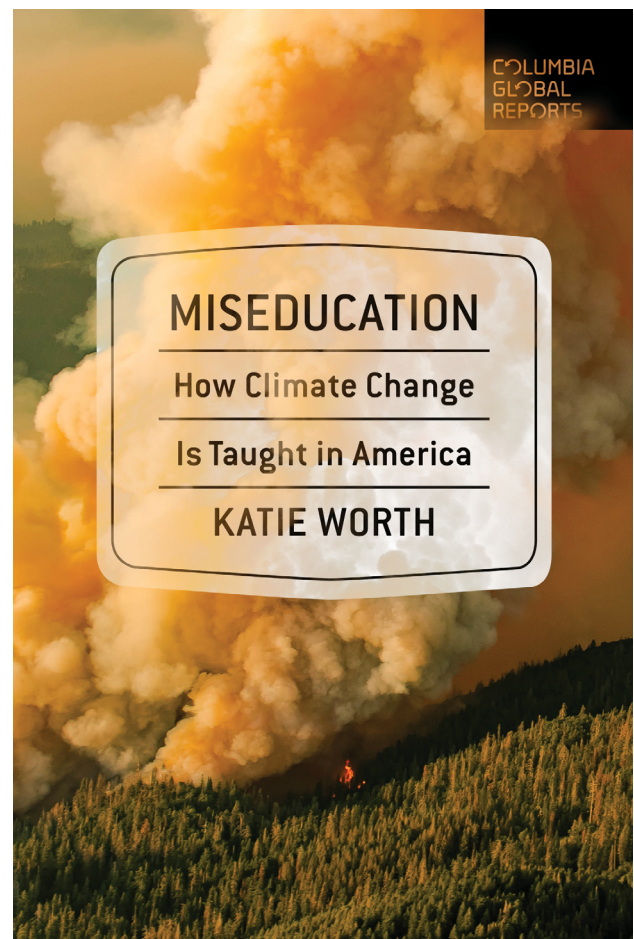


CLIMATE CHANGE MISEDUCATION **EXPOSED** IN MISEDUCATION

p. 3

That the **classroom is not an ideologically neutral space** when it comes to climate science is, in a way, strange, because climate science itself is ideologically neutral. The evidence for human caused climate change is now stronger than the evidence linking cigarettes and cancer. Yet... **students are often asked to debate a subject that scientists themselves do not.**

Adult politics soak into the spongy minds of schoolchildren in a number of ways. Many of the nation's most popular textbooks introduce them to alternate theories for which there is no evidence. Teachers, usually unwittingly, find their way to **online lesson plans created by moneyed interests.** Some states require a robust climate science education, while others carefully omit it from their academic standards. Every year, **lawmakers propose legislation aimed at swaying what children learn** about the subject. And of course, kids hear it outside school, too.



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ERRATA

In the Random Samples interview with Jeremy
Thorner (*RNCSE* 2021; 41:4, pp. 12–13),
“the genes and gene products that drive
the cell division cell” should have read “the
genes and gene products that drive the cell
division cycle.” The online version was cor-
rected. In the Members in the Spotlight fea-
ture in the same issue (p. 6), Clyde Peeling’s
Reptiland should have been described as in
Allenwood, not Allentown, Pennsylvania.

Dear NCSE Members,

Last Christmas, my family received a holiday card from a friend that featured a photo of the sender, leaping into the air, arms outstretched, and smiling (presumably) behind her mask. The photo is captioned “Good Riddance 2020!”

I still have the card on our refrigerator because it captured so perfectly how I was feeling toward the end of last year. I just couldn’t wait for 2020 to end and for life to return to normal. Traveling to see family, going to restaurants and movies, laying down the heavy burden of worry, uncertainty, sadness, and anger—I assumed that 2021 would bring all these good things.

Needless to say, it didn’t quite turn out like that. 2021 has continued to throw curveballs, the uncertainty continues, and returning to normal life has been a little bit herky-jerky. But despite all the challenges, NCSE has had a remarkable year.

As you’ll read in this issue of *RNCSE*, our curriculum field study is in full swing, with 30 teachers testing our new nature of science, evolution, and climate change lessons in their classrooms. True to the spirit of respect for science that permeates all of NCSE’s work, we are diligently gathering evidence about how well the lessons work, both in resolving students’ misconceptions and improving teacher confidence and skill in teaching sometimes fractious topics. You will find some preliminary results on page 10. In addition to cold, hard data, we are also hearing from our teacher partners, like Melissa Lau of Oklahoma on page 5, how much our programs mean to them. Sure, we know that the plural of anecdote isn’t data, but that doesn’t mean anecdotes can’t be extremely gratifying and informative!

Getting a good sense of what’s going on in the nation’s science classrooms is a big job, and NCSE can’t do it alone. So we are very happy to be helping spread the word about *Miseducation*, a new book by journalist Katie Worth examining in depth how climate change is being taught. Worth details how various corporate and conservative activist groups have tried to keep accurate climate change education out of classrooms, even providing inaccurate or misleading instructional resources. We are gratified that Worth gives considerable credit to NCSE for its work and cites our original research. I think you’ll enjoy reading our interview with Worth on p. 3 and our review of her book on p. 14.

As we look ahead into 2022, we are anticipating a flood of data from the curriculum field test, all of which will be used to fine-tune our lessons, and to begin organizing professional learning opportunities to introduce many more teachers to our resources. It’s going to be another busy year—even without taking into consideration the continuing efforts across the country to undermine the teaching of climate change and evolution, which NCSE of course will continue to monitor and counteract.

We’re grateful for journalists like Katie Worth, for all the teachers who partner with us (and, really, all the teachers who are valiantly continuing to teach science during these “worst of times”), and to you, our members, who make all our work possible. May 2022 bring you only good surprises and much joy.



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Climate Change Miseducation Exposed in *Miseducation*



Katie Worth, an investigative reporter formerly with *Frontline*, is the author of [*Miseducation: How Climate Change is Taught in America*](#) (Columbia Global Reports, 2021; reviewed on page 14).

Her book discusses NCSE's work on both climate change and evolution education, and we thought that we'd return the favor! The interview has been edited for length and clarity.

Paul Oh: You describe two powerful forces at work against accurate climate education. First, the "problem of Mr. Nokes" as you put it: inadvertent misinformation from a source, in this case a teacher, who is well-intentioned but misunderstands the science. And, second, deliberate disinformation disseminated by moneyed interests like the fossil fuel industry. What did you discover about the scope of the problem each represents?

Katie Worth: There's been a lot of reporting that has shown that the fossil fuel industry and its allies worked really hard to instill doubt in the American public's mind when it comes to climate change: whether climate change was happening at all, what was causing it, whether scientists were in agreement about it. A huge, huge amount of money—hundreds of millions of dollars a year for a while—went to organizations that spread climate denial. A lot of that happened in the 1990s, but it continues today. And then there are people like Mr. Nokes, who is a teacher in Arkansas. He is very skeptical that climate change is happening or that we know why it's happening. He thinks there's a good chance it's natural. I have a lot of respect for him as a teacher and as a thinker, but he has bought into this narrative that was spread by people who knew better but who had a motive to spread disinformation. These ideas then filter down into the minds of children

because the adults in their lives embrace them: kids' parents, teachers, administrators, coaches, clergy people—they are all spreading this message. So there's that kind of passive spread of disinformation. But there have also been several attempts by fossil fuel companies and by think tanks, to directly affect what kids learn in school through climate change miseducation campaigns.

PO: To your last point, you write about a visit by an oil and gas lobby representative to a seventh-grade science class in Arkansas where she downplays the problems with fossil fuels and sows doubts about renewable energy. What was it like to experience that?

KW: Every year she comes in and gives a presentation about gas and oil to the seventh-graders. Some of it's really legit. Like, "This is where geology predicts that oil and gas exist, and this is the technology we use to pull it out." But there were parts that were about the environmental impact of fossil fuels, and there she really, really downplayed climate change. She said briefly that the problem with fossil fuels is greenhouse gases. She didn't describe what those were. She then immediately said, "But you're going to find a problem with any kind of fuel. Windmills kill birds. Solar panels don't produce when it's cloudy. Dams do damage to rivers. So anything you choose is going to be problematic." Equating climate change with birds

killed by windmills. Not to minimize the deaths of birds by windmills, but it's a completely different scale of problem. And of course, as many as two thirds of American bird species could be extinguished by climate change this century. So it's a false equivalency. But these seventh-graders don't know that. The teacher was deferential, the students were deferential. The only question I heard them ask was how much they would make if they worked in the industry. That was a very vivid example of how fossil fuel

... the fossil fuel industry and its allies worked really hard to instill doubt in the American public's mind when it comes to climate change ...

messages get into classrooms. This woman's job is to go from classroom to classroom across the state of Arkansas pushing the messages of the industry. I definitely knew there were a lot of fossil fuel industry messages and curricula out there. But I had never witnessed a presentation to kids that was so blatantly climate-change-minimizing. I was not expecting it.

PO: I found it especially chilling that fossil fuel groups exploit the fact that districts, schools, and teachers are often scrambling for resources and so may be willing to accept questionable curricular materials.

KW: I talked to one teacher who was like, "I barely have time in the day to pee. So if somebody sends me or if I run across something that looks professionally done, some lesson plan or curricula that's already created for me and it looks good and it looks like the kids will be into it, maybe I use it." It's hard to blame the teachers. They're really doing the best they can. And of course they can fall victim to these campaigns that are preying on them.

PO: You talked to a number of teachers and you got them to open up about their experiences. (See Random Samples with Melissa Lau, p. 5, for an interview with one of these teachers.) You even were invited to witness their conversations with students about climate science. What was that like?

KW: It was really a privilege to hear the stories of what happens in these classrooms and how teachers navigate this pretty tricky situation. It's not tricky for every teacher. There are some teachers who are teaching in a community where climate change is broadly accepted and there's no drama whatsoever. But in a lot of this country, that's not true. They bring up the words "climate change" or "global warming" and the only time their students had ever heard them before was along with the words "it's a hoax." So how do you teach through that and teach the actual data and persuade students to think critically when they're hearing a very political and false message about climate change in other parts of their lives? I have so much respect for teachers. So many of them are so thoughtful about how they teach and prioritize their relationship with students. I don't think I came across any teacher who was super-dogmatic. And I think that's good because I don't think that's necessarily how you get through to someone who is being taught other things. Probably every science educator

in the country has an interesting story to tell about teaching climate change.

PO: The interaction between Marc Kessler and Nakowa towards the end of your book is so heartbreaking because Kessler—who's teaching in a former hardware store, since the 2018 Camp Fire forced his school to relocate—does everything right. And yet in the end his student, Nakowa, still questions whether climate change is even happening.

KW: Nakowa raised his hand and said, "My parents told me not to talk back to the teacher, but I don't know what to believe. My parents told me climate change is not true.

But then I come in here and I hear that NASA is saying it's true. And I just don't know who to believe." He was really having this soul-searching, confused moment. And Mr. Kessler handled it beautifully. He said, "I'm not trying to tell you what to think. I'm just trying to give you the best data I can and teach you how to think about it and let you draw your own conclusions." So Nakowa seemed to accept that in the moment.

But then later, Mr. Kessler gave a writing prompt to the students and Nakowa wrote, "I don't think climate change has affected my life at all yet"—even though his house had burned down five months earlier in the Camp Fire—and "I don't know if it will affect my life in the future because I don't know if I believe it yet." It was just stunning to see that even after he's already been deeply impacted by climate change.

PO: In the face of all that you encountered researching your book, what gives you hope about climate change education? And what do you hope the impact of your book will be?

KW: I hope that the book makes people demand better education for their children and our schools. I hope that it shines light on the messages that come from moneyed interests that appear in schools and in textbooks. In one sense, this issue is really niche—it's about climate education, which is just a very small sliver of both education and climate. But it's really essential. That's why moneyed interests have put so much effort into it because it really will influence what kids think about this issue for decades. And that will be the difference between a world where aggressive action is taken to slow the climate crisis and one where it's just a free-for-all and we see what happens.



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... how do you teach
the actual data and
persuade students
to think critically ...



NCSE Teacher Ambassador [Melissa Lau](#) has taught 6th-grade

science for over a decade and currently teaches high school chemistry in Piedmont, Oklahoma. In 2018, Lau was selected as a PolarTREC educator and spent 32 days on the North Slope of Alaska working with a team of researchers from Florida International University studying phenology and vegetation change in the warming Arctic. In 2019, she was named the Middle Level Teacher of the Year by the Oklahoma Science Teachers Association. Since she began as an NCSE teacher ambassador, she has been interviewed by numerous media outlets, including the Associated Press, *The Washington Post*, and local public media about her efforts to teach climate change. Recently, she and several of her students were interviewed by Katie Worth for her just-published book [Miseducation: How Climate Change is Taught in America](#). (See p. 14 for a review of Worth's book.) This interview has been edited for length and clarity.

Paul Oh: What has it been like to be interviewed for and then to see your name and your students' names in a published book?

Melissa Lau: It's exciting and humbling at the same time. Here is this permanent record of my efforts, my students' learning, our time spent wrestling with the topic of climate change. I know there are other teachers out there doing their best to counteract mis- and disinformation in the classroom, and this publication is a written record and recognition of all our efforts.

PO: Worth asked your students about global warming and its impacts, and their responses seem to downplay climate change, despite their having engaged with data in your class that demonstrates it's real. How do you make sense of that?

ML: I get why my students may not always make the personal connection to climate change. We live in an area where the effects aren't as dramatic as other places, or as evident. Most of my students' families have resources available to them to withstand any adversity (think insured homes against natural disasters, the ability to move to a better location in case of flooding, food security, etc.). The threat isn't immediate or pressing in their day-to-day lives. It's the same with adults. Climate change is someone else's problem and far away from their families. Of course, that's not really true. Supply issues, transportation, disease, economies, trade, conflict over resources: all are connected to our planet's changing climate. I think of it as a global version of the game Seven Degrees of Kevin Bacon—but in this game, we don't connect actors. We connect climate's influence on a sphere of human life.

PO: You teach in a part of the country—Oklahoma—in which there are many fossil-fuel-related interests. How do you navigate that reality while teaching about climate change, its causes, and what's needed to solve the climate crisis?

ML: It's a matter of how you frame the conversations, whether they occur in the classroom or beyond. Effective communication starts by

finding common ground, something that we can both agree on, and then making sure my tone isn't one of accusation or demonization, but one of opportunity and hope. You or your family members are not bad people because you depend on the fossil fuel industry to feed, clothe, and provide for your loved ones. I have family members that depend on this industry for their livelihood too. But where do we go from here? Let's continue the dialogue and look for solutions that are mutually beneficial.

PO: You've been an NCSE teacher ambassador now for several years. What has that experience been like?

ML: I have a voice that is amplified by the efforts of people like Katie Worth and her book *Miseducation*. I have been given the opportunity to connect with and support other educators across the country by collaborating with my fellow teacher ambassadors to create model lesson plans and engage in the rigorous vetting process that they undergo. The teacher ambassador program has empowered me to feel confident in my conversations with standards writers in my state and know that I have something to add to the standards revision process. In short, as an NCSE teacher ambassador, I have been able to act effectively on my passion and concern for climate change education and the threat of science misinformation in general to help to defend and promote science education.



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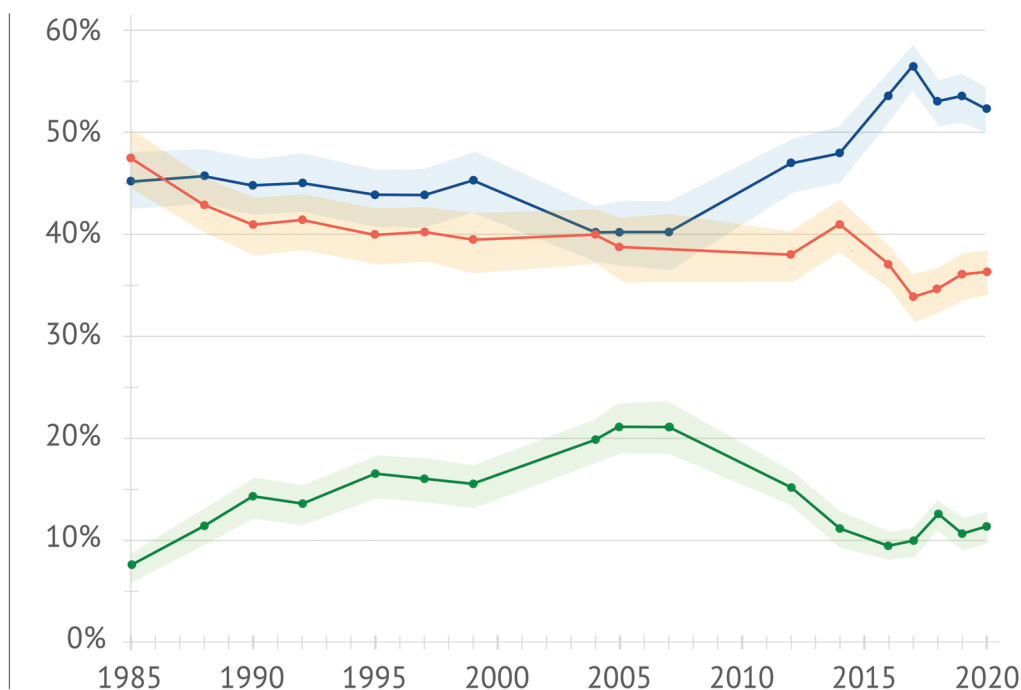
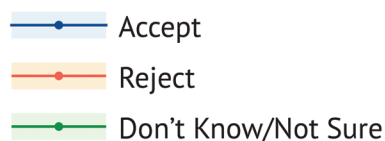
EVOLUTION ACCEPTED BY A MAJORITY OF

Public acceptance and rejection of evolution in the United States, 1985–2020

(after Miller et al., 2021)

Prompt:

“Human beings, as we know them today, developed from earlier species of animals.”



Note: Acceptance reflects “definitely true” and “probably true” responses; rejection reflects “probably false” and “definitely false” responses. Shading indicates the 99% confidence interval.



The level of public acceptance of evolution in the United States is now solidly above the half-way mark, according to a [new study](#) based on a series of national public opinion surveys conducted over the last thirty-five years. “From 1985 to 2010, there was a statistical dead heat between acceptance and rejection of evolution,” commented lead researcher Jon D. Miller of the Institute for Social Research at the University of Michigan. “But acceptance then surged, becoming the majority position in 2016.”

In these surveys, American adults in representative national samples were asked whether they accepted, rejected, or didn’t know (or weren’t sure) about the statement “Human

beings, as we know them today, developed from earlier species of animals.” From 1985 to 2007, the respondents were in effect evenly divided between acceptance and rejection of evolution: although acceptance enjoyed a slight lead for all of these years except 1985, its lead was not statistically significant except in 1999.

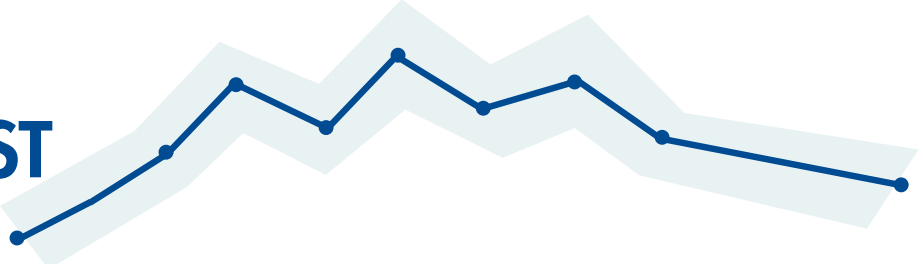
From 2012 to 2020, however, acceptance of evolution was consistently, and statistically significantly, in the lead—and over the last five years, in the majority. In 2020, the most recent year available, 52% of respondents accepted evolution while only 36% rejected it. The scientific community’s level of acceptance of evolution is upward of 98%, according to a 2015 survey by the Pew Research

Center, so there remains a substantial discrepancy—but the progress is nevertheless encouraging.

What factors are responsible for the increase in the acceptance of evolution? In their study, Miller and his collaborators identified aspects of education—taking college courses in science, having a college degree, and possessing civic science literacy—as the strongest factors promoting the acceptance of evolution. Improvements with regard to these factors—the proportion of Americans with a college degree almost doubled between 1988 and 2018, for example—thus result in improvements in the acceptance of evolution.

A particularly important route for such improvement is through the prepara-

AMERICANS AT LAST



tion of public school teachers. A pair of recent studies by researchers at the National Center for Science Education and Pennsylvania State University found, in analyzing data from a nationally representative survey conducted in 2019, that high school biology teachers and middle school science teachers were both more likely to teach evolution as a matter of scientific consensus if they had studied evolution themselves at the college level.

The strongest factor obstructing the acceptance of evolution, according to Miller and his collaborators, is religious fundamentalism, unsurprisingly. For the purposes of the study, religious fundamentalism was measured in terms of belief in a personal God who hears prayers, acceptance of a literal reading of the Bible, self-reported frequency of attendance of religious services during a typical week, self-reported frequency of prayer during a typical week, and agreement with

“We depend too much on science and not enough on faith.”

In 2019, only 32% of those who scored highest on the scale of religious fundamentalism accepted evolution, as opposed to 54% of the whole sample and 91% of those who scored lowest on the scale. But even those who score highest on the scale of religious fundamentalism are showing a shift toward acceptance of evolution: in 1988, a mere 8% of religious fundamentalists accepted evolution. While their numbers declined slightly in the last decade, approximately 30% of Americans are religious fundamentalists as defined in the study.

Antievolutionism remains a political force. The Republican party often panders to religious fundamentalism, and attitudes toward evolution are politicized as a result. Miller and his collaborators found that 34% of conservative Republicans accepted evolution in 2019, as compared to 83% of liberal Democrats. There is evidence that the politicization is increasing: in 2009, 54% of Republicans and 64% of Democrats accepted human evolution, but by 2013, the ten-point gap widened to a twenty-four-point gap, according to the Pew Research Center.

Miller and his collaborators concluded their study by expressing a degree of optimism for the future. Between “[t]he continued growth of educational attainment among American adults in the twenty-first century” and “changes in the religious profile of Americans” such as the increase of non-religious people and the decrease of inerrantism and

related attitudes among religious people, they suggest, “we might expect a moderate rate of growth in the public acceptance of evolution in the United States in the decades ahead.”

“we might expect a moderate rate of growth in the public acceptance of evolution in the United States in the decades ahead.”

The study, “Public Acceptance of Evolution in the United States, 1985–2010,” was published in the journal *Public Understanding of Science*, a peer-reviewed journal covering all aspects of the interrelationships between science and the public. Besides Miller, the authors are Glenn Branch and Eugenie C. Scott of the National Center for Science Education, Belén Laspra of the University of Oviedo in Spain, Carmelo Polino of the University of Oviedo and Centro REDES in Argentina, and Mark S. Ackerman and Jordan S. Huffaker of the University of Michigan.

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Artwork by Roy Trull © 2017 www.roytrull.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.ngo.

ARIZONA

Arizona's Senate Bill 1532, as amended and passed by the House of Representatives in May 2021, would have required public school teachers who choose "to discuss controversial issues of public policy or social affairs" to "present these issues from diverse and contending perspectives without giving deference to any one perspective." Asked whether climate change denial would have to be presented under the bill, the amendment's author replied only by paraphrasing the provision. The bill died when the legislature adjourned in June 2021.

FLORIDA

A lawsuit filed by the flamboyant young-earth creationist Kent Hovind asking for more than half a billion dollars from the federal government was summarily dismissed by a federal district court in June 2021; the suit was described as "frivolous and delusional." The dismissal was then upheld on appeal in September 2021. Hovind was convicted of a variety of tax-related offenses in 2006 and spent eight years in federal prison; he is now attempting to challenge his conviction while operating a creationist theme park, Dinosaur Adventure Land, in Lenox, Alabama.

MAINE

House Paper 395 would have required teachers to "provide students with materials supporting both sides of a controversial issue being addressed and to present both sides in a fair-minded, nonpartisan manner," where "a controversial issue" is defined as "a point made in an electoral party platform." As *Ars Technica* observed in discussing a spate of similar measures in 2019, "a large number of state party platforms specifically mention evolution and climate change." The legislature rejected the bill in June 2021.

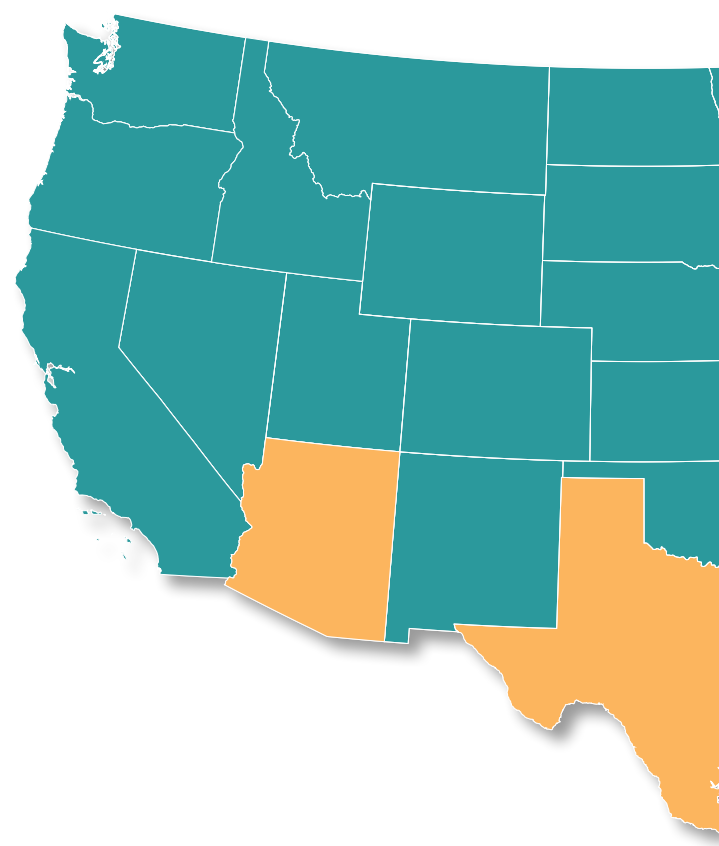
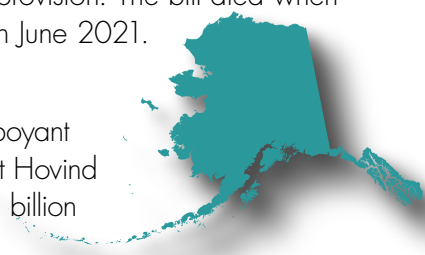
MASSACHUSETTS

A pair of identical climate change education bills introduced in March 2021, House Bill 614 and Senate Bill 311, would, if enacted, "implement an elementary and secondary interdisciplinary climate education curriculum" in Massachusetts. The bills would initiate processes to revise

state standards for science and technology and history and social studies and also require the state department of elementary and secondary education to provide "professional development opportunities for educators on the history and social science and science and technology frameworks."

SOUTH CAROLINA

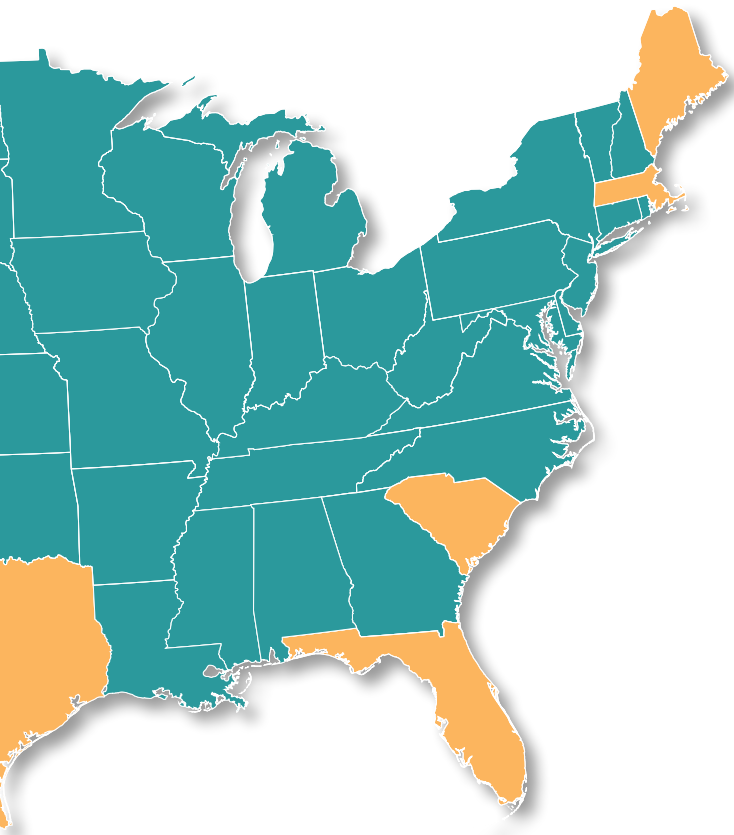
A new set of state science standards for South Carolina's public schools was approved by the South Carolina state board of education on May 11, 2021, and by the independent non-partisan Education Oversight Committee on June 14, 2021. The previous standards were adopted in 2014 only after a high school standard addressing evolution was removed at the behest of the Education Oversight Committee, as NCSE previously reported. And the 2014 standards received the grade of F in "Making the Grade?"—the NCSE/Texas Freedom Network Education Fund report on the treatment of climate change in state science standards across the country—for their "incomplete and piecemeal approach" to climate change.



In contrast, the treatment of evolution and climate change in the new standards is comparable to that of the Next Generation Science Standards. The state department of education described the adoption as “a huge success for students of South Carolina.”

TEXAS

“The State Board of Education today voted to approve new curriculum standards for selected high school courses, marking a limited but important step forward in teaching Texas students about climate change,” the Texas Freedom Network reported in a June 25, 2021, press release, adding, “Two of those courses [Earth Systems Science and Environmental Systems, both electives] will include coverage of climate change that is substantially more robust than all of the standards adopted by the board in 2009.” Those previous standards were among the worst in the country for their treatment of climate change, according to a study conducted by NCSE and the Texas Freedom Network Education Fund. In 2020, the treatment of climate change in Texas’s standards for required high school science classes was improved slightly, as NCSE previously reported.



CANADA, ONTARIO

Canada Christian College was denied university status by Ontario’s Postsecondary Education Quality Board in May 2021, after the legislature sought to bestow it by legislation, apparently at the behest of Ontario’s Premier Doug Ford. Presently authorized only to grant degrees in fields such as theology, religious education, and Christian counseling, the college hoped to offer bachelor of arts and science degrees. The controversial views, including creationism, of the college’s president Charles McVety were widely cited in the press.

GHANA

Johnson Anane, a lecturer at Sunyani Technical University, reportedly filed a lawsuit with the Ghana Supreme Court asking for a ban on the teaching of not only evolution but also astronomy in the nation’s educational system. “The implications of the theories are that the creative work of God as stated in Genesis has been cancelled, denied[,] or nullified.” The Attorney General’s Office of Ghana, among the defendants, reportedly filed a response asking for the lawsuit to be dismissed.

NEW ZEALAND

“A teaching resource on climate change produced by meat and dairy interests is being criticised as targeting schools with a one-sided view on farm emissions,” Stuff reported in June 2021. The booklet purports to explore “the complex relationship between environmental, economic, nutritional, social and global food security outcomes in New Zealand’s food system,” but was criticized as being misleading about the industry’s greenhouse gas emissions. The Ministry of Education declined to take a stand on the use of the booklet.

UNITED KINGDOM, NORTHERN IRELAND

Edwin Poots was elected leader of the Democratic Unionist Party in May 2021, amid a plethora of reminders that he is a vocal young-earth creationist, consistently with the views of the Free Presbyterian Church of Ulster. The party has a slim plurality in Stormont (i.e., the Northern Ireland Assembly) and is the fifth largest party in the House of Commons in the United Kingdom. In June 2021, Poots was forced out of his position for reasons unrelated to his creationism.

NCSE’s curriculum study, launched in July 2021 to test the efficacy of new and revised curricula for nature of science, climate change, and evolution, is well under way. The two-year study includes both evaluation and research components. The evaluation component will help us answer questions about the effectiveness of the lessons such as: What changes in student knowledge and attitude do the lessons support? How easy is it for teachers to implement the lessons in their classrooms? To what degree do the curricula adequately address science education standards? The research component will examine how teachers’ participation in a professional community—which is an integral part of the curriculum study—influences their classroom practices and other factors that support teacher implementation of new curriculum.

During the fall 2021 semester, teacher participants implemented the nature of science lessons and provided NCSE staff with feedback. In order to evaluate student understanding and attitudes toward the big ideas in the curriculum, teacher participants used surveys administered to students prior to starting and then again following the conclusion of the lessons. The [Student Understanding of Science and Scientific Inquiry](#) (SUSSI) (PDF) survey, developed by Ling L. Liang and her colleagues, focuses on six essential principles emphasized in K–12 science education standards on the nature of science. As adapted for our use, these are:

- 1. Observations and Inferences:** Science is based on both observa-

Evaluating NCSE’s Curriculum Study Field Test

tion and inferences guided by the current perspectives of scientists.

- 2. Tentativeness of Science:** Scientific knowledge is both tenable and durable. We should have confidence in scientific knowledge while realizing that such knowledge may change with new evidence or reconceptualizing previous evidence.
- 3. Scientific Theories and Laws:** Scientific theories and laws explain and describe scientific phenomena. They are subject to change in the light of new or reorganized evidence.
- 4. Social and Cultural Influences on Science:** People from all cultures contribute to science. As a human endeavor, science is influenced by and reflects the values of the society and culture in which the science is conducted, interpreted, and accepted.

- 5. Imagination and Creativity in Scientific Investigations:** Science is based on observations and inferences of the natural world that originate from human imagination and logical reasoning.
- 6. Process of Scientific Investigation:** There is no single universal step-by-step scientific method that all scientists follow. Scientific knowledge is constructed in a variety of ways including observation and experimentation.

To assess their understanding of the nature of science, students are presented with 24 statements that represent a mix of informed views and naive interpretations of the nature of science as found in scientific literature. They rank each statement on a five-point Likert scale ranging from strongly agree to strongly disagree. Responses are then analyzed for each of the concepts. Results are classified as naive, transitional, or informed views.

The curriculum field testers have shared a summary of student results prior to using the nature of science lessons. Initial pre-survey results show consistency across schools involved in the NCSE curriculum study and with science education research on the public understanding of the nature of science. The results are, on average, as follows:

Observations and Inferences:

Informed

Tentativeness of Science:

Informed

Scientific Theories and Laws: **Naive**

Social and Cultural Influences on Science: **Transitional**

Imagination and Creativity in Science: **Naive**

Process of Scientific Investigation: **Transitional**

more careful with the language she uses when describing the process of science and scientific investigation. Jennifer Broo, Advanced Placement biology teacher, convinced her entire science department at Mariemont High School in Cincinnati, Ohio, to survey their students. They intend to use the schoolwide results to fuel data-driven conversations about student progress through their science courses so that all students have an informed understanding of science upon graduation. At the McAllie School in Chattanooga, Tennessee, biology teacher Michael Lowry is conducting his own curriculum evaluation. He administered SUSI to all his

students and will be teaching the nature of science lessons to half his classes; he'll teach the other half with materials he used previously.

NCSE's [nature of science curriculum](#), developed by our teacher ambassadors along with NCSE staff, includes classroom activities to help students develop informed views of science while addressing misconceptions that lead to or reinforce naive views. For example, both Lesson Set 2: Science is a Never-ending Process and Lesson Set 4: Science is about the Evidence include activities in which students examine how our understanding of germs and evolution have changed over time as the result of the development of new technologies, which in turn altered theories about these phenomena. Lesson Set 3: Science is an Inquiry Process provides students with an understanding of the ways in which innovation drives our understanding of how cells function, which then leads to new questions sparking new innovations to aid investigation.

We will continue to gather, analyze, and evaluate the data resulting from the implementation of our lessons. And we will continue to conduct research as a means to add to the body of knowledge about science education. Stay tuned for more news from the evaluation and research front over the course of the next year and a half.

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The curriculum field testers have shared the different ways in which they are already using the SUSI results to influence their teaching. Ericca Thornhill, environmental science teacher at Southern Boone High School in Ashland, Missouri, is using the survey results to address areas of lower proficiency for her students and to be




INFORMED

- Observations and Inferences
- Tentativeness of Science

TRANSITIONAL

- Process of Scientific Investigation
- Social and Cultural Influences on Science



NAIVE

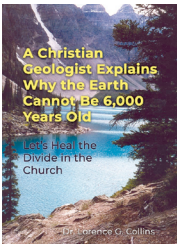
- Imagination and Creativity in Science
- Scientific Theories and Laws



Members in the SPOTLIGHT



Lorence G. Collins's *A Christian Geologist Explains Why the Earth Cannot Be 6,000 Years Old: Let's Heal the Divide in the Church* (Dorrance, 2021)



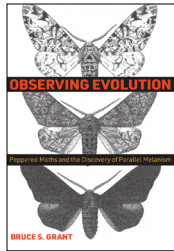
was published. According to the publisher, "The general themes of the book are: to

expose the false beliefs of young-Earth creationists regarding the age of the Earth being 6,000 years old and that Noah's Flood must have been worldwide (global) in extent; and to suggest that the Bible is not a science text." Collins adds, "The book provides a clear and useful explanation of evolution, differentiating the record, process, and theory of evolution. Perhaps most importantly, the book explains the process of science and argues that scientific knowledge does not—and cannot—conflict with religion, except when religion takes on its most fundamentalist form." A long-time member of NCSE, Collins is Professor

Emeritus of Geological Sciences at California State University, Northridge.



Bruce S. Grant's *Observing Evolution: Peppered Moths and the Discovery of Parallel Melanism* (Johns Hopkins University Press, 2021) was published.



The publisher writes:

The extraordinary tale of the humble peppered

moth is at the very foundation of our acceptance of Darwinian evolution. When scientists in the early twentieth century discovered that a British population of the small, speckled *Biston betularia* had become black over the course of mere decades in response to the Industrial Revolution's encroaching soot, the revelation cemented Darwin's theory of natural selection. This finding was the staple example of "evolution in action" until the turn of the millennium, when proponents of Creationism fomented doubts about the legitimacy of early

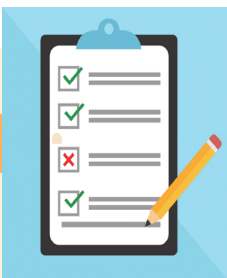
experiments. In the midst of this upheaval, evolutionary biologist Bruce S. Grant and his contemporaries were determinedly building a dataset that would ultimately vindicate the theory of industrial melanism in the peppered moth and, by extension, the theory of natural selection itself. *Observing Evolution* tells the remarkable story of this work.

Grant is Emeritus Professor of Biology at the College of William and Mary. An interview with him about his book will appear in a future issue of *RNCSE*.



Steve Rissing, Professor Emeritus in the Department of Evolution, Ecology, and Organismal Biology at Ohio State University

and a recipient of NCSE's Friend of Darwin award, devoted a column in the *Columbus Dispatch* to emphasizing the importance of understanding evolution in coping with the COVID-19 pandemic. "Knowledge is power," he concluded, "and in our democracy, we need voters to have the power of knowing and understanding evolution." His column appeared on January 17, 2021.



WHAT WE'RE UP AGAINST

Creationists Playing Fast and Loose with Poll Data

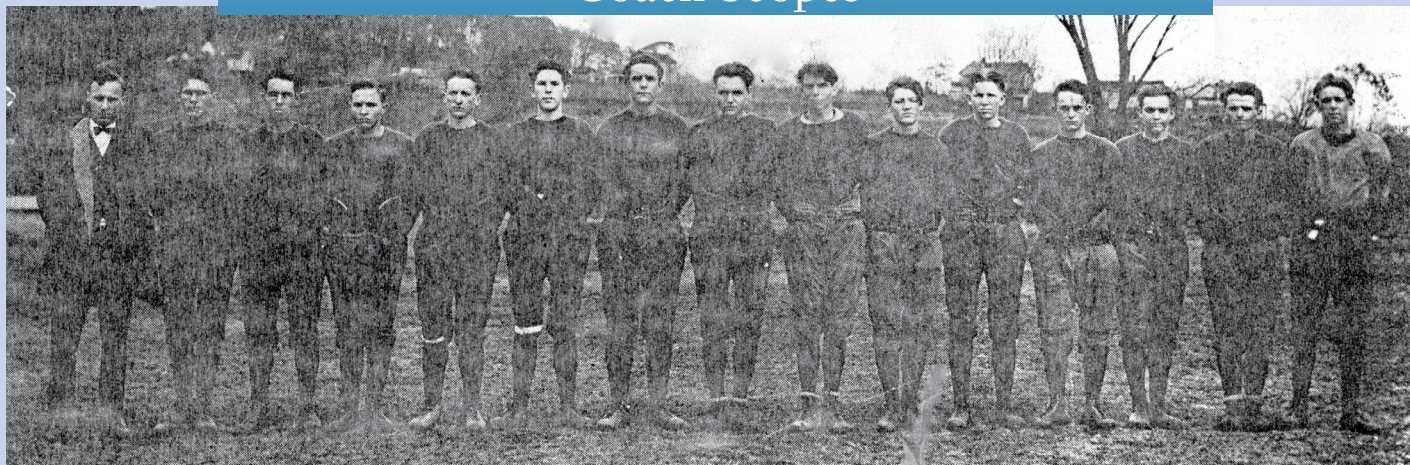
A creationist's letter to the editor of *The Bryan (Ohio) Times* in September 2021 claimed, "According to Gallup polls, 87% of Americans believe in God. In contrast, ... a survey of American Association for the Advancement of Science (AAAS) members indicated that close to 99% are functional atheists, mean-

ing that they live their lives as if there is no God." There was no question about "functional atheism" in the AAAS survey, conducted by the Pew Research Center in 2014. Rather, the survey found that 98 percent of AAAS members (and even more among those who were working scientists) agreed with "Humans and other living things have evolved over time." But if doing so is "functional

atheism," then Gallup's polls should be interpreted in the same way. In Gallup's latest poll on evolution, from 2019, 55 percent of respondents agreed with "Human beings have developed over millions of years from less advanced forms of life" (and 5 percent expressed no opinion), leaving only 40, not 87, percent who might qualify, by the creationist's lights, as believing in God.

PLACE & TIME

Coach Scopes



In the fall of 1924, newly hired John Scopes (far left) coached the Rhea Central High School Yellow Jackets to a 4–4–2 record.

Although John Scopes helped to put Dayton, Tennessee, on the map by allegedly teaching human evolution at Dayton's Rhea Central High School, he also was the school's football coach. Scopes was a popular teacher, but he knew that "coaching was the most important part of my job," as he wrote in his 1967 memoir. The many retellings of Scopes's famous trial have detailed the trial's events, but none include his coaching record. What kind of coach was "Coach Scopes"?

First, some background. In the fall of 1923, the Rhea High Yellow Jackets were coached by newly hired Raleigh Reece, a recent graduate from and gridiron star at Carson and Newman College (now Carson-Newman University). Reece's team posted a 5–6 record, according to the *Chattanooga Times* ("Rhea's green team makes big strides," December 9, 1923, p. 19). In May 1924, when Reece resigned his job to become a reporter for the *Nashville Tennessean*, he was replaced by the most famous hire in the history of Rhea County: John Scopes.

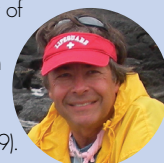
Hired to teach science and mathematics, Scopes had never played organized football. Yet in the fall of 1924, the chain-smoking Scopes—Dayton's first coach to let football players smoke during the season—coached the Yellow Jackets (photo above) to a 4–4–2 record, according to the *Chattanooga Times* ("Rhea High's raw material developed into a winner," November 30, 1924, 17.) Despite these mediocre results, a reporter—who acknowledged that "football [in Dayton] is more important than bootlegging"—proclaimed Scopes "the best football coach that Dayton ever had" ("Football, evolution, and bootlegging in east Tennessee," *Sioux City (Iowa) Journal*, June 8, 1925, 4).

When Scopes left Dayton after his infamous trial, he was replaced by Raleigh Reece, his predecessor. The day before he was hired, and presumably to help him secure the job, Reece announced that he was a fundamentalist, prompting one student at Rhea Central to lament, "Shucks, our football team is busted ... What does a

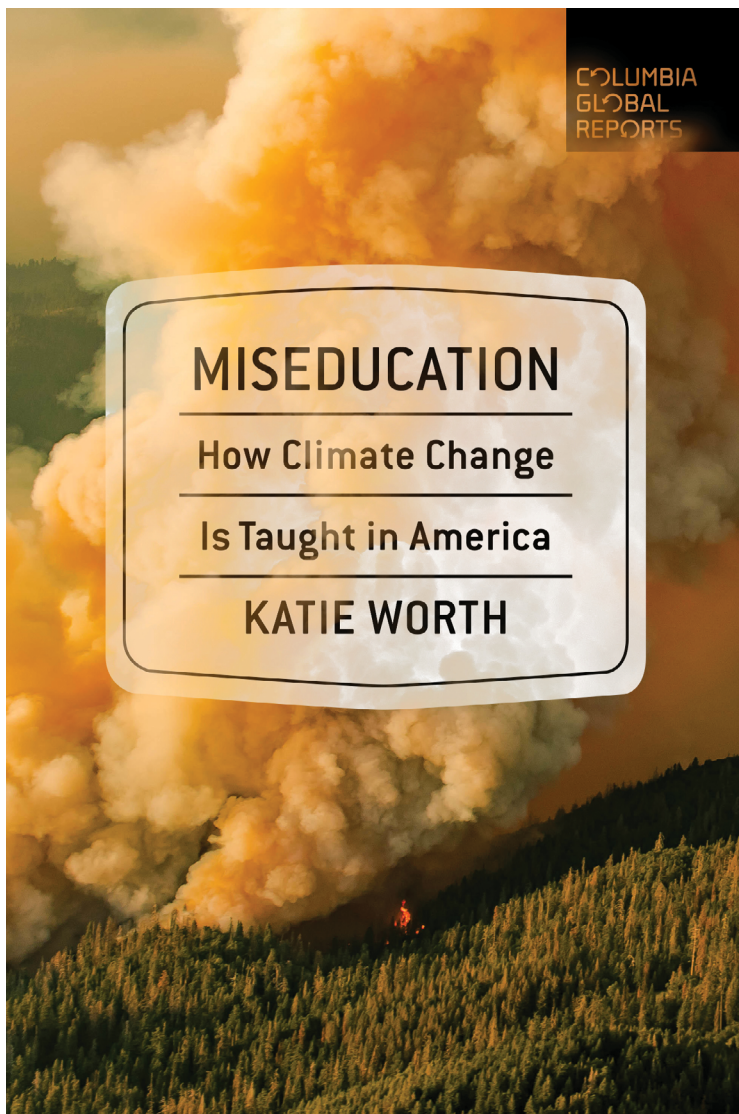
fundamentalist know about football?" (as reported in "Darwin in Scopes' place for a while," *Chattanooga News*, August 18, 1925, 1—the Darwin of the title was Darius Darwin, who briefly substituted in the classroom for Reece). Reece's team again posted a losing record (4–7). Although the team's official name remained the Yellow Jackets, after the trial several newspapers informally renamed the team The Fundamentalists (e.g., "Rhea High Fundamentalists have successful campaign," *Chattanooga Times*, November 29, 1925, p. 25).

In early February 1926, Reece abruptly resigned his job, allegedly because of an "entertainment incident" that upset the school board. Scopes never again coached a sports team, not even those that included his two sons.

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



THE RNCSE REVIEW



Miseducation: How Climate Change is Taught in America

author: **Katie Worth**

publisher: **Columbia Global Reports**

reviewed by: **Don Haas**

Fund—for the treatment of climate change in their state science standards, along with which political party controls each states' state legislature. Blue states are more likely to address climate change accurately in their state standards than red states.

But geographic differences can also be hyperlocal, with students learning about climate change with fidelity to the science in their science classes and then walking down the hall to hear the science refuted in their social studies classes. Unfortunately, it is not especially rare for science teachers to portray the science as unsettled or worse. This is unsurprising, since American teachers hold a range of beliefs on climate change, like Americans generally.

Miseducation's stories of the marriage of those who oppose the teaching of evolution to those who opposed the teaching of climate change and of how Texas became a dominant force in the shaping of textbooks are detailed and well-told, but the section of the book I found most gripping involved the National Science Teaching Association and those who tried, with some success, to have NSTA downplay and misdirect teachers and students on the science of climate change. Much attention is given to a 1998 meeting at the American

In *Miseducation*, Katie Worth tells an infuriating, well-researched, and engaging story about how climate change is taught—and how the teaching of climate change is and has been hampered—in American public schools. It's an excellent primer about those who have worked to prevent good climate science from being taught in our schools, and how they went about their dastardly work. The author is a former investigative journalist for PBS's *Frontline*, and the book is

in the same vein of careful and hard-hitting journalism. While there is more to the story than the work of bad actors, understanding their roles is essential to the vital work of improving climate change education.

Attention is given to the geography of climate change education. The opening image of the book is a US map showing the grades each state received in "Making the Grade?"—the 2020 report from NCSE and the Texas Freedom Network Education

Petroleum Institute’s Washington DC headquarters and a subsequent eight-page memo suggesting, among other things, the formation of a “Science Education Task Group” that would specifically target NSTA. It’s unclear whether that group actually formed, but with collaborations between NSTA and the likes of ExxonMobil, Shell, and ConocoPhillips on some curriculum materials development and millions of dollars in sponsorship, the goals of the effort seemed to be achieved—for a time.

I have a personal connection. While doing National Science Foundation-funded outreach and education about hydraulic fracturing (fracking), my colleagues and I submitted NSTA workshop proposals on fracking that were rejected in 2013, 2014, and 2015. One of the highest-profile environmental issues in those years, fracking did not appear in any substantial way in the conference programs. At the same time, energy companies were among NSTA’s most prominent corporate sponsors. We could not help but wonder whether there was a connection, though I suspect the rejections were due more to reviewers’ worries than to any formal policy.

Eventually NSTA came around. In 2016, a workshop proposal on fracking was accepted, and in 2018, a panel, led by Eric Pyle, now NSTA’s president, and including me, crafted NSTA’s 2018 statement on the teaching of climate science. Though 2018 was disturbingly late for the issuing of such a position statement, NSTA’s support for high-quality climate change education materials and professional development is now solid, abundantly clear, and remarkably extensive. Erika

Miseducation reveals some of the key difficulties we face as we work to build understandings of the climate and climate change for students and their teachers.

Shugart, NSTA’s relatively new executive director, told Worth, “NSTA supports quality science education and we fully embrace the teaching of climate science and climate change. ... [I]f the science in our resources is not accurate, then we correct it” (page 137).

While I do highly recommend the book, there are at least two important parts of the story missing—the mismatch between state science standards and state-level assessments, and the neglect of Earth sciences in American secondary education. These reflect profound challenges of making substantial changes to school curriculum and school structure.

First, standards and assessments often differ in focus. For example, New York received an A- in “Making the Grade?” for its state science standards, officially adopted in 2017. These standards hew closely to the Next Generation Science Standards and earned their high mark because of that. But, as I write this review in November 2021, New York students are still preparing to be tested on the content of the 1999 Earth Science

Core Curriculum Guide, which is based on the last set of standards adopted by the state in 1996. The first assessments based on the 2017 standards will not be administered until June 2025.

Second, high school Earth science courses, the most obvious place for climate change content, aren’t expected for the majority of American high school students. (New York is a rare exception.) The NGSS place earth and space science at the same level as life science and physical science at the high school level. But so did the 1996 National Science Education Standards, which did little to bring quality Earth science education to America’s high schools. Biology, chemistry, and physics have dominated the high school science curriculum for more than a century in this country, and it is not clear that this is about to change.

These problems are compounded by the mismatch between climate change’s highly interdisciplinary nature and the highly disciplinary nature of schooling, especially from grades 6 to 16. As a result, it’s easy to ignore climate change within the formal education system without much consequence. The consequences of ignoring climate change, of course, are becoming increasingly difficult to ignore. *Miseducation* reveals some of the key difficulties we face as we work to build understandings of the climate and climate change for students and their teachers. If you care about the state of climate education, read this book.

Don Haas is Director of Teacher Programming at the Paleontological Research Institution, which received NCSE’s Friend of the Planet award in 2019. haas@priweb.org.



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Kids need climate education now because...

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Michael Mann, Climate scientist and NCSE board member



... they already know climate change is a problem; we need to also make sure they know that there are solutions we all can be a part of.



Benjamin Santer, Climate scientist and NCSE board member

... they have to know how and why Earth's climate is changing, what those changes mean for their own future, and what they can do to prevent bad outcomes for our climate system.

Jacquelyn Gill, Climate scientist and paleoecologist



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