

reports

OF THE NATIONAL CENTER FOR SCIENCE EDUCATION | WINTER 2020 | VOLUME 40 | NO 1

NCSE National Center for Science Education

OUR WORK OUR IMPACT ABOUT NCSE GET INVOLVED RESOURCES AND ADVICE DONATE

Millions of students don't get an accurate science education

HOW DO WE KNOW?

The National Center for Science Education believes they deserve better.

THE ROOT OF THE PROBLEM

Science teachers recognize that evolution and climate change are widely misunderstood or rejected in many places.

Teaching these topics without specific training is challenging. Many teachers avoid these well-established yet culturally controversial areas of science to avoid conflict.

60% of high school biology teachers teach evolution inaccurately or inadequately.

40% of middle and high school teachers teach climate change inaccurately.

READ THE STUDY →

READ THE STUDY →

NCSE Redesigns its Website ncse.ngo

WHY
TRUST
SCIENCE
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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.ngo

BOOK REVIEW EDITOR

Glenn Branch

PUBLISHER

Ann Reid

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Dear NCSE members,

2019 was busy. If you've been reading RNCSE, you already know the highlights. But I do want to be sure that you don't miss this news: **We have a new website!** I hereby heartily encourage you to pick up your phone or fire up your computer and visit NCSE.ngo. I think you will love what you find. In addition to being elegant and intuitive, the site makes all of our programs and their resources much more accessible. Throughout this issue you'll find pointers to further information, lessons, activities, and archival material that you can find on the website. Indeed, from now on, most articles in RNCSE will be individually posted so that each can be searched for either from the website search bar or from any search engine. We hope this will help many more people discover NCSE and what we have to offer.

We cannot thank and commend Paul Oh enough for shepherding the new website from birth to launch, though of course this was ultimately a team effort.

In other news, in 2019 we added another three sets of teacher ambassadors, bringing the total number to 47. The new website has a [page](#) for each and every one of them; I think you'll enjoy getting to know them. And of course, while it was painful to say goodbye to Brad Hoge, who got the Supporting Teachers program off to such a good start, we are thrilled to have found Lin Andrews to help these master teachers take their ability to train their peers to new heights. You can learn more about Lin on page 10.

We are so fortunate to have Naomi Oreskes as a board member. And equally fortunate to have been able to interview her about her timely new book, *Why Trust Science?* Read my interview with her on page 4.

In each issue of RNCSE, we interview a long-time member. In this issue, we have a few questions for the longest serving member of NCSE's board of directors, Robert "Mac" West. Formally, he's leaving the board. Informally (pun intended: see his interview on page 5), we have his assurance that he will still be standing in the wings ready to help us whenever we need him, as he has for over 30 years.

In particular, I know Mac is happy that NCSE is making a concerted effort to connect with science museums, especially small museums in rural areas that make ideal partners for our work. On page 12, you can read about one of the [activities](#) that our Director of Community Science Education Kate Carter and our Program Coordinator Emma Doctors and their merry band of volunteers have developed for our museum partners. It isn't easy to make evolution come to life, but a combination of slime and climbing through tunnels is hard to beat.

In 2020, we anticipate another round of challenges to science education in the form of misguided bills and efforts to interfere with the treatment of evolution and climate change in the process of renewing state science standards. Glenn Branch will be ready for anything that happens. Look, too, for him to be bringing you the results of NCSE's latest teacher survey that updates the groundbreaking Berkman and Plutzer evolution teaching practices survey from 2007 and also asks the surveyed teachers how they teach climate change. We anticipate a lot of useful and intriguing results.

Finally, let me say thank you for your ongoing and generous support of NCSE. Without you, we could not support teachers, break down barriers, or catalyze action—all the components that we need to make sure that every student receives an accurate and effective science education. We greatly appreciate your continued support in 2020 and beyond.

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





NCSE

by the numb#rs

2019



BREAKING DOWN BARRIERS

OF PEOPLE REACHED **11,000**

OF ACTIVE STATES **19**

OF ACTIVITIES CREATED **14**

OF GRADUATE STUDENT FELLOWS **10**

CATALYZING ACTION

18 ANTI-SCIENCE EDUCATION MEASURES DEFEATED OR DEFUSED
3 STATES WHERE NCSE MUSTERED SUPPORT FOR QUALITY STATE SCIENCE STANDARDS

NCSE MEMBERS

MEMBERS **2,909**

SUSTAINERS **538**



SUPPORTING TEACHERS

OF TEACHER AMBASSADORS **47**

OF STATES REPRESENTED BY THE TEACHER AMBASSADORS **27** + PUERTO RICO

NEW WEBSITE

PIECES OF CONTENT ON THE NEW SITE **5,624**

OF PHOTOS ON THE NEW SITE **2,202**



Why Trust Science in a Post-Truth Age?

Why Trust Science? Is the latest book by Naomi Oreskes, an NCSE board member, Professor of the History of Science at Harvard University, and author of other notable books including *Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco to Global Warming* coauthored with Erik M. Conway (2010). Her honors include a Guggenheim Fellowship, the Schneider Award for Outstanding Climate Science Communication, and NCSE's Friend of the Planet award.



The publication of [Why Trust Science?](#) seems incredibly timely coming as it does during an era in which the public is forced to wade through layers of misinformation about science and period when those in the highest offices of US government cast doubt on scientific conclusions.

We talked with Oreskes recently about the implications of the current situation for science education and science educators. The interview has been edited for clarity and brevity.

Ann Reid: The subject of your book—trusting science—has a particular urgency today. Is there a crisis of confidence in science in the United States?

Naomi Oreskes: All of the evidence suggests that most Americans still trust science about most things. However, many people resist scientific conclusions in specific areas that they interpret as threatening their values or beliefs. Evolution is the obvious one, familiar to all members of NCSE. Some evangelical Christians interpret evolutionary theory to imply that life is meaningless. It's important to understand this, because an effective response means understanding this concern.

AR: What are the implications for science educators in terms of trying to understand concerns related to values and beliefs?

NO: That we should not be afraid to discuss values! And noting, as I try to do in the book, that even people who seem to have radically different views often have overlapping values, and this can offer the basis for a respectful conversation.

AR: Which sounds very much like how we approach our work in our teacher support and community outreach programs.

NO: I've just been reading a book by William Ury, a world-famous mediator. He stresses that even though the world is diverse, and we often stress the radical difference between cultures, in his experience even the most radically different cultures, and even the most radically hostile enemies, often share many values, such as fairness, honesty, integrity, and courage. In my experience, nearly all Americans have a deep respect for life, and for liberty. Shared values can be the basis for shared concern and respectful discourse.

AR: Given that one of the "stickiest" misconceptions about climate change is the heavily promoted idea that "the science isn't settled," how do scientists, teachers and science communicators successfully

navigate between the concepts of "science is never finished" and "some conclusions are backed by so much evidence that it is no longer productive to question them"?

NO: I think by saying just what you said. One lesson of history

is open-mindedness and humility: our ideas do change, and that is a good thing. In fact it is a strength of science that scientists are open to new evidence, new ideas, new ways of thinking. If science is a learning process, then it is inevitable that sometimes our ideas will change. But this is no reason to reject or disparage hard-won knowledge. As Carl Sagan famously said:

In science it often happens that scientists say, 'You know that's a really good argument; my position is mistaken,' and then they would actually change their minds and you never hear that old view from them again. They really do it. It doesn't happen as often as it should, because scientists are human and change is sometimes painful. But it happens every day. I cannot recall the last time something like that happened in politics or religion.

Of course, Sagan was wrong about politics and religion. Honest political and religious leaders can and do admit mistakes as well. Just think of the Catholic Church apologizing to Galileo. The difference, I think, is that science has an organized mechanism for identifying and correcting error. Scientists want to find mistakes, and fix them. That is not always the case with folks in other domains.

And students need to understand that when people are disparaging science, their motivation is rarely the truth.

AR: Perhaps it's a matter of helping students understand the distinction between debate and scientific argumentation. How would you describe the distinction?

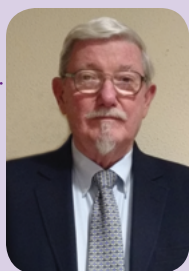
NO: That's a good question. I'm not sure there is a clear answer—after all, there is such a thing as scientific debate. I like to think of it as the difference between contested and controversial. The theory of evolution by natural selection and the reality of anthropogenic climate change are not controversial. For scientists, these are theories or conclusions supported by a wealth of evidence. The theory of natural selection is the best explanation we have to explain the origin of species and biological diversity. Human-caused climate change is a fact, proven beyond any reasonable doubt. But these conclusions are contested in the larger culture, for the reasons I mentioned above: because they threaten some one's values, or beliefs, or in the case of climate change, economic interests.

AR: One final question. What gives you hope that we can wade through the misinformation, denial, and doubt when it comes to scientific findings in this era of "post-truth"?

NO: Only that the stakes are too high to permit failure.

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





Robert “Mac” West joined NCSE’s board of directors at NCSE’s inception,

and has served on and off - but mostly on - ever since, cheering on the work of the organization and overseeing in his board capacity its finances and strategic goals. A paleontologist by training, West is a former director of the Carnegie Museum of Natural History and the Cranbrook Institute of Science. West, who is the principal of Informal Learning Experiences, a museum and informal learning consultancy firm, is scheduled to cycle off the board later this year. We asked Mac to reflect on his work with NCSE over the years and share his thoughts on informal science education with regard to NCSE’s focus areas. The interview has been modified for brevity and clarity.

Paul Oh: What was it that pulled you into dealing with the evolution “controversy” in the first place?

Robert “Mac” West: It goes back to my time as a curator at the Milwaukee Public Museum. I had gotten an NSF grant to redo the geology exhibit. I heard immediately after the grant was announced from the Creation Science Society, which said I must do what was fair to everybody and present “both sides” of the “story.” At that point in my life, I didn’t know creationists still existed and that made me consider where the science of the evolution of life stood in society. That really got me into the realm of the evolution/creationism controversy. I quickly moved into the national conversations about evolution and creationism, which is where I’ve been for the rest of my life. And that also led me to be part of the beginning of NCSE.

Random Samples

with Robert “Mac” West

PO: What was it like to be there at the beginning?

MW: NCSE was something that was absolutely necessary. There needed to be, if you will, a formal set of position statements that articulated what science is and how it should be presented and taught. That experience in Milwaukee opened my eyes. As a grad student, as a faculty member at Adelphi University in New York, I literally had not heard anything about creationism. What it indicates to me now is how separate the academic world, at least at that time, was from parts of the Christian world.

PO: Turning now to your expertise over the years in informal science education. Why is it important for teachers and professors to work together with educators from informal learning environments?

MW: It’s all the same world. We talk about formal and informal learning. The fact is that ultimately whether you’re at a university or a museum or you’re a 7th-grade teacher, you’re still dealing with the public. Ultimately, everyone is interested and obliged to make science as accessible and meaningful as possible to the public. The educators in the informal world have, if you will, a skill set that complements the people in the academic world, whether it be the professor or the classroom teacher. Museum educators “break loose” from the vocabulary of the curriculum and use vocabulary that’s meaningful to students. There are different ways of talking about science, and varied populations in the science world highlight those differences. We spend five percent of our life in schools and 95% of our life elsewhere. And that’s a very interesting thought when we look at the role of formal education and grades and all of that. Here is where, obviously, museums and science centers and zoos have a role. But also the mass media.

My gosh, what you get online these days. All of that is part of the 95%.

PO: What is the most memorable moment that comes to mind when thinking about the work of NCSE during your time on the board?

MW: Two things. One is the [Kitzmiller trial](#) in 2005 and the critical role NCSE played. Three members of the board were expert witnesses—Kevin Padian, Brian Alters, and Barbara Forrest—and another subsequently joined the board—Ken Miller. The fact is that we were there as part of the science world that said, yes, this is what science is, and this is what needs to be presented publicly as modern science. Great attention was paid to that particular trial—and there we were. And of course we won. The other thing that comes to mind is when we had the internal discussions about climate change and how the climate deniers are very adept at using the same kinds of strategies that the creationists use. When we on the board decided that we would include climate science as part of NCSE’s mission, that was a very important move to say that we are in the position of protecting and promoting science in general and not just biological evolution.

PO: As you leave the board, what advice would you give your colleagues?

MW: It’s important that we continue our work with teachers and monitoring curriculum and looking at what goes on in state legislatures when they say you must teach some element of creationism or intelligent design or whatever vocabulary they’re going to dream up next. But what’s also important is for NCSE to recognize the importance of the informal education world. I hope that NCSE never loses track of the fact that 95% of a student’s time is spent out of school.

Paul Oh is NCSE’s Director of Communication. oh@ncse.ngo

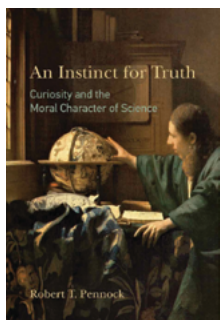




Robert T. Pennock

of Michigan State University was named as a University Distinguished Professor—one

of the highest distinctions a faculty member can achieve—in June 2019, and in July 2019 his new book *An Instinct for Truth: Curiosity and the*



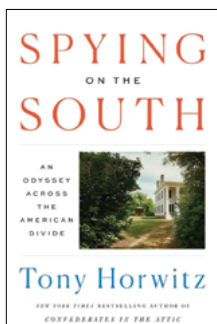
Moral Character of Science was published by MIT Press. The publisher explains, “Exemplary scientists have a characteristic way of viewing the world and

their work: their mindset and methods all aim at discovering truths about nature. In *An Instinct for Truth*, Robert Pennock explores this scientific mindset and argues that what Charles Darwin called ‘an instinct for truth, knowledge, and discovery’ has a tacit moral structure—that it is important not only for scientific excellence and integrity but also for democracy and human flourishing. In an era of ‘post-truth,’ the scientific drive to discover empirical truths has a special value.” A review by Doren Recker will appear in a future issue of *RNCSE*. In 2005, Pennock testified for the plaintiffs in *Kitzmiller v. Dover*, the case establishing the unconstitutionality of teaching “intelligent design” in the public schools.



Dan Phelps

was featured in Tony Horwitz’s *Spying on the South* (2019), in which the Pulitzer Prize-winning journalist recounted and retraced the antebellum journeys through the American South of Frederick Law Olmstead, who would later design New York City’s Central



Park. After visiting Answers in Genesis’s Creation “Museum,” Horwitz sought out Phelps, “foremost among [AiG’s] critics,” in order to better understand the brand of young-earth creationism peddled by AiG. Describing Phelps as “tall and geeky” and not fitting “the stereotype of ‘secular scientists’ depicted at the museum,” Horwitz quoted him as saying, “My problem with the museum isn’t religious. It’s bad science, or non-science.” Phelps received NCSE’s [Friend of Darwin award](#) in 2017.



The Clergy Letter Project (theclergyletterproject.org), founded by **Michael Zimmerman**, added a Humanist

Letter endorsing evolution education to the existing Christian Clergy, Rabbi Clergy, Unitarian Universalist, and Buddhist Clergy Letters. **Jason Wiles**, assistant professor of biology at Syracuse University and a signatory of the Humanist letter, told *The Humanist* that the letters help to “overcome the mistaken notion that one needs necessarily to abandon



religious faith in order to understand and accept evolution, and, further, to demonstrate that teaching evolution in schools is actually supported by religious leaders across many traditions.”

Glenn Branch is deputy director of NCSE. branch@ncse.ngo



A young participant in our “In Case of Cellulose” activity attempts to “digest” a bolus.

Photo by Dave Strauss

1 OF
14
ACTIVITIES
CREATED IN
2019



Photos: Randy Moore

ICR's Discovery Center for Science & Earth History condemns evolution and advocates the young-earth creationism popularized by Henry Morris, ICR's founder and the "father of modern creationism."

In 1970, Henry M. Morris (1918–2006) and Tim LaHaye (1926–2016) founded the Institute for Creation Research (ICR) to promote “creation science, biblical creationism, and related fields.” ICR was originally the research division of LaHaye’s Christian Heritage College, but ICR became autonomous in 1981. In 1992, ICR opened its Creation and Earth History Museum in Santee, California, but in 2008 sold the museum and its contents to Tom Cantor, the founder of Scantibodies Laboratory, Inc. Today, that museum is operated by the Life and Light Foundation, which was founded by Cantor and his wife Cheryl Cantor. The museum’s focus on biblical literalism, a young Earth, and evolution being a Satanic hoax remain unchanged.

On September 2, 2019, ICR returned to the museum business when it opened the Discovery Center for Science & Earth History adjacent to its headquarters in Dallas, Texas (Fig. 1). The sprawling, debt-free, \$37,800,000 museum was opened to “proclaim the whole of God’s creation truth to a lost world” because, according to Henry M. Morris IV, the Discovery Center’s Director of Operations, “the message of cre-

ation is needed more now than ever before.” More than 1,600 people attended the Discovery Center’s opening-day festivities.

Outside the Discovery Center are a variety of giant fossils and a 7.3-meter-tall (24-foot-tall), sterling silver molecule of DNA inscribed with Bible verses (Psalm 139:14, 16; see image at left). Inside, an impressive planetarium features shows exploring the cosmos and ocean, paintings depict the days of creation, and a 200-seat Founders Hall hosts lectures by ICR’s creation scientists. In the Founders of Science exhibit, visitors see animatronic, talking, interacting portraits of Isaac Newton, Johannes Kepler, Robert Boyle, and Louis Pasteur showing how “Biblical thinking led to great scientific discoveries.” (The Founders of Science exhibit also includes Henry Morris.) An animatronic Michael Faraday endorses ICR and welcomes visitors to the Discovery Center.

A variety of walk-through exhibits describe the life and resurrection of Christ, the origin of the Universe, and the Garden in Eden (including “humanity’s fall from perfection”). The Tower of Babel exhibit describes how the confusion of language caused people to “form the nations we know today,” and the Life on the Ark exhibit claims that “God probably sent young sauropod dinosaurs to the Ark since they wouldn’t take up as much space or require as much food.” Visitors shiver in the cold Ice Age Theater, and then learn about Noah’s year-long, planet-covering Flood, how the Grand Canyon was carved by Noah’s flood “in a matter of weeks,” and how humans lived with dinosaurs. Holograms and a variety of animatronic animals—ranging from chickens to *T. rex* and a circling pterodactyl—entertain visitors throughout the

Under an apple tree in the Garden in Eden, visitors meet the scaly, dust-eating, 1.5-meter-tall (5-foot-tall), talking serpent (Genesis 3:14-19) who convinced Eve to eat forbidden fruit. According to the adjacent exhibit, the serpent “may have looked like the creature” in this photograph.



museum. A highlight of the tour is a face-to-face encounter with the talking serpent from Genesis 3 (See image above). Nearby is a non-animated exhibit of the Bible’s only other talking animal, Balaam’s often-beaten ass (Numbers 22:21–39). Bathroom sinks in the Discovery Center are shaped like Grand Canyon.

The Discovery Center addresses all of the familiar themes of young-Earth creationism, including a six-day creation just a few thousand years ago, no transitional forms, no death (i.e., no predators or prey) before Adam’s sin, virtually all fossils being created by a worldwide flood, “human encounters with dinosaurs,” and evolution being a hoax that undermines Christianity. Visitors learn that radiometric dating is unreliable and that the dinosaurs that disembarked the Ark repopulated Earth, after which they may have been “hunted to extinction by humans.” Throughout the Discovery Center, visitors learn “Bible-based facts” that show “how science affirms what the Bible says.” The Discovery Store sells an assortment of ICR’s anti-evolution books, DVDs, games, posters, bags, coffee cups, stuffed animals, toys, caps, and other “faith-strengthening” products, including “The Fall of Man” t-shirts.

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



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.

FLORIDA

Florida's House Bill 855 and the identical Senate Bill 1454 would have required instructional materials in the public schools to "provide objective, balanced, and noninflammatory viewpoints on controversial issues"—presumably including evolution and climate change. The bills would also have facilitated challenges to instructional materials under a 2017 law that was aimed at evolution and climate change: three such challenges involving evolution and climate change were reported in 2017–2018. Both bills died in committee on May 4, 2019.

IOWA

Iowa's House File 428 would have reverted the state's science standards to "the science standards utilized by school districts in this state during the 2014–2015 school year"—just before the state adopted the Next Generation Science Standards. The lead sponsor, Sandy Salmon (R–District 63), persistently introduces legislation aimed at the NGSS partly on account of their treatment of evolution and climate change. The bill died in committee in March 2019.

MONTANA

Montana's House Bill 418, sponsored by Joe Read (R–District 93), would have dignified a litany of inaccurate and misleading claims about climate change as legislative findings and called for those findings to be offered "when providing education and informational materials on climate change." The bill would also have asked for regular reports to the legislature "regarding climate change curriculums" offered in Montana's public schools and universities. The bill was introduced and then tabled in committee in February 2019.

RHODE ISLAND

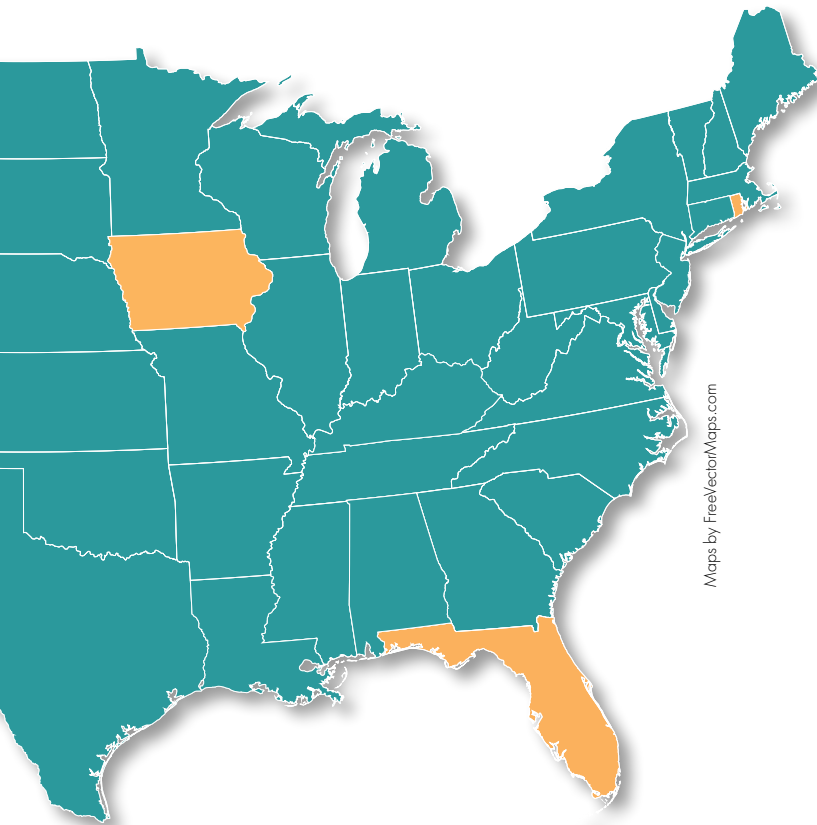
Rhode Island's House Resolution 5563 would have expressed the support of the House of Representatives for increased environmental and climate education in the state's public schools. Sponsored by Terri-Denise Cortvriend (D–District 72), Kathleen A. Fogarty (D–District 35), Lauren H. Carson (D–District 75), Teresa A. Tanzi (D–District 34), and Justine A. Caldwell (D–District 30), HR 5563 was held for further study—and thus died—in the House Committee on Health, Education, and Welfare.

NATIONAL

Darwin Day resolutions have been again introduced in both houses of Congress. House Resolution 123 and Senate Resolution 63 would, if passed, support designating February 12, 2019, as Darwin Day and recognition of Charles Darwin as "a worthy symbol of scientific advancement on which to focus and around which to build a global celebration of science and humanity intended to promote a common bond among all of the people of the Earth." No such resolutions have yet succeeded.

NATIONAL

S. 477 and the identical H.R. 2349 would authorize the National Oceanic and Atmospheric Administration to institute a competitive grant program aimed in part at developing and improving educational material and teacher training on the topic of climate change. S. 477 is sponsored by Edward J. Markey (D–Massachusetts) and fifteen colleagues in the Senate; H.R. 2349 is sponsored by Debbie Dingell (D–Michigan) and six colleagues in the House. NCSE endorsed the bills. Previous attempts have not succeeded.



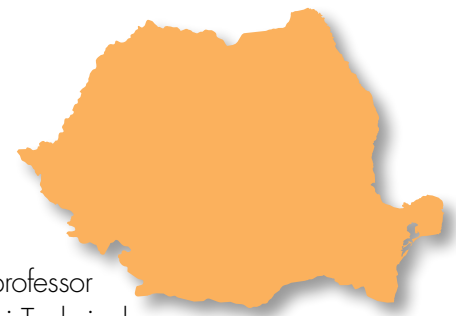
AUSTRALIA, NEW SOUTH WALES

A high school history textbook claiming that the former prime minister Tony Abbott “made international headlines as a climate change denier” is under attack, owing to a member of the House of Representatives who complained of the “offensive slur” and the “climate change indoctrination embedded in the course.” In response, the New South Wales Minister for Education raised the concerns with the publisher, Pearson; a Pearson representative said, “we stand by this text book and its author.”



ROMANIA

Nicolae Hurduc, a chemical engineering professor at the Gheorghe Asachi Technical University and the new Minister of Research and Innovation, is on record as rejecting evolution because he cannot accept that humans descended from monkeys and as preferring “a theory of parallel world, which says we may come from the future,” according to Romania Insider. The science advocacy organization Ad Astra expressed concern about what it described as his “series of pseudo-scientific fantasies about species evolution, human origin, and time travel.”



UNITED KINGDOM, HARTFORD

A planned performance of the musical *Darwin Rocks* was cancelled at Hartford Manor Primary School in February 2019, owing to expressions of concern from parents regarding the allegedly mocking portrayal of Samuel Wilberforce, the Bishop of Oxford who opposed evolution in Darwin’s day, as well as regarding lyrics including “bump and grind.” The school’s head teacher told the BBC that the school teaches evolution as part of its syllabus and no parents have withdrawn their students from those lessons.



UNITED KINGDOM

British students striking to express concern over climate change were joined on March 1, 2019, by teachers demanding “the national curriculum be reformed to make the climate and ecological crisis an educational priority,” according to the *Guardian*. The teachers complain that there is currently no requirement for climate change to be taught “so it is treated, at best, as a peripheral subtopic of geography and science” and that part of the curriculum appears to express doubt about anthropogenic climate change.



BUILDING COMMUNITY

I am a teacher. Even though I'm about to step out of the classroom for the first time in almost twenty years, I will still always be a teacher. I know this because I keep trying to think of ways to help my students even though I've just left the classroom for good. And boy howdy, do I have guilt about leaving them! While I know they will be just fine and learn to love their new teacher just like me, I can't help but feel I have somehow let them down. It haunts me.

However, despite every moment of doubt, I am excited to be NCSE's new Director of Teacher Support. It is an opportunity I have dreamed of my whole teaching career—to help other science teachers thrive and succeed, even when our nation seems to be appreciating and valuing us less and less. To offer up this one phrase of

reassurance to all science teachers everywhere facing misconceptions, lack of administrative support, and overloaded classrooms with few funds: You. Are. Not. Alone.

No teacher can thrive as an island, yet in many ways, the very routine of our daily teacher life can isolate and overwhelm us. For many years as a biology teacher, I felt just like this—trying to develop my teaching skills in survival mode. But, one day I realized something very important: there were organizations, groups, and online communities full of teachers working to help each other thrive and succeed as one. And with the click of a mouse button, my entire career changed.

Help from the National Association of Biology Teachers, the National Science Teaching Association, and other online social groups of fellow teachers has turned me into what I am today. I know without a doubt that I now have the pedagogy and teaching skills I need to tackle any situation—whether it be a climate-change-denying parent, a young-earth creationist co-worker, or students who offer the latest “news” they've collected from the internet to support the claim that the Earth is, “in fact,” flat. Sound outrageous? I've dealt with all three of these issues in recent years.

So how did it all start? Well, it began when I tried to develop an Advanced Placement Biology program at my school with zero funding and almost zero support. I needed training and I

had no AP biology experience, so I started seeking programs I could afford to pay for on my own. As luck would have it, I was chosen to be part of an AP Biology Leadership Academy just getting started by a powerhouse triumvirate of biological groups (NABT, Biological Science Curriculum Study, and the Howard Hughes Medical Institute).

The rest, as they say, is history. Through this program, I have met some of the best biology teachers, leaders, and scientists that I've ever come across in my life. This community, which started with around 50 teachers and grew to over 100 before the program ended, would change my life. I had found a home, a community, and many people whom I count among my dearest friends. We share ideas, lessons, and most importantly, hope. We help each other thrive, and I can guarantee you that if I was ever stuck on a topic and needed ideas, I'd shoot out one email and receive up to twenty replies.

And I now work with NCSE, an amazing organization that wants teachers to know the same thing: You.

This community, which started with around 50 teachers and grew to over 100 before the program ended, would change my life.



Students measuring hominin skulls.

Photo by Brooke Broussard

Are. Not. Alone. Through our Teacher Ambassadors community outreach initiatives, and library of online resources, we want all teachers to know they can come to us for help when they need it most: when they are under fire for doing exactly what is in their job description—teaching the science.

Furthermore, as we move into the next year, it is my hope to grow our Supporting Teachers program even more! We plan to offer professional development opportunities throughout the nation led by our Ambassadors, provide new resources for the classroom in much-needed areas like

evolution and the nature of science, and expand our climate change resources to include implementation guides for all grade levels. The sky's the proverbial limit! In my new role as NCSE's Director of Teacher Support, I look forward to hearing from you and fielding any concerns you might have moving forward.

One final note: If not for all the teachers who have helped me on my journey, I would be nothing today. If I could, I'd name them all right here (starting with Charlene Avery in the second grade), but I think my article would get a bit too wordy! So, instead, I'll simply say thank you to them all—you know who you are—to BSCS, NABT, and HHMI—thank you for taking a chance on me—and to NCSE—I can't wait to see where this new journey is going to take us together!

Lin Andrews is NCSE's Director of Teacher Support.
andrews@ncse.ngo



Lin Andrews with Teacher Ambassador John Mead at the 2019 National Association of Biology Teachers conference.

Photo by Paul Oh

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 AMBASSADORS
 EMPOWERING
 TEACHERS
2019

MAKING EVOLUTION DIGESTIBLE

"All that work and only 15 calories!" The exasperation in the 10-year-old's voice is amplified by the walls of the two-and-a-half-meter-long intestinal tract she's been crawling through. "That's like three jelly beans," one of our interpreters shouts meekly into the tube, unsure to which adult her frustration is directed. Suddenly, a crop of curly hair pops out of the large intestine: "Three? I had 36 jelly beans this morning."

This child, like many of the more than 400 participants we chatted with while leading our activity called "[In Case of Cellulose](#)" recently as part of the Bay Area Science Festival, was learning firsthand about evolutionary tradeoffs in the mammalian digestive system. We were very excited to see that, despite the inherent frustration of "digesting" low-calorie foods, families spent more than 20 minutes on average playing through the activity together. Through this extended engagement time we were able to craft an evolutionary story that avoided many common pitfalls.

While playing "In Case of Cellulose," participants choose to simulate the digestion of a cow, horse, panda, or a human. We create a digestive bolus of chewed leaves using baking soda, citric acid, cornstarch, and food coloring (you might call it a bath bomb in other circumstances). To digest these boli, participants must first chemically and mechanically process them in the "stomach"—a tray—using digestive enzymes. As a colorful chemical reaction takes place before their eyes, they first notice a few "nutrients" appearing—small, colorful, beads—before stumbling across a hard plastic ball that is unreactive to digestive enzymes. This ball of cellulose contains significantly more nutrients but is incredibly difficult to open.

Depending on their chosen species, participants will then get to experience different evolutionary strategies for digesting cellulose and absorbing nutrients in the intestines as they carry the bolus through the "intestines"—a long, collapsible tunnel. Once in the intestines, they will have to match the nutrition they found with the enzyme or part of the microbiome that helps it be absorbed.

Cellulose has been an important structural component of plants since the Paleozoic, but digesting it has presented a challenge for animals. In fact, no animal can digest cellulose without the help of microorganisms inhabiting their

guts, though the type and location of these digestive helpers vary. Foregut fermenters, like cows, break down cellulose in their first few stomachs, but need to regurgitate, chew their cud, and pass the bolus through the last few stomachs in order to absorb protein. Hindgut fermenters like horses, by contrast, use the microbiome located primarily in their cecum to break down cellulose. Pandas present a particularly weird case, as they subsist almost entirely on high-cellulose food, but have a short, carnivore gut that makes fermentation impossible and lacks the microbiome to process cellulose (though evidence is mixed on this last point).

While every strategy allows animals to extract at least some nutrition from plant resources, evolutionary trade-offs exist for all three animals. Foregut fermenters extract fewer nutrients overall, while hindgut fermenters often have to rest during digestion. Furthermore, the overall strategy of subsisting on plant resources means that animals often have to spend huge parts of their day foraging. Many participants were shocked to see how little caloric value they get out of each resource and how many hours of their day they would have to spend chewing and digesting in order to stay alive. Pandas, who get almost no nutrients from the leaves they eat, have devised an incredibly risky strategy for digestion, where any deviation in plant resource availability can end in their death. For our participants, it is also an important lesson in how adaptive strategies work.

Creating inquiry-based activities for evolution can be difficult, given that evolution occurs over a time scale that is difficult for humans to grasp. It is easy to introduce misconceptions through oversimplification. Activities that focus on an individual organism—an adorable panda bear, for example, or a hungry bird—are easily relatable, but often participants walk away with the impression that evolution responds to what an individual organism needs, thus undermining understanding of natural selection. Creating activities with too much nuance—that focus on change in allele frequency over generations,



Photos by Dave Strauss

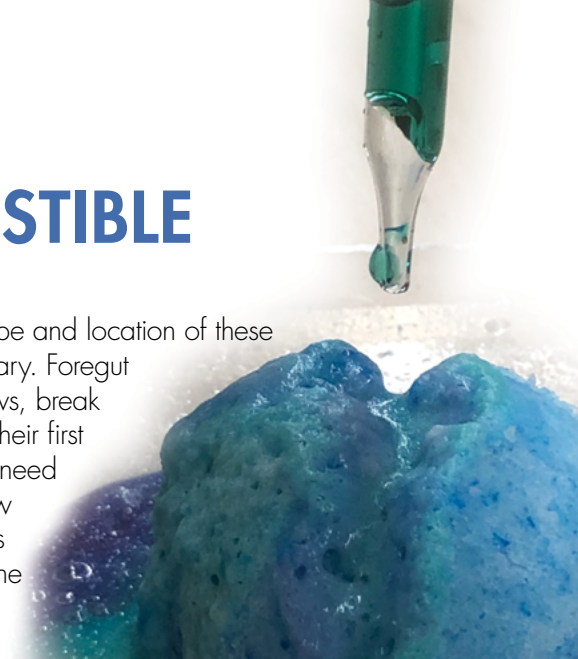


Photo by Brian Miller

CASE STUDIES IN EMPATHY

PRACTICE YOUR EMPATHY SKILLS AS WE UNPACK POTENTIAL REASONS BEHIND CLIMATE CHANGE AND EVOLUTION HESITANCE AND RESISTANCE AND DISCUSS BEST PRACTICES FOR ENGAGEMENT.

Scenario: Kylie and Liz, 16

Kylie and Liz are wearing matching t-shirts bearing the name of a youth group from a local conservative church whose van is parked outside. You notice that they are approaching all volunteers leading evolution activities at a science festival and attempting to debate evolution. Regardless of the activity, they appear to be asking the same questions, and you wonder whether they have been coached. They approach your activity about the parallel evolution of bioluminescence in sea creatures and start asking about missing links.

What Might Be Going On

First, it's important to realize that the girls' actions are performative, intended less to seek information than to take a stance, though this should not serve to undercut their importance or be cause for derision. Their actions help them to form their identities and reaffirm their values. They must realize that they will

be watched by those both sympathetic and unsympathetic to their causes. In their minds, it is easy to imagine that the stakes are high. They are facing real threats of ostracism from within the youth group for failure to perform, and they are probably genuinely afraid of anger from the scientists presenting the activities.

It is hard to overemphasize just how brave, if misguided, both these teens are. Teenagers as a whole don't like to stand out, and giving up a weekend to loudly advocate for your religion in public requires overcoming a lot of anxiety. Putting time towards advancing a cause you believe in is in fact a value that any science volunteer shares with Kylie and Liz. Both of you, from your varied perspectives, are working to make the world a better place.



for example—on the other hand, can overwhelm visitors and prevent breaking down the barriers to science, the core goal of our program. Mechanistic activities that focus on the process of evolution often don't have enough of an emotional hook to drive deep engagements. While adults typically engage with evolutionary questions that are relevant to their own lives, like health and disease, kids are more drawn to evolutionary activities that involve recognizable species (and allow them to make a mess). "In Case of Cellulose" tries to be mindful of each of these considerations while creating an activity that has resonance with a broad portion of the population.

"In Case of Cellulose" aims to be immersive by allowing participants to take on the role of a digestive bolus, exposing participants not only to cellulose but also to the digestive system as a whole. Such immersive experiences, if not carefully constructed, can prove to be intimidating. We don't expect

What Should You Do?

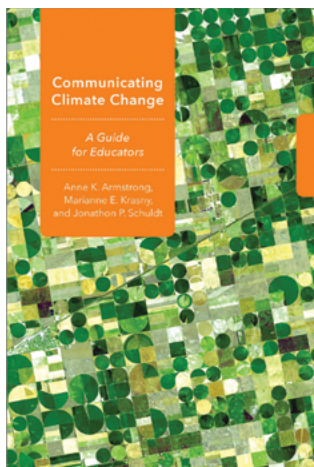
Two obvious options—arguing with the teenagers or ignoring them politely—are problematic. In addition to potentially causing you embarrassment (if you lose the argument) and putting other participants in an awkward position, these approaches reinforce a negative experience with science for Kylie and Liz. Instead, you might want to pay them a genuine compliment, recognizing their bravery and willingness to stand out from the crowd. As you engage with them, redirect their questions to learn more about them as people. Questions like "What are you studying in school?" or even "Where are you visiting from?" can deescalate a tense situation. If you see an opening, encourage them to try the activity and engage with the evidence themselves. Even if you're forced to admit that one of their "gotcha" questions has you stumped, you can win by losing if you can do it in a respectful and gracious way.

participants to know anything about digestive enzymes or the different pathways to absorb different nutrients; we therefore make the process of chemical digestion in the stomach and the matching of nutrient colors in the intestines intuitive. It is this combination of the intuitive and the novel that leads to early success that then allows for engagement with the deeper evolutionary content. It also allows volunteers to scaffold content that is appropriate for each family's age and interest levels. By creating activities that engage at different levels, we can truly make evolution digestible.

This activity was mailed out to the members of our Science Outreach Collaborative in early December 2019. If you want to do this activity in your community, you can check out a full list of instructions online at ncse.ngo/breaking-down-barriers.

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





Communicating Climate Change: A Guide for Educators

authors: Anne K. Armstrong,
Jonathon P. Schuldt, and
Marianne E. Krasny

publisher: Cornell University Press

reviewed by: K. C. Busch

At its heart, education is a communicative process. As such, science and environmental educators serve as important and trusted messengers about some of society's grandest challenges like climate change. Research has much to offer about how to best approach climate change communication, but that research exists in many different academic areas and is not synthesized for practical use by educators. To address this need, Armstrong, Krasny, and Schuldt drew from environmental psychology, science and environmental education, and science communication to write *Communicating Climate Change: A Guide for Educators*. The goal of the book is to create a relevant and immediately useful guide for climate change educators, bridging the gap between research and practice.

The authors start with the science, reviewing the basic scientific underpinnings of climate change including the difference between weather and climate, the greenhouse effect, the effects of climate change, and possible mitigation and adaptation actions. Written in clear and concise language, the scientific information helps

educators understand the science for themselves. Later in the chapter, in the "Bottom Line for Educators" section, the authors take an unequivocal stance against disinformation campaigns, stating, "We cannot allow distortion, bias, and fabrication to

“We cannot allow distortion, bias, and fabrication to prevent the evidence-based decisions and actions required at the individual and societal level to reduce climate change.”

prevent the evidence-based decisions and actions required at the individual and societal level to reduce climate

change” (p. 20) It is refreshing to see explicit reference to the terrible effects of these misinformation efforts, which are not only occurring in mass media but are also being targeted directly at teachers (as in the Heartland Institute's campaigns).

Successful educators begin at the end, by defining their intended outcomes and then working backwards to create the educational experiences that would be the most likely to produce that outcome. Chapter 3 is thus particularly useful for educators, as it presents a menu of possible outcomes for climate change education, including knowledge, attitudes, and behaviors. In particular, the section about community-level outcomes is a real contribution to the literature. Large-scale, collective problems, such as climate change, require moving beyond individual-level outcomes. Instead, consideration of community resilience, collective efficacy, social (or science) capital, and collective action as potential outcomes for educative efforts inspires and challenges the field.

Communication strategies for climate change often begin with “knowing your audience.” The second part of the book delves into some of the more interesting findings from environmental psychology to help educators understand why their audiences may not hold the same science knowledge and attitudes as themselves. Moving beyond the myth of the ignorant public, in which it is erroneously

assumed that more knowledge leads to more concern, the authors acknowledge the role of identity in influencing climate change attitudes. For U.S. adults, political identity is more predictive of climate change concern than knowledge. Promisingly, the authors present research that indicates that, for youth, political identity isn't a strong predictor of climate concern.

In part three of the book, the authors illustrate three research-based strategies for communicating climate change: framing, use of metaphor and analogy, and establishing trust. "Framing" comes from communication theory and research, and it refers to how some aspects of a message can be emphasized or made more salient to the audience. For example, climate change can be presented as a global or a local issue. While it is both, communication research indicates that framing climate change as a local issue creates more relevance for the audience. Relevance, the authors note, can decrease psychological distancing, which may hinder taking action.

The authors also recommend the use of metaphor and analogy to help audiences better understand the science of climate change by connecting complex abstract ideas to everyday lived experience. For example, the "blanket analogy" can be used to help the audience understand the greenhouse effect. Lastly, the authors emphasize the importance of trust between the educator and the audience. One way an educator can nurture trust is to understand and speak to the values of those in their audience.

In the last part of the book, the authors recount "Stories from the Field." In four richly described vignettes, the authors provide specific ways in which practicing educators are using the research-based practices in formal and informal settings. Each story ends with a "tip for educators" taken directly from the educator highlighted in the vignette: for example, "Instead of letting the climate change blues get you down, harness your frustration into something productive and active, like a climate change action



Artwork © Roy Troll 2018 www.trollart.com

project" (p. 87). This book provides some very clear direction on how to approach such a project successfully.

K. C. Busch is an Assistant Professor of STEM Education and faculty in the Leadership in Public Science interdisciplinary cluster at North Carolina State University. Her research has focused on climate change education in formal and informal learning spaces. In particular, she seeks to understand how educational experiences can inspire action. kbusch@ncsu.edu



WHAT WE'RE UP AGAINST

Suggestions from the Board



Before a new version of the elementary and high school Utah state science standards was presented to the state board of education for its final approval on June 6, 2019, a few members of the board submitted a list of recommended changes.

Among them was:

The unity among species, as evidenced in the fossil record, similarities in DNA and other biomolecules, anatomical structures, and

embryonic development, is the result of evolution according to many scientists. Other scientists see neutral outcomes or discrepancies in the data. Regardless both groups agree that an evolutionary process explains much of the diversity within and among species.

After what the *Salt Lake Tribune* [described](#) as "a grueling back-and-forth," the standards were adopted without any changes undermining the treatment of evolution and climate change. The new standards will be in place no sooner than the 2020–2021 school year.

—GLENN BRANCH

CHANGE SERVICE REQUESTED



*Michael E. Mann, NCSE board member
and climate scientist*

For **all of you**
who stood up for
uncompromised
science education
in **2019**, you have
my deepest
gratitude.
Together, with NCSE,
we are proving
science
makes you
strong.

[NCSE.ngo/donate](https://ncse.ngo/donate)