WHAT YOUR COLLEAGUES ARE SAYING . . .

This is a book for educators by educators. I wish I had had this book during my early years as a science teacher. It provides a wealth of information about the current state of climate education as well as practical advice and resources for educators.

—Blake Touchet
Science Education Specialist, National Center for Science Education
Abbeville, LA

What Teachers Want to Know About Teaching Climate Change *delivers on the promise of its title. Bertha Vazquez, Kimi Waite, and Lauren Madden offer research-based and classroom-tested guidance to equip K–12 educators to teach climate change not only accurately but also effectively. A tremendous contribution!*

—Glenn Branch
Deputy Director, National Center for Science Education
Oakland, CA

The authors deftly explore the facts, feelings, and future needed by every educator to teach climate change accurately and equitably. The book is structured for ease of access where each chapter includes Q-and-A format reinforcement, teaching tips, success stories from schools around the country, reflection questions, and resources. I have already begun to apply things I've learned from this book!

—Anne Farley Schoeffler
President, National Middle Level Science Teachers Association
Cleveland, OH

This critically important book helps teachers consider how climate change relates to the topics they are already teaching today so that students can consider how they can lead the way to a better tomorrow.

—Stephen Hupp
Editor of *Skeptical Inquirer: The Magazine for Science and Reason*
Edwardsville, IL

This book is a powerful resource for STEM educators to implement intentional lessons in climate education for students of any age. It narrates the tools, tips, and how-to in a myriad of contexts so that there's something for everyone.

—Sephali Thakkar
K–12 Education Ambassador, T-Mobile for Education
Allen, TX

A "get ready, get set, go" guide for teaching climate change in your classroom. Thoughtful information on climate change, science literacy, and supporting hope regarding this complex topic.

—Alison Betz Seymour
Biology Teacher, Winchester College
2022–2023 President, National Middle Level
Science Teachers Association
Scottsdale, AZ

Grades K–12

What Teachers Want
to Know About

TEACHING CLIMATE CHANGE

To every student who ever walked
through our classroom doors.

Grades K–12

What Teachers Want to Know About

TEACHING CLIMATE CHANGE

An Educator's Guide to
Nurturing Hope and Resilience

Bertha VAZQUEZ

Kimi WAITE

Lauren MADDEN

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CONTENTS

PART IV

HOW DO I INTEGRATE CLIMATE CHANGE EDUCATION INTO MY SCHOOL AND MY CURRICULUM?

For downloadable resources related to
What Teachers Want to Know About Teaching Climate Change,
please visit the companion website.
companion.corwin.com/courses/TeachingClimateChange

EDITOR'S NOTE

The summer of 2024 was the hottest on record. We saw extreme storms, flooding, fires around the world, and damage into the tens of billions of dollars, much of which was attributed to human-induced climate change. Climate change is one of the greatest threats humanity has collectively faced. Time is running out on our ability to attenuate its threats to human life on this planet. We believe understanding climate science and its potential solutions is essential learning for our students. But when researching the state of climate change education, we were puzzled by recent research that indicated a disconnect between teacher beliefs in the need to teach climate change and their classroom behavior.

A recent report by the North American Association for Environmental Education Research indicates that 74% of U.S. teachers and 80% of administrators agree that climate change will have an overwhelming impact on students' futures.[1] In addition, the survey found that more than half of middle school and high school teachers reported that their students have expressed a deepening anxiety over the climate crisis, including worrying about the future and how climate change will affect their lives. Almost half of the elementary teachers surveyed say students raise the issue in class. Likewise, parents overwhelmingly agree that students should be taught climate change in school: More than 80% of parents in the United States support the teaching of climate change—and that support crosses political divides for the majority of people, according to the results of an NPR/Ipsos poll: Whether they have children or not, 66% of Republicans and 90% Democrats agreed in this survey that the subject needs to be taught in school.[2]

However, the same NPR poll indicates that most teachers aren't actually teaching climate change in their classrooms. According to the survey of more than 1,000 teachers, only 42% of teachers say they even mention climate change in the classroom.

To get a better understanding of what's happening in the classroom and to find ways to support teachers in their efforts to teach climate change, we at Corwin did our own market survey to find out what teachers really want

[1]Braus, J., & Morales Garcia, M. (2023). *Students have climate anxiety. Here's what educators need to be able to help them.* EducationWeek. https://www.edweek.org/teaching-learning/opinion-students-have-climate-anxiety-heres-what-educators-need-to-be-able-to-help-them/2023/04

[2]Kamenetz, A. (2019). *Most teachers don't teach climate change; 4 in 5 parents wish they did.* NPR. https://www.npr.org/2019/04/22/714262267/most-teachers-dont-teach-climate-change-4-in-5-parents-wish-they-did

to know about teaching climate change and to try to understand how we can best help teachers approach this difficult topic. We sent a survey questionnaire to more than 135,000 teachers and school leaders and received responses from around the country and Canada outlining the issues classroom teachers face. The three concerns most consistently expressed by the respondents were as follows:

- 65% of respondents said the content was "not related" to the subject they teach. (Another way this was expressed was that teachers felt climate change would be an additional topic that they didn't have time for in their already busy school day.)
- 20% of respondents said children were too young/too vulnerable to be exposed to such an upsetting topic. Teachers reported being anxious about managing the students' social and emotional well-being during such lessons.
- 17% expressed a lack of confidence in their own understanding of the science behind climate change.[3]

We decided to build this book around these concerns, as well as others expressed in our survey. To give teachers the tools and the confidence they need to teach climate change, our book addresses these issues in turn, demonstrating how climate change can be taught across disciplines and how it can be aligned to the existing standards across the curriculum, so that it is not an additional course on top of an already extended course load.

To ensure we truly captured what teachers want to know about teaching climate change, we also asked our survey respondents

1. Do you have any tips for reducing our collective carbon footprint?
2. Can you share any success stories you've had with your students around teaching climate change?

We present these tips and success stories as a source of inspiration, so that you can learn from what other classroom teachers have found most useful.

* * *

We hope this truly addresses the questions teachers have about teaching climate change, and we invite you to learn more by checking out additional resources listed in the appendix and online at https://companion.corwin.com/courses/TeachingClimateChange.

[3]Ibid.

PREFACE

Why Students Need You to Teach Climate Change Now More Than Ever

Climate change is a complex, rapidly evolving field, and many educators today find themselves stepping into the classroom to teach a subject they never formally learned in school.

If you're passionate about preparing your students for the future but feel anxious about navigating the ever-growing mountain of data and the emotional complexities of the issue, this book is here to help.

Climate change is not just a scientific concept; it's a reality that touches every aspect of our lives, from extreme weather events to food security and social justice to the emotional well-being of our students. Our students, the generation that will inherit the consequences of our actions, deserve to be informed, engaged, and empowered to take action. As educators, we have a responsibility to equip them with the knowledge and skills to understand and address this global challenge.

ABOUT THE BOOK

We wrote this book as a team, with each coming to the party with our own expertise, unique viewpoints, cultural history, and regional allegiances. Bertha, who taught middle school science in Miami-Dade County for 34 years, wrote Parts I and II and curated the appendix and online content. Bertha is the education director at The Center for Inquiry, an international nonprofit organization that promotes reason and science. Her multifaceted approach to teaching climate science has been featured in the *New York Times*, NPR, *Earth* magazine, and in a book and film series by Lynne Cherry titled *Empowering Young Voices for the Planet*. Her efforts led to her being awarded the 2008 National Environmental Education Charles C. Bartlett Award, among other awards. Kimi wrote Part III. She is an assistant professor of child and family studies at California State University, Los Angeles. A former elementary teacher in South Los Angeles and a K–12 STEM curriculum specialist in Compton, her approach to climate change focuses on interdisciplinary climate/environmental justice. An Asian American educator-activist-scholar, she was named a North American Association for

Environmental Education EE 30 Under 30 in 2019 and the 2021 California Council for the Social Studies Outstanding Elementary Social Studies Teacher of the Year. Lauren, who wrote Part IV, is a former middle school science teacher who has worked in New Jersey for the past 13 years as a professor of elementary science education. In recent years, her teaching and research has centered on New Jersey's adoption of comprehensive climate change standards across subject areas and grade levels K–12, and she was the lead author on the New Jersey School Board Association & Sustainable Jersey for Schools *Report on K–12 Climate Change Education Needs in New Jersey*. She was voted the Association for Science Teacher Education (ASTE) Science Teacher Educator of the Year in 2021 and the Alliance for New Jersey Environmental Education Outstanding Environmental Educator in Higher Education in 2023.

How to Use the Book

In Part I we set the foundation for what teachers need to know before they start teaching climate change. Chapter 1 dives deep into the history of climate science. The chapter explores the connection between climate change and economic health and sets up the theme of hope that will carry through all chapters. The chapter also initiates a discussion of equity that threads throughout the rest of the book. Chapter 2 addresses the most common misconceptions surrounding the science of climate change and looks at how teachers can help their students overcome any misunderstandings they bring to the topic. It is our hope that this chapter also provides confidence to teachers who will be teaching the science of climate change.

In Part II we discuss ways to overcome obstacles to teaching climate change. Chapter 3 explores the need for data literacy when teaching climate change and provides examples of different types of graphs and infographics that can be used to teach data literacy in the classroom. Each example is followed by sample questions and possible answers, uncovering a pathway to add data literacy to the curriculum. (You will find the graphs, tables, and infographics along with the accompanying questions reproduced on our companion website, for easy reproduction. The answers to all accompanying questions, including the extension questions, can be found in Chapter 3.) Chapter 4 delves into the politics of climate change, offering advice on talking with students, parents, and administrators who are uneasy about the topic. We introduce the idea of how our own biases and preconceptions influence how we present and process information in our daily classroom instruction. Strategies for fostering open, productive discussions in the classroom are laid out, with humility at the center of all debate.

In Part III we discuss how to foster hope in students and how to acknowledge climate anxiety and channel this into activism and meaningful action that provide hope and an outlet for students. In Chapter 5 we explicitly discuss the reality of climate change impacting some populations more than others, focusing especially on the disproportionate impacts on women and girls around the world. At the same time, we offer examples of women who have taken back the narrative and written themselves into myriad climate change solutions. Chapter 6 further explores student activism as a way to combat climate anxiety.

In Part IV we focus on the practicalities of fitting climate change into existing educational frameworks, such as the Next Generation Science Standards and the Common Core State Standards, and we look at ways you can advocate for climate change in your schools and districts. Chapter 7 discusses integrating climate change across the curriculum and focuses on interdisciplinary instruction. Chapter 8 offers a roadmap for advocacy in climate change by looking first at New Jersey's climate standards. Recognizing the urgency of this issue, New Jersey emerged as the first state in the United States to integrate climate change education across all K–12 content areas. We also look at work done in California, Maine, New York, and city-specific measures.

Each chapter features Success Stories submitted by educators from around the United States and Canada, from which you'll learn about inspiring climate change lessons and school-based activism on topics ranging from planting a pizza garden on campus to attract birds and other pollinators, to one girl's effort to replace the fleet of gas-guzzling buses in her district with electric vehicles, to a long-term ecological study on plant and animal interaction in a local forest. We also provide a vignette feature called Learning From Our Colleagues at the end of every chapter, which walks through how a climate change lesson might play out. The vignettes are set in a variety of classes, from kindergarten through middle and high school, and tackle lessons such as how electricity is provided for a city, using persuasive writing to teach climate change, and activism for the very youngest students around inequity in the proximity to greenspace.

Throughout the book there are questions from educators like you who asked us tough questions about teaching climate change—and we answered them—and along the way provided all the additional resources you should need to help you work through any challenges you face in teaching this important content. We also scatter throughout the pages Tips to Make a Difference, offering tons of suggestions for reducing our carbon footprint, reducing waste, and preventing the release of additional greenhouse gases

into the atmosphere. Most of these tips were provided by educators, too. We really couldn't have written this book without *you*!

The book ends with a wealth of classroom resources in the appendix, with links to the free curriculum mentioned in each chapter. We also provide content on our companion website at https://companion.corwin.com/courses/TeachingClimateChange.

About the Language Used in This Book

Jamila Lyiscott asks in her TEDx talk *Why English Class Is Silencing Students of Color*, "What if I told you that the way you use language every day had the power to either uphold or disrupt social injustice? What if I told you that because language is saturated with history and culture and memory, the way that it is policed within our classrooms and our communities is deeply connected to racism and colonialism?"

As lifelong students of anti-racism, central to our writing and collaborative process was ensuring we respect how groups of people and individuals want to be identified. To make language decisions explicit, we outline our language choices and reasoning below, which were created with the consultation of the APA Style and Grammar Guideline for Bias-Free Language:

1. Black, Indigenous, and People of Color (BIPOC) people: A term referring to "Black and/or Indigenous People of Color." BIPOC explicitly leads with Black and Indigenous identities, which helps to counter anti-Black racism and the erasure of Indigenous communities. (Racial Equity Tools Glossary: https://www.racialequitytools.org/glossary)
2. Historically and contemporarily marginalized people: The presence of structural racialization and racism in the present day and also throughout history is evidenced in differences in lifespan, family wealth, educational attainment, etc. In our writing we emphasize the historical and contemporary injustices that exist.
3. Black, White: We are following the APA Style Guide's principles of writing about race and ethnicity, which stipulates that racial and ethnic groups are designated by proper nouns and are capitalized. For example, "Black," and "White" instead of "black" and "white."
4. Community science: Until recently, *citizen science* referred to projects where the general public participates in scientific research. It's a way for people to contribute to scientific discovery and data collection

alongside professional researchers. However, there is debate about the term *citizen science*, and "citizen and community science" or "community science" is now commonly used. (https://www.calacademy.org/community-science)

5. Latin and Hispanic: The cultures of Latin and Hispanic people are extremely diverse, and there is no singular Latin or Hispanic experience. Although imperfect, this term will be used to refer to people whose origins are from Mexico, Central and/or South America, and the Spanish-speaking countries of the Caribbean (Lopez et al., 2023).

* * *

In so many ways, the future is uncertain, but one thing is clear: Our students need climate change education, and they need it now. This book is your roadmap to becoming a confident, informed climate change educator, empowering the next generation to build a more sustainable, hope-filled future. The urgency of this issue cannot be overstated, and your role in addressing it is vital. Let's embark on this journey together.

—Bertha, Kimi, and Lauren

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Bertha: My deepest gratitude goes to my colleagues at the Center for Inquiry and to Melanie Trecek-King, who, like beacons in the dark, champion science and reason. In the science classroom, my lifelong partnership with Ana Driggs, Mary Martinez, and Elia Valdes helped me navigate climate education in a state lacking climate science standards. We supported each other and instilled this knowledge in our students. It's a joy to witness so many of them now actively shaping a better world, including my own son, Brendan. At Corwin Press, my thanks go to senior acquisitions editor Debbie Hardin, one of the most competent professionals with whom I've ever had the pleasure of working, and to senior editorial assistant Nyle De Leon, whose patience helped bring this project to life. I'm grateful to Kimi Waite and Lauren Madden, my co-authors, and to the teachers who contributed valuable content to my chapters. It was a pleasure to work with you. Finally, to my friends Kelly Dawson and Michelle Drucker, tireless climate activists, moms, and engaged citizens—their work inspires not only me but countless children they encounter. They are true role models.

Kimi: Thank you to my grandfather, who taught me how to be an environmentalist and that my history and culture as a Japanese American are part of environmental history. I would also like to thank my former kindergarten students in South Los Angeles, who inspired my research and practice in environmental justice. I thank my mentors, who have encouraged my leadership in sustainability education throughout my professional career. From the California Global Education Project: Emily Schell, Barbara Doten, Lisa McAllister, and Tom Herman. From Prescott College: Emily Affolter, Kimberley Greeson, Scott Ramsey, Dianna Gielstra, and Calvin Centáe Richards. I would also like to acknowledge all of my fellow teachers who were frontline workers during the COVID-19 pandemic and teachers around the country who dare to teach the truth, whether about systemic racism or climate change. I'm honored to collaborate with two amazing co-authors, Bertha Vazquez and Lauren Madden, and the teachers who contributed to our book. Thank you to the Corwin Team: Debbie Hardin, for her amazing support and encouragement, and Nyle De Leon.

Lauren: I appreciate the guidance and partnership of Sarah Sterling-Laldee at the New Jersey Department of Education and vision and inspiration from New Jersey's First Lady, Tammy Snyder Murphy. Your leadership has shifted conversations and made climate change education a viable and fruitful solution to this tremendous issue. My heartfelt gratitude goes to the current and

future teachers of New Jersey who have allowed me to learn alongside them. Your work on the front lines lets us tell the story of what widespread climate change education is. It has been an honor and a joy to work alongside Bertha Vazquez and Kimi Waite in creating this book. To the Corwin Team: Debbie Hardin and Nyle De Leon for bringing this story to life. I am forever grateful to my family, especially my sons Connor and Luke Madden. Your creativity is unmatched. I'll fight forever to make the world a better place for you.

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Bertha Vazquez is a retired science teacher who taught middle school for 34 years in Miami-Dade County Public Schools. She is the education director at The Center for Inquiry, an international nonprofit organization that promotes reason and science. She runs a teacher-led network of more than 100 teachers who have presented more than 400 professional development sessions for their fellow teachers in all 50 U.S. states. Her multifaceted approach to teaching climate science has been featured in the *New York Times,* NPR, *Earth* magazine, and in a book and film series by Lynne Cherry titled *Empowering Young Voices for the Planet*. Her efforts awarded her the 2008 National Environmental Education Richard C. Bartlett Award, among others. She is the editor and contributing author of the book *On Teaching Evolution,* published in 2021. She has also worked on several translation projects, including the translation of Maria Jinich's book into English, *A Brief History of Four Billion Years of Evolution: Understanding Darwin*. She is a regular speaker at skeptical and humanist conferences and is a Fellow of the Committee for Skeptical Inquiry.

Kimi Waite is an assistant professor of child and family studies at California State University, Los Angeles. A former elementary school teacher in South Los Angeles and a STEM curriculum specialist in Compton, she has received both national and state recognition for her leadership in environmental education, social studies, and climate change education. She is an early career fellow with the UCLA Center for Diverse Leadership in Science; the 2021 California Council for the Social Studies Outstanding Elementary Social

Studies Teacher of the Year; a 2021 Public Voices Fellow on the Climate Crisis with the OpEd Project and the Yale Program on Climate Change Communication; and the recipient of a 2019 Environmental Education 30 Under 30, awarded by the North American Association for Environmental Education. Since 2019, she has been a steering committee member for California's statewide climate change initiative, the Environmental and Climate Change Literacy Projects (ECCLPS). Her work has been published by outlets such as PBS, the *Boston Globe, Grist, Ms. Magazine,* the *Progressive Magazine,* the *Journal of Curriculum & Pedagogy,* and more.

Lauren Madden is a professor of elementary science education at The College of New Jersey. She holds a BA in Earth Sciences-Oceanography, MS in Marine Science and PhD in Science Education. In recent years, her work has focused directly on K–5 climate change education, and she was the lead author on the New Jersey School Boards Association & Sustainable Jersey for Schools *Report on K–12 Climate Change Education Needs in New Jersey*. Her work advocates for scientific literacy and the health of our planet through teaching and learning. Her research has been supported by grants from the New Jersey SeaGrant Consortium, National Science Foundation, and the U.S. Environmental Protection Agency. She has written a textbook on elementary science teaching methods along with more than 50 peer-reviewed journal articles and book chapters. Her expertise has been cited widely in media venues including the *New York Times, Washington Post*, and PBS *Weekend News Hour*. She was named the 2021 Outstanding Science Teacher Educator of the Year by the Association for Science Teacher Education and received the inaugural I CAN STEM Role Model Award by the New Jersey STEM Pathways Network.

PART I

WHAT DO I NEED TO KNOW TO GET STARTED TEACHING CLIMATE CHANGE?

Source: istock.com/Don Mennig

CHAPTER ONE

THE FOUNDATIONS OF TEACHING CLIMATE CHANGE

The best time to plant a tree was 30 years ago, and the second best time to plant a tree is now.

—Anonymous

THIS CHAPTER WILL DISCUSS

- The history and evidence that scientists have long cited to sound the alarm about climate change
- The importance of incorporating green technology into the 21st-century economy
- Why some teachers are reluctant to teach climate change
- How to teach climate change without causing anxiety in students; and
- Where to find excellent classroom resources for empowering students

The best time for humanity to have made a serious course correction and addressed the dangers of climate change was 30 years ago—probably earlier. There's no question that the second-best time to commit to corrective action is now.

LOOKING BACK

Many of us well-versed in the science of climate change play a morbid thought experiment when the reality of today's climate crisis keeps us up at night. We wonder how different the world would be today if policymakers worldwide had heeded the warnings of scientists from generations ago. The world we envision in our midnight musings is not economically depressed or worse off because humanity chose environmental preservation over the economic growth of specific sectors, such as fossil fuel companies. On the contrary, this imagined world that altered its course to clean energy decades ago is filled with astounding energy innovations and thriving global industries. The atmosphere is not polluted and the constant news of climate disasters does not appear on our media screens.

Interestingly, the history of climate science begins in the 19th century. Eunice Newton Foote, born in 1819, was an American scientist, inventor, and a vocal advocate for women's rights. She became the first person to demonstrate that certain gases trap heat from sunlight, potentially causing the atmosphere to warm. This phenomenon, now known as the greenhouse effect, is a key principle in understanding climate change. Despite the significance of her work, Foote's contributions were largely overlooked for many years. However, her research is now recognized as a vital stepping stone in our understanding of climate science.

Fast forward to 1957 and Roger Revelle, one of the pioneering scientists to research human-caused global warming. Unfortunately, his warnings 70 years ago went largely unheeded. He played a significant role in establishing the International Geophysical Year (IGY) and founding the first Committee on Climate Change and the Ocean (CCCO). Along with Hans Suess, he authored a study and subsequent article in 1957 that was the first to suggest that gas emissions as a result of human activity could potentially alter the balance of the planet, leading to what they called a "large-scale geophysical experiment" (Revelle & Suess, 1957). At the time, Revelle also warned the U.S. Congress about the dangers of rising seas and desertification. His research was the first to use the phrase "global warming" to describe the potential consequences of a large-scale warming trend.

Revelle's testimony went mostly unheeded.

Q&A **Q:** How far back do we have actual scientific data?

Shanna Burcham, Health Academy High School, Chesapeake, OH

A: The oldest continuous temperature record is the Central England Temperature Data Series, which began in 1659. The Hadley Centre has some measurements beginning in 1850, but there is too little data before 1880 for scientists to estimate average temperatures for the entire planet.

The greenhouse effect was first theorized in the early 1800s by Foote and other scientists like Joseph Fourier and John Tyndall. In the late 19th century, Svante Arrhenius provided quantitative calculations demonstrating that increased carbon dioxide could lead to global warming (NASA, 2024).

Twenty years later in 1979, under the leadership of President Jimmy Carter, a panel of climate scientists warned that greenhouse gas emissions could cause changes in climate (Alter, 2020). Carter himself was the first global leader to recognize climate change—and during his administration, there were fourteen environmental statutes passed, including the first funding for research into alternative fuels, the first fuel economy standards, and the first federal toxic waste cleanup (known as Super Fund). However, subsequent administrations failed to act, even taking backward steps. Carter's successor, President Ronald Reagan, metaphorically and literally took the solar panels off the roof of the White House, and Carter's energy initiatives, such as tax credits and research funds around alternative energy, were eliminated from the budget (Wihbey, 2023).

In a letter to the editors of *Scientific American* in 1982, Revelle stated that there was still considerable uncertainty about the extent of the impact of increased atmospheric CO_2 on climate change. He concluded, "If the modelers are correct, such a signal should be detectable within the next 10 or 15 years" (Revelle, 1982).

As hypothesized, 10 years later, during a U.S. Senate Committee hearing on June 23, 1988, another respected scientist, James Hansen (1988), who worked for NASA, declared that the record temperatures that year were most likely not due to natural causes and reported his findings with a 99% confidence level. This was the first instance when a prominent scientist had enough data available to correlate human activities, pollutants in the atmosphere, and global warming.

"It's time to stop waffling so much and say that the evidence is pretty strong that the greenhouse effect is here," Hansen said. He cited the Villach Conference (held in Austria in 1985), which concluded that an increase in global mean temperature greater than any in history could occur in the first half of the 21st century due to increasing greenhouse gases (World Meteorological Organization, 1986). The hearings received a lot of media attention, with the *Washington Post* featuring them on their front page. And yet again, little action was taken.

Teachers, the Zinn Education Project has created an interactive timeline of how we arrived at this inflection point in the history of climate action. The timeline encourages teachers and students to explore the decisions and implications that drive the climate crisis and collaborate on effective resolutions. qrs.ly/c5g36sv!

Although climate scientists are frustrated that their warnings have been ignored for decades, they are not surprised by the current situation. And for the first time ever, a Gallup survey conducted before the heat wave of 2023 showed that a majority of Americans prioritize protecting the environment (52%), even if it negatively impacts the economy (Gallup, 2023).

WE HAVE REACHED THE TIPPING POINT

TIPS TO MAKE A DIFFERENCE: Ditch the Plastic!

Christine Briske, Ronan High School, Ronan, MT

1. Stop selling plastic water bottles at school.

The Importance of Teaching Climate Change

Here we are, nearly 70 years after Revelle sounded the first warning. His hypotheses and the hypotheses of others have been validated, and the impact of a warming planet has been evident since the late 20th century. This evidence and conclusion are supported by an *overwhelming majority* of actively publishing scientists. Ninety-seven percent of active scientists agree that human activity is causing global warming and climate change (Cook et al., 2016). Likewise, the vast majority of leading science organizations around the world agree, including international and U.S. science academies and the UN Intergovernmental Panel on Climate Change (IPCC). Many

believe we've already reached the tipping point. In November 2023, James Hansen published a new study predicting that the average increase in global temperature can pass 2°C in as little as 6 years unless we take action to reduce the energy imbalance (Hansen et al., 2023). A survey of 380 climate scientists revealed that 77% of these experts expect a 2.5°C increase between now and 2100 (Carrington, 2024b).

The term *tipping point* refers to the point when minor alterations become significant enough to trigger a more substantial and critical change that can have abrupt, irreversible consequences, leading to a cascade of effects. Initially, the IPCC believed that tipping points would only occur if global warming reached 5°C, but recent assessments have suggested that such points could be reached at much lower levels of warming, between 1°C and 2°C. Scientists look at several tipping points, including the effects of the deforestation of the Amazon rainforest (see Figure 1.1), the melting of Antarctic ice shelves, and changes in ocean currents (IPCC, 2021).

FIGURE 1.1 • Deforestation in Amazon Rainforest of Brazil

Source: istock.com/luoman

Despite agreement on the cause and effects of climate change, we are still not going far enough to take the actions required to reverse warming trends. Since 1970, global surface temperatures have risen faster than in any other 50-year period over the past 2,000 years (IPCC, 2021).

The report released by the IPCC in March 2023 revealed that the Earth's climate is undergoing unprecedented changes due to human-induced global warming, which has caused a rise of 1.1°C since 1900. The report states that the impact of climate change on ecosystems and people is more severe and widespread than anticipated, and the risk will increase with every fraction of a degree of warming.

The IPCC (2023) report concluded that it is now imperative that we implement comprehensive changes to achieve a net-zero, climate-resistant future. (Net zero means the amount of carbon emitted into the atmosphere is equal to the amount of carbon removed from it.) Reducing carbon emissions is no longer enough to limit global temperature increase; carbon removal from the atmosphere is now a necessity. It may seem like a small number, but a 1.5°C increase in global temperature would significantly impact our planet. We can expect harsher weather, rising seas, stressed ecosystems, water scarcity, food insecurity, and health problems (IPCC, 2023).

According to the IPCC (2023) report, nations worldwide need to increase their financial commitment to combatting climate change if humanity is to effectively address both mitigation and adaptation. The somber report addressed how climate change will affect some countries and communities more than others, and some populations within communities will suffer more. Inequality will only worsen as we strive to deal with the effects of climate change.

A survey completed by the *Guardian* newspaper reveals the despair felt by many of the world's leading climate scientists. They've witnessed the increasing frequency and intensity of extreme weather events, rising global temperatures, and melting glaciers. For example, data show that warmer ocean temperatures fuel stronger tropical cyclones. On September 23, 2024, Hurricane Helene encountered sea surface temperatures in the Gulf of Mexico that were about 1.26°C (2.3°F) warmer than the 20th-century average. According to Climate Central's Climate Shift Index, those temperatures are 300 times more likely due to climate change (Climate Central, 2024). Hurricane Helene demonstrated that even places we consider climate havens, like Asheville, NC, are not safe from climate change. And just two weeks later on October 7, 2024, Hurricane Milton explosively intensified from a Category 1 to a catastrophic Category 5 storm near the Yucatan Peninsula in less than 24 hours, with sustained winds of 290 kilometers per hour (180 miles per hour; Gramling, 2024).

Despite their research and warnings, many say they feel the world's response to climate change has been inadequate. They see the devastating effects on

ecosystems, communities, and economies, yet they feel the world isn't taking the necessary actions to mitigate the crisis (Carrington, 2024a).

If we continue on the current path, those still living—including many of our students of today—will feel the full effects of climate change and will undoubtedly question why we allowed this to happen.

Q&A

Q: How do we teach the history of what has and has not happened over the past 100 years so students can make claims, collect evidence, and then come to a conclusion?

Debra Yliniemi, Little Falls High School, Little Falls, MN

A: Teaching the history of climate change can help students enhance their critical thinking and empower them to actively participate in ongoing conversations about climate change.

1. **Start with historical awareness.** Using primary sources, introduce students to historical data like weather records, scientific papers, photos, and oral histories. Analyze these sources to see how understanding of climate change has evolved.
2. **Focus on evidence collection and data analysis.** Use interactive tools to show how climate has changed. Let students identify trends and patterns in different data sets.
3. **Focus on local stories.** Connect climate change history to your local area, making it more relatable for students.
4. **Explore diverse perspectives.** Include voices from various communities and cultures. Consider the social, economic, and political factors shaping societies' understanding of climate change.
5. **Promote critical thinking.** Encourage students to question assumptions, analyze bias, and consider limitations in different sources of evidence.

The Financial Costs of Climate Change

Climate change is expensive.

Between 2019 and 2023, the United States averaged 20 climate disasters per year for a total cost of more than $600 billion. These disasters included severe storms, catastrophic fires, and record flooding (see Figure 1.2), and it's clear from the statistics that such "once in a lifetime events" are happening more frequently and with greater intensity. Contrast this to an average of 3.3

Have any of the effects of climate change affected your community?

climate disasters per year in the United States from 1980 to 1989, which caused $21.9 billion per year in damage, adjusted for today's economy (NOAA, 2023).

FIGURE 1.2 • A new weather phenomenon, known as a Bomb Cyclone, touched down in 2023 in Pacifica, California, just south of San Francisco.

Source: istock.com/JasonDoiy

Q&A

Q: How does climate change affect the economy of an area?

Georgina Whalen, DuVal High School, Lanham, MD

A: It depends on where you live. Stronger storms, floods, and fires can damage roads, homes, and the overall infrastructure of a location. Rising sea levels and warming waters will negatively affect beaches and docks in coastal areas, impacting tourism and local fisheries. Heat waves, air pollution, and waterborne diseases will increase healthcare costs and decrease worker productivity across the country. And as we will see throughout this book, climate change disproportionately affects people with the lowest incomes. But there is hope: Policymakers can improve an area's economic future by investing in green tech and infrastructure upgrades.

Because the costs of climate change are enormous, investment in alternative energy sources could be the key to a thriving 21st-century U.S. economy. The United States is experiencing a surge in clean energy development, leading to increased investment and job opportunities nationwide. The 2023 U.S. Energy and Employment Report from the Department of Energy reveals that almost 300,000 new energy jobs were created in 2022, with 114,000 in clean energy technologies such as renewables and zero-emission vehicles.

Clean energy jobs grew 3.9% in 2022 compared to the previous year, surpassing the 3.1% growth rate for jobs nationwide. The solar energy sector is a significant contributor to this growth, employing 263,883 workers in all 50 states, the District of Columbia, and Puerto Rico in 2022, with a 3.5% increase in jobs since 2021 (IREC, 2023).

The majority of people who will be working in the climate sector by 2030 have not yet started their careers, creating a demand for a diverse range of professionals, including engineers and technicians. This represents an enormous opportunity for our students.

What skills should you teach your students when preparing them for exciting careers that don't even exist yet?

Q&A

Q: Why do the seasons seem to be pushed back? For example, it used to snow here in October, and now it doesn't start until December; April used to have rain showers, and now those are in June.

Andrea Finley, Endeavor Academy, Centennial, CO

A: Climate change is the primary driver behind the shifting seasons we're experiencing. As the Earth's average temperature rises due to the increasing concentration of greenhouse gases, we see a domino effect on weather patterns. Winters are becoming warmer, leading to later first snowfalls and shorter overall winter durations. This warmth also delays the onset of spring rains, pushing them closer to summer months. Additionally, summer heat lingers longer, extending the season and further compressing the window for spring and fall. These changes are likely to become even more pronounced in the years to come (USDA, 2024).

Success Story: Green Champions Club

Helena Paisley, MAST Academy, Key Biscayne, FL

In 2017, a group of students, parents, and teachers formed the Green Champions Club at the Maritime and Science Technology (MAST) Academy, a middle and high school in Key Biscayne, Florida.

"A big part of MAST's original mission was to teach our kids to be responsible stewards of the environment," says Helena Paisley, a 32-year veteran teacher at MAST and one of the club's founders. "The Green Champions really brought that aspect of our philosophy into the limelight again."

FIGURE 1.3 • Photograph of one of the solar panels installed at MAST Academy with grant money.

Source: Michelle Drucker

The Green Champions goal is to work toward making MAST the first zero energy and zero waste school in Florida. The club secured a $40,000 grant for a 26-kilowatt solar array to power the school's athletic field (see Figure 1.3)—and the club's impact hasn't stopped at the gates of MAST Academy. Parent Michele Drucker, environmental chair of the Miami-Dade County Council's Parent Teacher Association, and the students introduced a resolution that called on their district to commit to 100% clean energy by 2030. The resolution was presented to the School Board of Miami-Dade County and passed unanimously.

In August 2023, the Green Champions racked up another success when Miami-Dade Public Schools received 20 electric school buses, the first of 125 electric buses they'll have on the road by 2026. The funding came through a $8.8 million Clean School Bus grant from the Environmental Protection Agency (MDCPS 2024).

Holly Thorpe, a Green Champion team member, was a seventh grader when she began studying the health hazards diesel fuel fumes posed for the students and bus drivers exposed to them daily. She measured the excessive levels of CO_2 inside the buses and in MAST's bus loading zone in a science fair project and began attending school board meetings, lobbying Miami Dade County Public Schools to purchase electric buses.

"This experience has helped me feel more confident as a person and better as a person that I helped to do something like this for the environment and for the people of Miami," says Holly.

Holly counts her determination and her membership in Green Champions as critical to her success:

"I think that finding a good group that supports you is really important. And then also just being determined and not giving up. I understand that problems are solved with solutions and not by complaining. I understand that we have to fight for a livable future. People are going to try and push you away, but you just have to keep trying and speaking on what you stand for, and eventually, you can make a change."

NOW WHAT? HOW THIS BOOK CAN HELP

The purpose of this book is climate science education, not climate policy and solutions. Therefore, the question is not, "Now what?" but rather, "Now what, teachers?"

The answer to this question is now is the time to prepare our young people for a future of consistently more extreme weather events and more general changes in climate, such as permanent changes in precipitation levels and air temperatures, as well as to prepare them for the future economy. These are complex issues, making climate education very challenging (see Figure 1.4).

MAST Academy's successes have been featured by many news media outlets. Check out the following article to learn more about the electric buses that the students lobbied for:

- **Montoya, P. (2021, February 3). Yellow and green: MAST students bring electric buses to Miami. *The Beacon*. qrs.ly/z3g36vm**

FIGURE 1.4 • Images of Climate Change in 2023 From Around the World

a. Flooding in Australia

Source: istock.com/Beyondimages

b. Dead Coral Reef in Thailand

Source: istock.com/Johan Holmdahl

c. Air Pollution in New York City from Fires in Canada in 2023

Source: istock.com/James Andrews

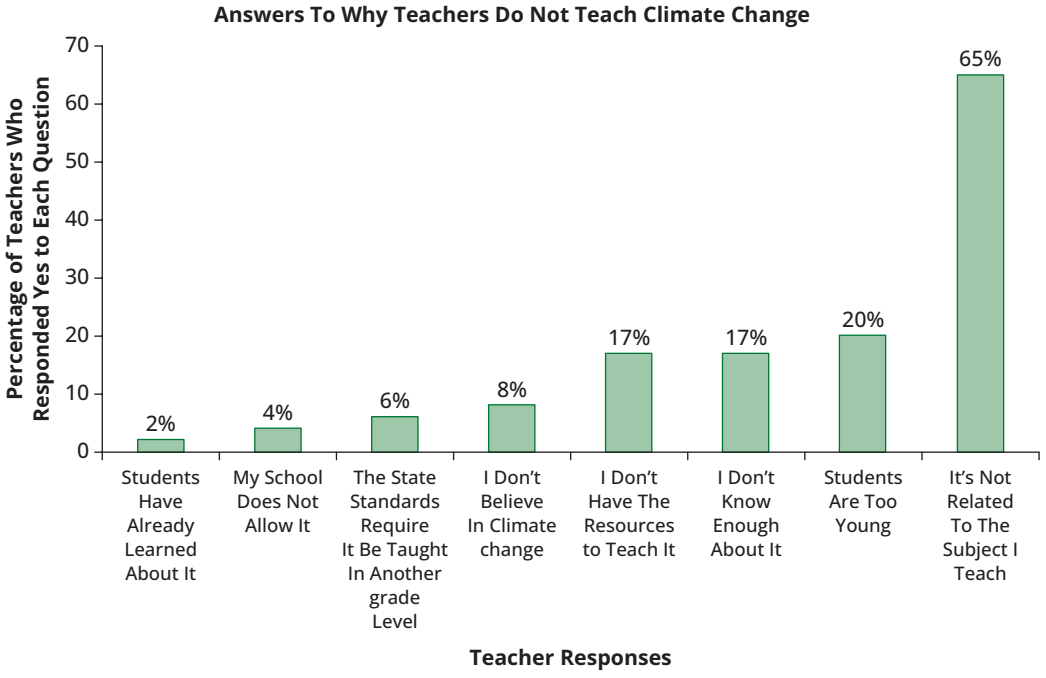
d. Extreme Drought in Turkey

*Source:*istock.com/Selçuk KARABIYIK

Nevertheless, parents and students want climate change to be taught in schools. More than 80% of parents in the United States say they want their children to learn about climate change in school—and 79% of kids report that they want to learn this content (Will & Prothero, 2022). Whether they have children or not, 90% of Democrats and 66% of Republicans agree that climate change should be taught in school (Kamenetz, 2019), and 86% of teachers agree. So why are some of us reluctant to teach climate change?

You'll see from Figure 1.5 that according to a widescale poll, the biggest issue preventing teachers from tackling the subject is that they see it as distinct from the subjects they teach. The next biggest concern teachers express is that students are too young to understand the content and they are likely to be overwhelmed with a feeling of hopelessness. The last two concerns reported by more than a small fraction of responding teachers are that teachers feel like they don't understand the science behind climate change well enough and that they don't have the materials needed to teach the subject. (This is why we wrote this book! We will be addressing each of these issues in turn throughout the book.)

FIGURE 1.5 • Reasons Teachers Say They Don't Teach Climate Change



Note: NPR conducted a poll in March 2019 asking teachers whether they teach about climate change. The answers in the figure refer to the 55% of teachers who responded that they did not teach climate change in their classrooms.

TIPS TO MAKE A DIFFERENCE:
Actions Speak Louder Than Words!

1. You don't have to start from scratch: There are plenty of worthy organizations who can help you get started on your school's climate journey.
   - The Climate Initiative (https://www.theclimateinitiative.org/)
   - Organization180 (https://generation180.org/)
   - Kids Fight Climate Change (https://www.kidsfightclimatechange.org/)
2. Your students may ask you what they can do right now; the United Nations offers these nine things you can do right now.
   - Join the United Nations' #ActNow campaign for climate action and sustainability (qrs.ly/jeg3gk1).
   - Calculate your carbon footprint (qrs.ly/bbg3gk4).
   - Learn from your peers on the Reach Not Preach platform (qrs.ly/n1g3gk7).
   - Educate yourself on the impact of climate change through an online course offered by UNICEF (qrs.ly/vkg36w0).
   - Be a Climate Superhero! (qrs.ly/m3g3gka)
   - Read the Global Youth Statement on Climate Change and COP26 Outcomes (qrs.ly/n6gd299).
   - Join YOUNGO, a global network of children, youth activists, and youth NGOs on climate change (qrs.ly/2fg3gkg).
   - Speak up! Share this information through social media.

We teachers today face many obstacles, including crowded classrooms, student behavioral problems, constant state assessments, and teaching multiple courses. Frankly, we have more than enough on our plates as it is. But let's reflect on an aphorism commonly used by people trying to make an environmental difference in their communities: "Don't let the perfect be the enemy of the good."

This book aims to meet you where you are and help you build your skills around teaching climate change. We will address the three most-cited concerns: finding time to teach a new curriculum (spoiler alert: you don't have to!), addressing the social and emotional needs of students learning

about climate change, and providing the science background needed to teach the content. Our companion website (https://companion.corwin.com/courses/TeachingClimateChange) will address the fourth concern, lack of resources, by offering an extensive index of free lesson plans and other resources on climate change. These resources can also be found in the appendix at the end of this book.

Other chapters in this book will address how to identify reliable scientific content; how to navigate political and community pressure; how to tie climate change to existing national standards; and how one state (New Jersey) has created standards and a curriculum around climate change (and what other states have done subsequently). We'll also look at climate justice—acknowledging areas and groups of people most vulnerable to the effects of climate change, especially women and girls.

The Need to Invite Communities Most Affected by Climate Change to Participate in the Solutions

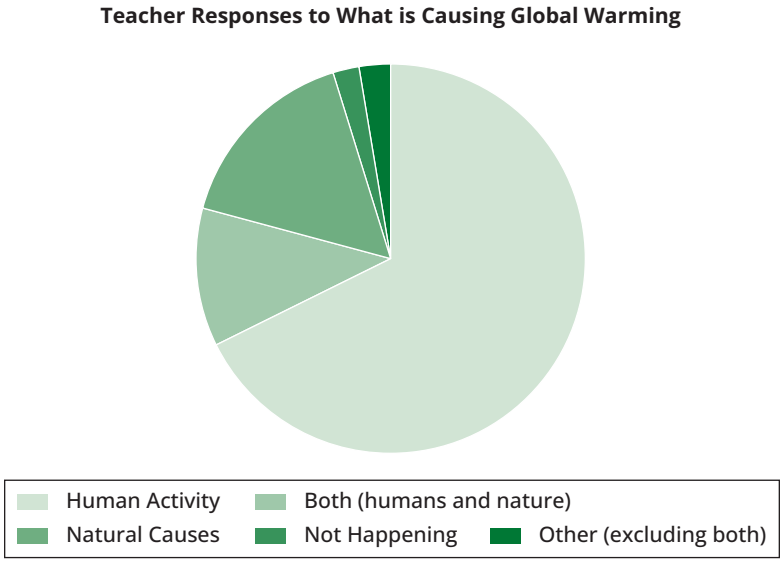
BIPOC communities in the northern hemisphere are more likely to suffer from the effects of climate change due to their proximity to pollution sources and contaminated water (Patnaik et al., 2020). Despite their high level of concern about climate change, these communities are often absent from climate conversations. Moreover, research and articles contributing to climate policy and action predominantly focus on the northern hemisphere despite the southern hemisphere experiencing more immediate and severe environmental impacts. Diverse perspectives and inclusive approaches in climate science are crucial for comprehending intricate climate challenges and engaging policymakers and the public effectively (Ballew et al., 2021).

What Are Teachers Teaching Today?

The first step in understanding what information and training teachers need is to gauge the state of climate education in the United States today. In March 2016, the National Center for Science Education (NCSE) published a report called "Mixed Messages: How Climate Change Is Taught in America's Public Schools." The NCSE is a nonprofit organization in the United States that defends the teaching of evolution and climate change in public schools. This report investigated the accuracy, comprehensiveness, and balance of the materials, textbooks, and curricula used in teaching students about climate change in U.S. public schools. The report aimed to determine whether there are inconsistencies, gaps, or biases in how this critical topic is taught across different schools or regions in the United States.

The study showed that approximately 75% of public-school science teachers cover climate change, with students receiving education about recent global warming. Teachers who dedicate at least one class hour to the topic cover important aspects such as the greenhouse effect, carbon cycle, and consequences of climate change. Positive steps to alleviate recent global warming are also discussed by many educators. However, up to 30% of teachers who teach about climate change believe that there are different perspectives regarding the primary causes of global warming (see Figure 1.6).

FIGURE 1.6 • Polled Teachers' Personal Acceptance of the Existence and Causes of Global Warming



Source: Data from Plutzer and Hannah (2016).

The research also reinforces the idea that many teachers are not confidant about the adequacy of their understanding of the science behind climate change. Many teachers rate their expertise in climate models as lower than their peers and relatively less than their knowledge of other science topics. This is not surprising because less than half of all teachers polled had any formal coursework on climate change, and less than half are aware that more than 97% of practicing scientists believe that global warming is primarily caused by human activities.

The conclusion of NCSE's report was that the complex nature of climate change education calls for a coordinated and cumulative approach:

- Current teachers require assistance to stay updated with the latest scientific knowledge through effective teaching materials and professional development opportunities.

- Authors of teaching resources should not assume that educators using their materials have completely grasped the underlying science.
- Teacher education programs must also prepare future teachers to handle the politicization of science in general, and educators, administrators, and community members must remain watchful for attempts to introduce denial into the classroom.

Any publisher or organization that aims to help educators present climate science accurately and engagingly must recognize the ideological diversity of educators and tailor climate change education to be inclusive at all levels of instruction. According to the survey, no single policy or program can fundamentally change how climate change is taught in U.S. schools. However, the survey results can guide those who aim to provide today's students and future generations with the scientific knowledge required to tackle the challenges of climate change (Plutzer & Hannah, 2016).

REASONS FOR HOPE

Q&A

Q: How do we communicate the severity of the climate change situation without making it too scary?

Kylie Currie, Classical Preparatory Academy, Springhill, FL

A: This may be one of the most important questions answered in this book. It is not an easy task. In this section, some of the strategies that teachers can implement are addressed. We also delve deeper into climate anxiety in Chapter 6. The short answer is to provide students with agency and to remind them that scientists and innovators are working on solutions. Our fellow humans who engage in scientific inquiry are capable of great achievements; they are responsible for rocket ships, computers, and hospitals. Our species has the potential to solve the climate crisis, and young people are part of the equation.

Before any discussion about climate change education can take place, we must address how to proceed with the mental health of our students in mind. The Centers for Disease Control (2023) reported that even before the COVID-19 pandemic, there was a mental health crisis among students for well over a decade: Young people have experienced a 40% increase in feelings of sadness, hopelessness, and suicidal thoughts and behaviors since 2010.

This crisis was amplified by the pandemic, which resulted in additional social isolation, academic disruption, loss of parents and other caregivers, and abuse at home. In addition, concerns about wars, mass violence, racial injustice,

Those of us living today often take for granted advancements like lifesaving breakthroughs in antibiotics, vaccines, water filtration, and medical procedures. Other breakthroughs have made our lives easier, like electricity and automobiles. Your students can use the lesson *Science Saves Lives* at https://qrs.ly/7ng36wk to come up with creative solutions for specific climate problems, like pollution, ocean acidification, and glacial melting (Vazquez, 2021).

natural disasters, political polarization, depersonalization through social media, and climate change have added to the already difficult challenges that children and teenagers face.

These factors can be overwhelming for those of us who work with children daily in the classroom. How do we cover this important concept without making the situation worse? One way is to present climate solutions along with the facts. Helping students find their agency is a proven strategy (Stevenson & Peterson, 2015). In each chapter of this book, you will find success stories that exemplify how teachers around the country have promoted student agency around the topic of climate change. Share these with your students and look for similar success stories in your local news.

Another way to present the reality of today's climate crisis in a way that fosters hope is to discuss how quickly technology is changing. An excellent exercise is to invite retired volunteers to speak with students. Children's eyes grow wide when they hear about people who lived to see the first smart phones, computers, and astronauts. If we were to transport a person living in 1950 to today, they would not recognize the world. Technology advances at an astonishing rate (see Figures 1.7 and 1.8, which demonstrate innovative approaches to alternative energy based on the unique locales in which they are based). Even a time traveler from 1990, a seemingly recent year, would be shocked when presented with the latest AI technology.

FIGURE 1.7 • Geothermal Pipes at the Krafla Power Station in Iceland

Source: istock.com/Travel_Motion

Note: Reminding students that scientists and engineers are working on the climate crisis and that the decades ahead hold innovations we cannot even begin to imagine might ease their climate anxiety. Indeed, those of us alive today would likely be astonished if we time traveled to encounter the world of 2050.

FIGURE 1.8 • A Field of Wind Turbines in Palm Springs, California

Source: istock.com/Ginton

TIPS TO MAKE A DIFFERENCE: Pack It In, Pack It Out

Angela Anthony, Oklahoma Union High School, South Coffeyville, OK

1. When possible, reuse or recycle food packaging (deli cups, plastic cutlery, etc.).
2. Support environmentally friendly companies.
3. Find ways to talk about conservation and environmentally friendly practices with students, regardless of the subject that you teach.
4. Become involved in research and/or citizen and community science projects that aim to educate, conserve, and restore.

WHAT SHOULD STUDENTS KNOW?

Today, climate action across North America is real. Local municipalities, states, and the federal government are showing that the transition to a carbon-free future is possible. For example, the government leaders of Miami, Florida, came to a unanimous decision in April 2021 to aim for a net-zero reduction in greenhouse gases by 2050, with a 60% reduction target by 2035 (City of Miami, 2021). The Austin Climate Equity Plan was adopted by the City Council of Austin, Texas, in September 2021. The plan's objective is to achieve net-zero communitywide greenhouse gas emissions by 2040 (City of Austin, 2021).

Many states are also taking action. In January 2023, the Minnesota House of Representatives passed a significant bill mandating that the state's electric utilities obtain all their electricity from carbon-free sources by 2040 (Marohn, 2023). From December 2022 to May 2023, California Climate Investments invested almost $511 million in 7,326 projects, which are expected to reduce greenhouse gas emissions by 3.3 million metric tons. More than 84% of the implemented funds are being utilized for the benefit of priority populations, including low-income communities and households (CCI, 2024).

Q&A

Q: Are there any easy-to-access and up-to-date simulations that will help teaching climate change?

Tracy Majors, Wyoming High School, Wyoming, OH

A: Yes! Climate science is very complex, but thankfully, numerous interactive tools are accessible online that help students link different concepts, visualize abstract ideas, and anticipate the future.

The Climate Reality Project reviews six of these excellent simulations on their website.

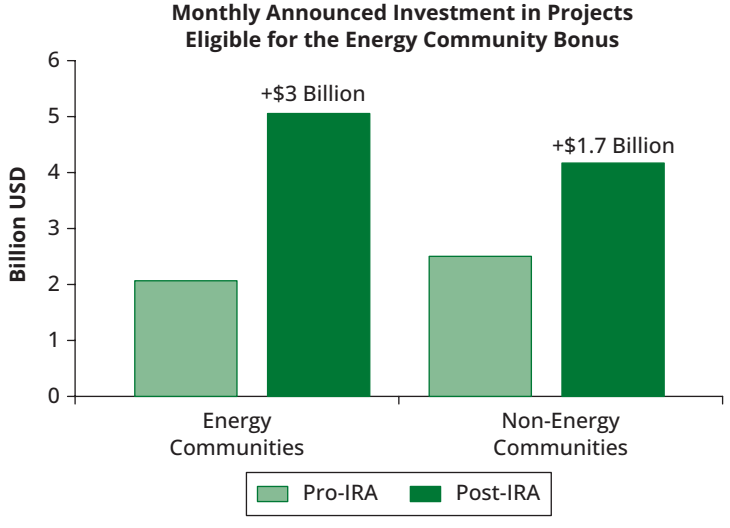
- Our favorite: En-ROADS is a climate simulator that operates worldwide and enables individuals to investigate the effects of numerous policies, such as carbon pricing, electrification of transportation, and advancements in agricultural practices, on numerous factors, including energy costs, temperature, air quality, and sea level rise (https://qrs.ly/k1g378q).
- *The Guardian*'s Fossil Fuel Interactive shows how much coal, oil, and gas the world extracts every day (https://qrs.ly/i8g379q).
- The Climate Time Machine tool by NASA offers a visual representation of the link between our emissions and the subsequent increase in temperatures. It also shows some of the possible effects of global warming (qrs.ly/hqg3gno).
- The Yale Climate Opinion Maps illustrate the diversity of Americans' views on climate change (https://qrs.ly/exg378v).
- Discover how climate change is affecting your country with the *New York Times'* Climate Risk by Country (https://qrs.ly/2sg3791).

- The Earth Overshoot Day Calculator helps individuals understand their own impact on the environment by calculating how many Earths would be needed if everyone lived the same lifestyle as you (qrs.ly/ghg3gki). (The Climate Reality Project, 2021)

All in all, more than 600 local governments in the United States have developed climate action plans (Markolf et al., 2022). As of the end of 2023, a minimum of 147 bills have been presented in 24 states with the aim of lowering emissions and enhancing energy efficiency in buildings (National Caucus of Environmental Legislators, 2023).

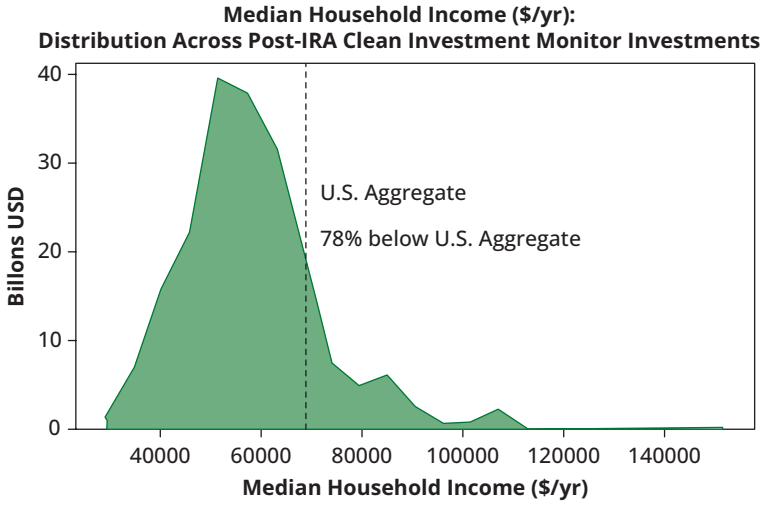
At the level of the U.S. federal government, the current most significant legislation touching on climate change in U.S. history (Environmental Protection Agency, 2023), The Inflation Reduction Act (IRA), was signed into law by President Joe Biden on August 16, 2022 (see Figure 1.9). The IRA provides funding, programs, and incentives to facilitate the transition to a clean energy economy. It is expected to drive the deployment of new clean electricity resources and reduce renewable energy costs for various organizations, including Green Power Partners. Utilizing the incentives offered by the IRA, such as tax credits, will be crucial in accelerating the clean energy transition and lowering greenhouse gas emissions. In 2023, the U.S. Department of the Treasury reported that IRA investments are taking off in "Energy Communities"—areas with a history of fossil fuel production. Clean investments have increasingly been directed toward economically disadvantaged counties, with more than 80% of such investments allocated to counties with below-average wages and more than 85% to counties with below-average college graduation rates (U.S. Department of the Treasury, 2024; see Figure 1.10).

FIGURE 1.9 • Growth in Clean Investments After the IRA Passed (U.S. Department of the Treasury, 2024)



Source: U.S. Department of the Treasury (2024).

FIGURE 1.10 • Where Clean Investment Dollars Are Flowing (U.S. Department of the Treasury, 2024)



Source: U.S. Department of the Treasury (2024).

Carbon capture technology is one exciting part of the climate solution that is receiving a lot of attention recently. Under President Biden, the U.S. government is investing billions of dollars in demo projects, research, and tax breaks to incentivize carbon capture. Private companies, including venture capitalist firms and energy giants, are also making large investments. There have been some big wins in this space, with millions of dollars being awarded for capturing CO_2 from power plants and gas wells. In December 2023, the Department of Energy awarded $890 million to support carbon capture projects at natural gas and coal plants. ExxonMobil also announced a $100 million investment in a carbon capture and storage project in Wyoming in October 2023 (U.S. Department of Energy, 2023). Heirloom Carbon Technologies, a U.S. climate champion, launched a direct air capture plant in Tracy, California, in November 2023. This innovation can pull up to 1,000 tons of CO_2 from the air each year and is critical in our fight to keep global warming below 1.5°C (Chase, 2024). Carbon capture technology offers a great opportunity to address climate anxiety in the classroom. Students can research important aspects of carbon capture and explore its different methods, limitations, and future possibilities, which will foster a sense of agency and empower students to learn more about potential solutions. Teachers can also connect the rise of carbon capture technology

to potential career paths, discussing the need for scientists, engineers, and policymakers in this growing field.

At the time of publication, another promising development emerged in Europe. Carbon capture technologies gained significant momentum, particularly in countries like Norway and the Netherlands. The European Union has committed to continue substantial funding to scale up carbon capture and storage (CCS) infrastructure, positioning it as a key tool for addressing climate change (Earth.org, 2024).

Young people are leading the charge in many places. In a landmark settlement, Hawaii agreed to decarbonize its transportation system by 2045 after 13 youths sued the state, arguing its policies threatened their future due to climate change (Raymond, 2024). And a lawsuit filed by young Montanans forced the state to consider the climate impact when issuing permits for fossil fuel projects. In BREAKING NEWS: The Montana Supreme Court has just ruled that the young people who sued the state in that climate-change lawsuit have a constitutional right to "a clean and healthful environment."

In Canada, the government has passed a number of economic plans, including The Pan-Canadian Framework on Climate Change and Clean Growth (PCF) in 2016 and 2020's Healthy Environment Healthy Economy plan (HEHE). The country has also seen a steady increase in carbon pricing, which is crucial in tackling climate change, and it has also pledged to phase out coal-fired power entirely by 2030.

Carbon pricing is a system that charges polluters for their greenhouse gas emissions. The goal is to make those who cause pollution pay for the damage it creates, such as extreme weather events and rising sea levels. Putting a price on carbon encourages businesses and individuals to reduce their emissions to save money. For example, the Energy Innovation and Carbon Dividend Act of 2023 would put a fee on carbon pollution from fossil fuel companies and then return 100% of the net fees to households as a dividend. The dividend would be paid directly to eligible individuals, who are defined as residents with a Social Security number or TIN. According to the Citizens' Climate Lobby, about two-thirds of Americans would receive more in dividends than they would pay in higher prices. They also say that the act could inject billions into the economy, protect family budgets, and encourage innovation (Citizens' Climate Lobby, 2024).

Here are some other well-known solutions to climate change that students can explore that can reduce carbon emissions and help the world prevent climate change's worst effects. Think about assigning a writing project to report on any of the following.

1. **Electrifying the Grid** involves shifting energy generation away from fossil fuels to cleaner sources like renewables, reducing carbon emissions as electricity production becomes less reliant on fossil fuels (Union of Concerned Scientists, 2021).
2. **Decarbonizing the Grid** calls for removing or offsetting the carbon emissions associated with electricity generation, using carbon capture technology or implementing reforestation projects that absorb atmospheric carbon dioxide (IEA, 2020).
3. **Agriculture Solutions** involves adopting practices that reduce emissions from farming and livestock operations (World Resources Institute, 2020).
4. **Protecting Nature** refers to preserving and restoring ecosystems like forests, wetlands, and oceans, which act as carbon sinks by absorbing and storing carbon dioxide (United Nations Environment Programme, 2021).
5. **Plastics Cleanup** addresses the issue of plastic waste and its environmental impact (Ocean Cleanup, 2021).
6. **Cement Technology** focuses on reducing the carbon emissions associated with cement production by using alternative materials (Global Cement and Concrete Association, 2020).
7. **Carbon Capture Technology** captures CO_2 emissions from sources like power plants and stores them deep underground in geological formations to prevent them from entering the atmosphere (Carbon Capture and Storage Association, 2021).

If students are provided with hopeful examples like these and are given agency and ways to be a part of the solution, they are more likely to have hope for the future (Stevenson & Peterson, 2015), and we as teachers may be able to present this difficult subject in a way that does not lead to hopelessness.

The key is trying to build a narrative for people which is positive. It's "This is the world we can build. We can address climate change alongside other issues. It's not going to cost you a ton of money. It might save you money. We'll have cleaner air. We'll have more energy security." This is more appealing than "We're all going to die from climate change."

—Hannah Ritchie, PhD, data scientist and science communicator, University of Oxford. Author of *Not the End of the World.*

The year 2024 had many depressing climate milestones, such as being the hottest year since records began in 1940. Global carbon emissions reached 45.8 billion metric tons, a new high. Emissions remain on an upward trajectory globally, emphasizing the need for rapid, global action to achieve a peak and then reduce emissions significantly to meet climate targets. (Friedlingstein et al., 2024).

On a positive note, according to a recent study on global electricity generation, renewable energy is growing quickly and is almost at the pace required to triple capacity by the end of the decade (IEA 2023).

Q&A

Q: Where can I find good lesson plans about climate change?

Andrea Strouse, Wes Del High School, Gaston, IN

A: Many trusted organizations offer free ready-to-go lessons on climate change.

- The NASA Climate website (https://climate.nasa.gov/for-educators/) offers lessons and activities designed for students in grades K–12 that are aligned with both Next Generation Science Standards and Common Core Math Standards.
- Teachers can utilize NASA's Climate Kids (https://climatekids.nasa.gov/) as a valuable resource for teaching about global climate change. The Big Questions section can provide essential background information, while games like Offset can make learning about the carbon cycle more engaging. Videos such as "What Is Happening in the Ocean" can spark whole-class discussions, and the Activities page is full of resources and links that teachers may find useful for planning lessons.
- The CCL Climate Classroom curriculum is divided into three modules: Impacts of Climate Change, Climate Solutions, and Taking Action. Students learn about the impacts of climate change around the world and in their own communities, as well as potential solutions and how to take action to address climate change. The program includes activities such as creating climate stories, contacting members of Congress, and lobbying. https://qrs.ly/ygg3798

TIPS TO MAKE A DIFFERENCE: Keep It Simple

Katherine Korn, Williamsville East High School, East Amherst, NY

1. Don't waste food.
2. Take shorter showers.
3. Don't overconsume goods (you don't need a new phone every year).
4. Reduce, reuse, recycle (in that order).
5. Avoid fast fashion. Buy local.

Success Story: The Power of Collaboration at George Washington Carver Middle School, Miami, Florida

Bertha Vazquez, formerly of George Washington Carver Middle School, Miami, FL

This is my story.

It all started in 2007 when a friend gave me a ticket to see former Vice President Al Gore speak at the University of Miami. He was presenting a screening of *An Inconvenient Truth,* his incredibly influential documentary about climate change (Guggenheim, 2006). It really hit me. I lost sleep.

The school where I taught for 33 years, George Washington Carver Middle School, sits just 8 feet above sea level; several of the surrounding neighborhoods are even lower. Miami is often cited as the city with the most to lose economically because of climate change, not just in the United States, but globally.

In 2007–2008, I asked my colleagues at Carver to join me in a schoolwide effort to show our students that change was possible. The results were astounding. I developed and conducted several initial workshops on energy-saving strategies and environmental curriculum with the principal's permission. The first step was building awareness and encouraging a sense of the school community. I included everyone, creating workshops for my school's faculty, cafeteria employees, custodial staff, students, and parent-teacher association.

Science teachers focused on basic climate science in their classes (e.g., units on energy and energy transfers, ecology, and meteorology). Students in other disciplines participated in engaging lessons, ranging from art installations to writing pen pal letters to children in other countries.

As a result of what the school community learned, we made several efforts to reduce our energy consumption:

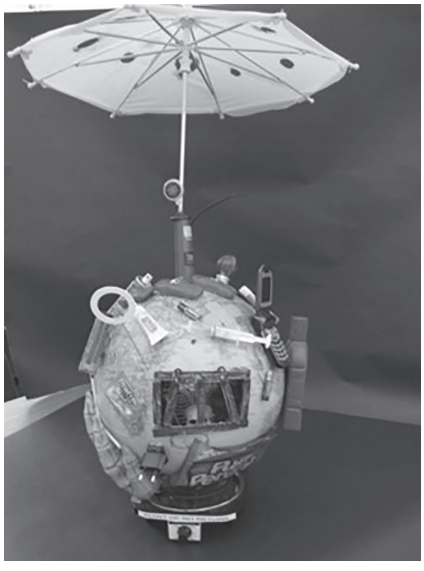
- Increased efforts to reduce and recycle. For example, the PTSA and school administration switched to digital communications to save paper.
- Swapped in energy-efficient light bulbs
- Added smart thermostats in the cafeteria and auditorium
- Added weather stripping around doors and windows
- Collaborated with a local business that donated labor and materials to paint a school roof white (which reflects heat and keeps buildings cooler)

Every department at Carver participated in our green efforts. For example, the art students created "trash monsters" out of the litter they found near the school (see Figure 1.11).

As a result of schoolwide initiatives, the school's electric bill decreased by $52,700 from September 2007 to September 2008. Our carbon emissions were reduced by 297,000 lbs., as calculated by Dream in Green (2008). This was an enormous accomplishment, and it was the beginning of continued work by the school community that goes on to this day.

And lest you think this work is thankless: The school community and I received enormous publicity around our achievements (leading to my opportunity to coauthor this book!). George Washington Carver's successes were highlighted in the film series *Young Voices for the Planet,* written and produced by Lynne Cherry (2013).

FIGURE 1.11 • A Trash Monster, Titled "Warming Earth."



Source: Alexandra Garcia

Photo Credit: Janas Byrd

TIPS TO MAKE A DIFFERENCE: Carpools and Composting

Andrew McCullough, Brunswick High School, Brunswick, ME

1. Create a school carpool for teachers.
2. Unplug appliances over vacations.
3. Start a compost collection in the cafeteria.

LEARNING FROM OUR COLLEAGUES
How Do We Provide Electricity to the World?

After the bell rings, it takes a few minutes for the students to settle down. The usual round of requests for bathroom passes and trips to the Lost and Found ensues before Ms. V starts her class.

"Can somebody tell me what their favorite electronic device is?" The hands shoot up immediately.

"I love my cell phone!" cries Massimo.

"Yeah, but I prefer the computer,' says William, "or my Xbox."

"Wait a second, what about your refrigerator? That's more important, in a way," answers Sophia.

"So are the lights," counters Aiden.

Microwave ovens, heaters, car chargers, hair dryers, the list continues to grow.

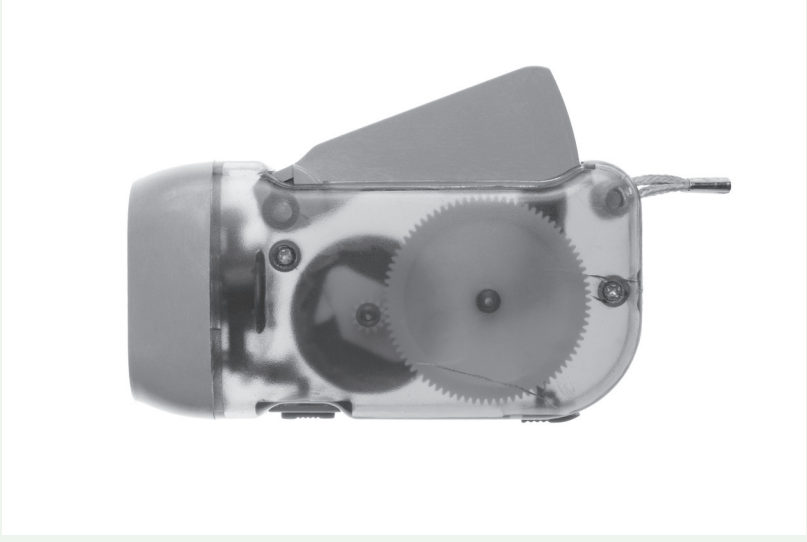
"You know, all of these things are important. And let's not forget air conditioning. I don't know if we could live here without it," says Ms. V. The students nod in agreement. "So, it's okay to say electricity is an important part of our lives. I mean, in addition to all the devices you mentioned, think about how important electricity is in a hospital. Now, if it's such a big deal, tell me, how do we generate electricity?"

The teacher smiles as silence ensues. She's done this before. And she knows that not a single seventh grader in her Honors Physical Science class will know the answer. She will lovingly tease her class now. "You mean, you guys all love everything electricity gives you, but you don't know how humans provide electricity for our city? You know all the words to your favorite songs, but you don't know where the electricity in your homes comes from?"

Slowly, the students will begin to work out the answers; they'll guess that their electricity comes from solar or wind energy. "A small percentage may come from those alternative sources, but the majority does not," replies Ms. V.

Ms. V pulls a flashlight out of her desk drawer similar to the one in Figure 1.12. "I can generate electricity right now; this flashlight has no batteries in it." The students are stunned. "I only need two things to generate electricity, sort of. What's in this flashlight?" Ms. V asks probing questions as the flashlight goes around the room and the students discuss the possibilities. Eventually, the answer emerges.

FIGURE 1.12 • A handheld flashlight powered by the mechanical energy of the human hand.



Source: istock.com/Garry518

"You have to turn a magnet around a copper wire or the other way around!" exclaims Josephine.

"Great! We call the copper wire/magnet thingy a generator. Now for the tough part. How do we do that? How do we get it to turn? That requires energy. I know Jose mentioned wind energy earlier. The wind can turn the generator. Solar panels do not use copper wires and magnets to make electricity, we'll learn more about that soon. But most cities turn the generators another way."

Another round of probing questions begins as students are reminded of their unit on energy transfers. It takes 15 minutes before the answer becomes clear. Ms. V asks John to summarize the answer for the others.

"We light fossil fuels on fire or use uranium in a nuclear power plant to create heat. Either way, the heat boils water, which produces steam. The steam is used to turn the generator."

Ms. V has set the foundation for her next lesson. The students will learn how different sources of energy generate electricity. They will compare their costs and benefits. The project will include how the burning of fossil fuels contributes to climate change.

Reflection Questions

1. What's your biggest concern about teaching climate change? Can you see that changing after you read this book?
2. How do you feel when you think about the opportunities lost to correct environmental damage earlier?
3. How would you help your students work through their feelings about climate change? Can you think of actions that can be done at your own school or in the local community to give your students agency?
4. Why do you think it's important to talk about climate change and other societal challenges on a personal level?
5. Have you taken any personal steps to address the climate crisis? If so, what were they and which one was the most challenging for you? What inspired you to make these changes in your life?
6. When it comes to combating climate change, which do you think is more crucial: individual behavior change or broader policy change? Or do we need both to make a significant impact?
7. What is your connection with nature and the climate? What do you think this relationship will look like in the future?
8. Are you concerned about climate change? If yes, what worries you the most? And what measures would you like to see taken to combat it?
9. Have you ever experienced or witnessed the effects of climate change directly?

For Further Reading

FOR TEACHERS

Doerr, J. E. (2021). *Speed & scale: An action plan for solving our climate crisis now*. Portfolio.

Hayhoe, K. (2021). *Saving us: A climate scientist's case for hope and healing in a divided world*. One Signal Publishers/Atria Books.

Figueres, C., & Rivett-Carnac, T. (2020). *The future we choose: Surviving the climate crisis* (1st ed.). Alfred A. Knopf.

Ritchie, H. (2024). *Not the end of the world: How we can be the first generation to build a sustainable planet*. Little Brown Spark.

FOR STUDENTS

Ages 8 and up

Gilles, R. (2021). *Climate change in infographics*. Cherry Lake.

Ages 7–10

Jackson, T., & Kordić, D. (2022). *How do we stop climate change?* Weldon Owen Children's Books.