communication skills to work with communities that have lacked exposure to, and may be skeptical of, science. To that end, we're proud to announce the launch of the Science Ambassador Fellowship, a year-long course for six graduate students from around the country in informal education pedagogy and science communication.

Over the course of the year, the Graduate Student Fellows will get to know their communities as they perform outreach using hands-on activities they develop based upon their own research. While our first cohort of Graduate Student Fellows vary in their backgrounds and areas of interest, they are united in their passion for engaging their communities and communicating science effectively.

In order to give you a sense of this dedicated group, we present excerpts from our interviews with these six pioneers.

Each fellow will be keeping a video diary of their work. Subscribe to our e-newsletter to be alerted to the latest entries!

Photo: James Sanovia

Measured section of Brule Formation

You're researching Geological Engineering. Why did you choose this project for your PhD?
I attended college on the Pine Ridge Reservation as an undergraduate student. The reservation has a number of challenges associated with its wastewater management and drinking water accessibility. I wanted to make things better and to make sure that everyone has access to safe and clean drinking water.

What's one thing the future generation of scientists will need to know?
Climate is changing. It may occur in ways that we haven't adequately predicted. This is one of the biggest challenges scientists will face today.

Lilly Jones
South Dakota School of Mines and Technology, Geology and Geological Engineering

Photo courtesy of Sandy Phillips-Long

Genetic healthcare beliefs among evolution disbelief

Describe a positive experience with science outreach you had as a child.
My father worked in construction when I was growing up. In the summer, we would travel with him and stay in state parks within the Appalachian Mountains. The park staff were constantly trying to entertain the kids, and learning about the birds and trees in the area became a social event for me.

What's a misconception about science that you've had to counter?
I was teaching a class and asked my students to research a popular news story about a twin that went into space and one that stayed on earth. They were supposed to identify genetic changes between the two individuals. And I had a student who refused to acknowledge the science behind epigenetics.

Sandy Phillips-Long, Clemson University, Healthcare Genetics

Photo: Ian Breckheimer

Collecting data on insect herbivory

What's one thing the future generation of scientists will need to know?
Policy and science should not be separated. A scientist can no longer just publish papers and let the data be interpreted by others. It is important for scientists to be involved with policy in some capacity. Scientists should be able to state what their research means and what society should do about the implications moving forward.

What's a misconception about science that you've had to counter?
If kids draw a scientist, they typically draw a white man in a lab coat. But this idea about the identity of a scientist is rapidly changing. I am a woman of color and the other researchers I look up to are also other women of color within this field.

Meera Sethi, University of Washington, Seattle, Biology

Photo: Elizabeth Cochran

Understanding bacteria in mine drainage

What's one thing we should know about your community?

Pittsburgh is a very diverse city. Despite differences in science, religion, politics and things that would tend to divide people, here there is a common thread that unites our city. This allows for common ground and communication channels to remain open.

What's one thing the future generation of scientists will need to know?

Definitely big data—scientists may run into issues of proving their interpretations of large data sets are fair. The line of ethics will become blurred because the vast amount of data that is available can be manipulated to tell any story. This is particularly concerning with perpetuating false misconceptions surrounding science.

Michelle Valkanas, Duquesne University, Biological Sciences

Photo courtesy of Laurie Luckritz

Outreach in University of Central Missouri's volunteer fair

What inspired you to be a scientist?

I was first exposed to evolution when I was 21 and didn't understand it. Growing up, I was taught not to believe in it. So I wanted to find out the truth about the origin of the world and did so by continually asking questions. And now I'm a graduate student in biology, and the rest is history.

What's one thing we should know about your community?

There is a lot of history and opportunity for growth here. For example, the university's second president, James Johonnot, was fired by the board of governors in the 1870s because he refused to stop teaching evolution in the classroom. He is one of only three presidents of the university that doesn't have a monument or structure named in his honor.

Laurie Luckritz, University of Central Missouri, Biology

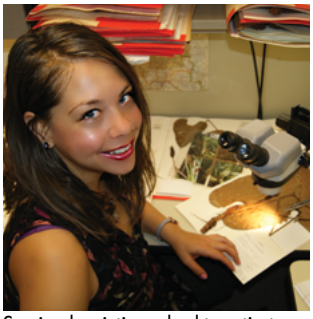


Photo courtesy of Taryn Dunivant

Species descriptions, dead to extinct

What inspired you to be a scientist?

I was searching for myself in community college and took a variety of classes, one of which was a physical anthropology class. I loved everything about it and began researching to find out what a career in botany might be like. The more I learned, the more I loved it.

What's one thing the future generation of scientists will need to know?

Interdisciplinary concepts. Scientists tend to focus on one specific area of study (taxa, gene, technique, etc.), but forget to relate it to other disciplines in order to help science as a whole move forward.

Taryn Dunivant, University of Kansas, Ecology and Evolutionary Biology

Kate Carter is NCSE's Director of Community Science Education. carter@ncse.com

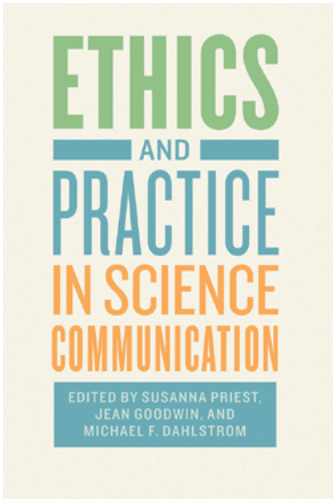
WHAT WE'RE UP AGAINST

Fossil Fuel Denial, Too

At the October 25, 2018, meeting of the Albemarle County School Board in Charlottesville, Virginia, a proposal for the county schools to commit to using renewable energy and reducing greenhouse gas emissions was under consideration. Jason Buyaki, a member of the board, expressed skepticism about the proposal's statement "there is scientific consensus regarding the reality of climate change and the recognition that human activity, especially the combustion of fossil fuels that create greenhouse gases, is an important driver of climate change." According to the weekly *C-VILLE*, Buyaki not only denied the existence of such a consensus but also challenged the appropriateness of the term "fossil fuels," saying, "I find that really strange as a concept, that fossils are buried so deep in the earth, and we can pump 'em out. And some of these oil fields run dry, and then 30, 40 years later they can pump out more." —*GLENN BRANCH*

A school bus that runs on fossil fuels.

Photo: Bill McChesney, 2012. Used under Creative Commons Attriubtion 2.0 Generic (CC BY 2.0) license



THE *RNCSE* REVIEW

Ethics and Practice in Science Communication

editors: **Susanna Priest, Jean Goodwin, and Michael F. Dahlstrom**

publisher: **University of Chicago Press, 2018**

reviewed by: **Andrew J. Petto**

For most people in the sciences, ethical scientific communication involves telling the truth and telling it plainly, a practice that Chris Mooney once called "decide-announce-defend." Its less-than-impressive track record in influencing policy makers and the general public is testament enough to the need for something different.

Ethics and Practice in Science Communication explores issues that arise when democratic societies need to rely on scientific inquiry and conclusions for making policy. The problem—made clear by Susanna Priest in her chapter—is this: How should science communication engage ethically in the democratic environment of public opinion and policy making when there really is a right answer?

Many of the chapters recall Sarah Tinker Perreault's "critical understanding of science," presented in her *Communicating Popular Science* (2013), as a model for the role of science in democratic societies. The approach avoids the problems of "decide-announce-defend," as scientists and the public work together in a complementary fashion to apply scientific knowledge to contemporary problems.

Of particular interest is the chapter by Susanna Priest taking on issues in communicating the science of climate change. Although the conclusion may seem obvious, it is salutary to be reminded that the decisions about climate change policy are *not* going to be made by scientists. Ultimately, the power to decide is in the hands of the audience to whom we address these communications.

Despite some unevenness among chapters, this book is full of valuable lessons for anyone "talking science" to the public. One recurring lesson is to establish a relationship with the people with whom we are communicating: understand their issues and their assessment of risks, help them gain access to information, and provide a pathway for critical assessment of the impact on the issues that matter most to them. NCSE's community engagement program shows how learning these lessons promotes success in communicating science.

A set of case studies in the final section of the book provides examples of successes

© Paula Spence

Dinner Party 101: How Do I Tell My Grandfather That Science

On TV, computer experts can enhance grainy security video footage to read sneaker serial numbers, scientists can pinpoint a murderer's whereabouts based on bird DNA recovered under the victim's fingernails, and lab technicians always manage to complete even the most complicated analyses by the end of a commercial break. Since margins of error and complex funding decisions rarely figure into compelling 44-minute stories, these shows often wrongly portray science as cut-and-dried. Their influence is so pervasive that lawyers, wary of the so-called CSI effect, are quizzing potential jurors on their viewing habits in order to screen out those who may have internalized the unrealistic expectations of TV science.

So how do you talk to friends and family who think that the data in a *Nature* paper could have been as sembled in fifteen minutes by your average local police precinct? Here are some NCSE-approved strategies:

Focus on the process. While the results may be overblown, often the types of data and the process of science are depicted accurately on TV crime dramas. Ask questions about why the show's characters chose that technique and what they learned from it. You might be surprised to learn how well your relatives understand the big picture, even if small details are inaccurate or fuzzy.

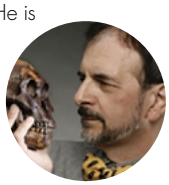
Share personal stories. Relating your own similar experiences with science can help your friends and family improve their understanding without feeling attacked.

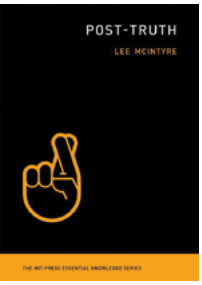
For me, this meant bringing my own experience determining age and sex from skeletons where the margin

and failures in meeting the standards raised by the editors and contributors. For anyone interested in successful communication of science with the general public with the goal of influencing policy—whether in education, health policy, or environmental conservation—there are several chapters in this volume that will be eye-opening and provide a framework for getting better results.

(Disclosure: I reviewed the book proposal and the manuscript for the publisher.)

Andrew J. Petto is Distinguished Lecturer Emeritus at the University of Wisconsin-Milwaukee and a former member of NCSE's board of directors. He is currently blogging for Tophat.com on classroom practice and student success. His next project, with Alice Beck Kehoe, is a revision of her textbook *Humans*—an introductory textbook in four-field anthropology. ajpetto@uwm.edu





Post-Truth

author: **Lee McIntyre**

publisher: **MIT Press, 2018**

reviewed by: **Glenn Branch**

Taking its title from the Oxford Dictionaries' word of the year for 2016, Lee McIntyre's slim book addresses the coming of the post-truth era, in which truth loses its political salience and facts are regarded as "subordinate to our political point of view" (p. 11). The discussion is unavoidably political, and McIntyre is clearly no admirer of Donald Trump, but his intention is not to engage in polemic. Instead, he offers a clarification, a diagnosis, and, tentatively, a remedy for post-truth. While *Post-Truth* is not the only such treatment on offer, it is noteworthy—and of interest to readers of *RNCSE*—on account of its emphasis on the role of science denial, especially climate change denial and "intelligent design" creationism, in post-truth.

After a chapter devoted to unpacking the idea of post-truth, McIntyre suggests that "the phenomenon of science denial in general is relevant as a way to understand the phenomenon of post-truth" (p. 21). His central example is the manufactured controversy over climate change, which will be familiar to readers of Naomi Oreskes and Erik M. Conway's *Merchants of Doubt* (2010). He then turns to the task of diagnosis, devoting chapters to the cognitive biases that underlie post-truth and the social developments, particularly in the media, that enable post-truth. Post-modernism is also assigned a share of the blame, although here the argument is not particularly convincing, relying only on similarities and anecdotes.

Unsurprisingly, the final chapter, entitled "Fighting Post-Truth," provides no panacea: it is not helpful simply to be told, "In an era of post-truth, we must challenge each and every attempt to obfuscate a factual matter and challenge falsehoods before they are allowed to fester" (p. 157). And there is no discussion of the likely attempts of science deniers to coopt the tactics used in such challenges (as in creationist appeals to the value of open-mindedness). Yet it is overall helpful to have such a brisk, engaging, and timely treatment of these issues. Readers of *Post-Truth* will also want to look for McIntyre's *The Scientific Attitude* (2019), which promises to develop the theme that caring about evidence—the antithesis of post-truth—is the essence of science.

Glenn Branch is Deputy Director of NCSE. branch@ncse.com

Doesn't Actually Work Like It Does on TV?

of error can be as much as fifteen years for adults into a conversation about *Bones*. Once my relatives got over my skills' not being up to par with the those of the TV forensic anthropologist Temperance Brennan, we were able to have a discussion about why determining the age of adults is so difficult.

Complicate; don't contradict. It's very easy to turn a healthy skeptic into a cynic by carping about TV science. Instead of dismissing the science outright, add qualifiers that help your friends and family understand the time involved, the margins of error, and the sheer cost associated with the techniques. Adding these nuances to their comprehension may help to lead them to learn more (and may even encourage them to support adequate funding for science).

Watch the shows yourself. Finally, I strongly suggest that scientists watch these shows themselves. What TV-based forensics may lack in scientific accuracy, they make up for in the millions of dollars spent on market research. The techniques shows use to explain complicated science topics to a diverse TV viewership can help scientists as they try to explain their work to the community. After watching an episode of *NCIS*, you might just come away with some new ideas for science communication.

I've concentrated here on physical anthropology, my professional specialty, but I hope that you can see how the same strategies could be used by chemists talking about *Breaking Bad* or physicians talking about *House*. But when it comes to *Fringe*, you're on your own!

— *KATE CARTER*

NATIONAL CENTER FOR SCIENCE EDUCATION, INC.
1904 FRANKLIN STREET, SUITE 600
OAKLAND CA 94612-2922

CHANGE SERVICE REQUESTED

Non-Profit Org.
U.S. Postage
PAID
Oakland CA
Permit 686

Introducing NCSE's *SCIENCE CHAMPIONS SOCIETY*

Make a Leadership Gift of $1,000 or More

Invest in NCSE's innovative and bold ideas to ensure students get the evolution and climate science education they need and deserve. As a member of the *Science Champions Society*, you'll have unique opportunities to learn about and celebrate NCSE.

For more information, contact Deb Janes at janes@ncse.com or call her at 510-601-7203.

NCSE.com/donate/science-champions-society