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AMERICAN Educator

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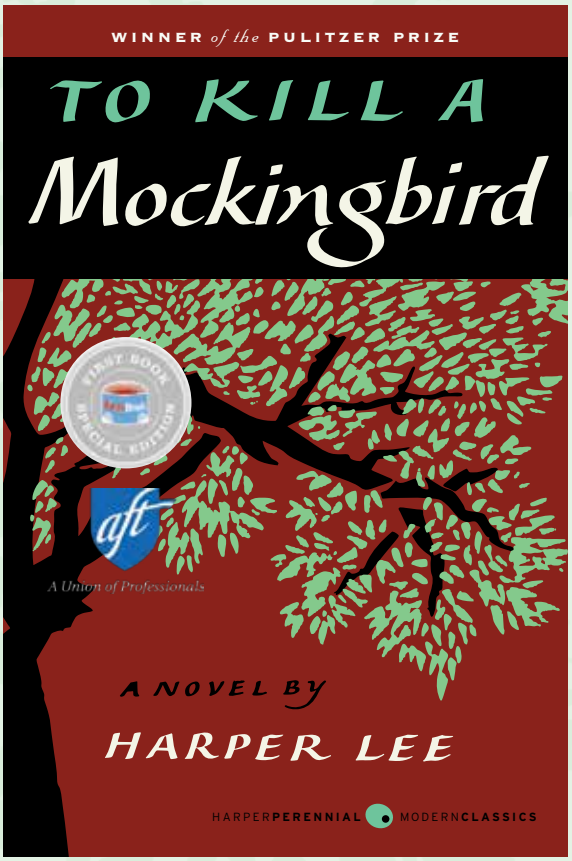
Teaching Climate Change

WHAT EDUCATORS SHOULD KNOW AND CAN DO PAGE 4



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Public Schools Week

LEARNING FIRST ALLIANCE

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A Beacon of Hope on Climate Change

RANDI WEINGARTEN, AFT President

STUDENTS AND EDUCATORS are involved in many of the mass movements of our time—from calling for sensible policies to combat climate change and gun violence, to protesting the inhumane treatment of immigrants and supporting the Black Lives Matter movement. In the fight for environmental justice, much of the leadership is coming from students—and their teachers couldn't be prouder.

One of the foremost purposes of education is to prepare young people for the possibilities and responsibilities of citizenship. This goes way beyond the memorization and regurgitation of facts. Teachers guide their students to develop judgment and discernment to be engaged and empowered participants in society.

This is why the American Federation of Teachers fights for the freedom to teach so classrooms are freed from the tyranny of high-stakes testing and test prep, to allow time for project-based learning—so students can analyze problems in their communities, figure out potential solutions, and advocate for change. It's why we reject lockstep pacing calendars, so we can have extended classroom discussions and debates. Teachers need this latitude to help their students develop the confidence to make their voices heard, the courage to challenge injustice, and knowledge of the levers that can bring about change.

All this is necessary to prepare this and future generations to address the enormous crises of our age—extreme economic inequality; dangerous assaults on our democracy; polarization, bigotry, bullying, and divisiveness; and, as this issue of *American Educator* explores, existential climate change.

In one of the largest youth-led demonstrations in history, the Global Climate Strike in September galvanized millions of activists worldwide to take to the streets for climate action. It was started by 16-year-old Greta Thunberg, led by thousands of students, and supported by hundreds of organizations, including the AFT. Students across the United States walked out of school to participate. Educators, including AFT members, didn't just show up, they helped navigate an array of policies in various districts regarding student absences, logistical support, and participation in student-led actions—as well as teaching classroom lessons on climate change.

Young Americans have grown up in an age of the earth warming, seas rising, devastating wildfires, and frequent "once in a century" storms. They are taking their future into their own hands. They understand their power to bring about change. But they need people already in power to act now to address the worsening climate crisis. Beyond demonstrations, people must use the political process to change policy.

Today, even as the focus of the environmental movement has evolved from concerns about pollution to fear of possible *extinction*, proponents and opponents of tackling climate change largely take their places along party lines. But safeguarding the environment was not always a partisan matter. The Environmental Protection Agency was established during the Nixon administration, and President Richard Nixon planted a tree on the South Lawn of the White House to recognize the first Earth Day. The Senate passed the Clean Air Act in 1970 without a single nay vote.

In the decades since, environmental regulations and enforcement have helped clean up rivers so polluted with toxins that they once caught on fire, and reduced smog and acid rain. Wind and solar energy are booming. Cleaning up our environment is not a choice between jobs and the environment. As new green technologies show, we can grow the economy, sustain good jobs, and save our planet.

The disastrous effects of climate change are outpacing policy changes to combat them. Corporations and opponents of government regulations have leveraged their fortunes and influence to undo environmental protections. Communities of color and low-income people suffer disproportionately from environmental degradation and climate change. President Trump has withdrawn from the Paris climate agreement, and his administration has reversed many efforts to safeguard the environment. Trump and his administration have abandoned the once bipartisan leadership of the United States in addressing global climate change.

Young people recognize the urgency of the climate crisis that their elders failed to summon.

People want a better life and a better future. But we need the means. That is why it is so important that individuals—not just the most powerful—have a voice in our democracy. Young voters increasingly name protecting the environment as one of their top concerns. People too young to vote are raising their voices in other ways—walking out in climate strikes, standing up, and speaking out.

Young people recognize the urgency of the climate crisis that their elders failed to summon. We must join them—pushing for bold political and policy initiatives to reverse climate change and reduce the intertwining issue of economic inequality. Our youth have lit a spark and given us a beacon of hope. We must follow their lead.

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TEACHING CLIMATE CHANGE

OUR MISSION

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Praise for "Confronting Bias in Schools"

As an educator in the Bethpage school district for 22 years, I felt compelled to write. The Fall 2019 issue on bias in schools is one that I will be keeping. I found every article to be not only interesting but useful to me in my classroom, from the educator who wrote about the principal being asked to stop walking Muslim students to their mosque, to the article on how Abraham Lincoln in his first presidential address did not mention anything about wanting to free the slaves, to the article on developing inclusive youth.

I teach sixth-grade social studies, and I have 100 students of different ethnic backgrounds, which I LOVE about my class. One of the units I teach is "Religions of the World," and it's my favorite. I must say, after the week-and-a-half-long unit, the religion that the kids say they learned the most about is Islam, as it's the one religion about which so many of them know so little.

Stay positive!

—MONICA KLEIN
JFK Middle School
Bethpage, NY

Sharing the Importance of Art

Thank you for the two art education articles in the Spring 2019 issue. I love and use Visual Thinking Strategies (VTS) all the time, which was discussed in "Art in School" by Philip Yenawine, and I know social studies and English language arts teachers who use VTS, too. The format makes for terrific introductions and segues between units of study and for all age groups. Whenever I have used it, students were enthusiastic and highly successful.

I also enjoyed reading "Art and Healing in Puerto Rico," another article valuing arts in education. Half of my school day is spent working with at-risk teenagers in an alternative high school. The students experience an alarming amount of anxiety, depression, and trauma. One of my primary goals in art is to offer a healthy outlet for my students. I'm not a therapist, but I engage them in therapeutic projects and a supportive environment, and I let students open up to me about as much or as little as they feel comfortable with.

Sometimes as an art teacher, I feel like I spend more time than other teachers might need to in defending my program. Most of us in public education experience belt tightening and program cuts; too often it's the arts that get squeezed. Thank you for sharing the importance and contributions of visual arts. "Art in School" should be required reading for all administrators, school board members, and policymakers… and the occasional coworker or parent who scoffs at art class.

—JILL WAZ
North Park Junior High School
Lockport High School West
Lockport, NY

Reflecting on Math

In "Developing Mathematical Mindsets," which appeared in the Winter 2018–2019 issue, math education professor Jo Boaler contends that "mindless practice and speed drills" constitute an "approach to early learning about numbers that causes damage to students." That's a serious charge. Is it justified? Let's see what science says about "practice" and "speed."

In the Spring 2004 issue of *American Educator*, cognitive scientist Daniel T. Willingham advised, "It is difficult to overstate the value of practice. For a new skill to become automatic or for new knowledge to become long-lasting, sustained practice, *beyond the point of mastery*, is necessary." In a 2008 report on learning processes in mathematics education, five U.S. leaders in the scientific study of how the brain solves problems wrote, "Verbatim recall of math knowledge is an essential feature of math education, and it requires a great deal of time, effort, and practice."

Is *speed* in math recall necessary? Science says yes. Why? As measured by science, "working memory" (where the human brain solves problems) has an essentially unlimited ability to apply facts and procedures that can be *quickly* recalled from long-term memory. However, at each step during reasoning, working memory can generally hold only seven or fewer elements of data and/or *not*-well-memorized relationships, each for 30 seconds or less (see "Putting Students on the Path to Learning" in the Spring 2012 issue of *American Educator*).

To work around this bottleneck, scientists in the learning processes report cited above agree that the "central" strategy is "the achievement of automaticity, that is, the fast, implicit, and automatic retrieval of a fact or a procedure from long-term memory."

For most of her article, Boaler rejects practice or assessment that requires speed in recall (automaticity). But near the end, she endorses automaticity if it is achieved by methods such as her untimed math cards, which require students to explain each basic arithmetic answer to their teacher.

In classes with 25–35 students, for the over 200 basic arithmetic facts, is there time for such explaining?

As education professionals, we must do our best to follow scientific best practices. If we listen to science on the importance of speed and automaticity, student prospects in careers that require math will rise. Poor and minority children will especially benefit.

For teachers seeking to know how we can apply science to help children learn, *American Educator* has always been a vital and unique source of guidance. I hope that tradition will continue.

—ERIC "RICK" NELSON
Former president of the Fairfax County (VA) Federation of Teachers

Teaching Climate Change

What Educators Should Know and Can Do

Fires in the Jamari Forest Reserve, Brazil.

By Daniel P. Shepardson and Andrew S. Hirsch

Heat waves and wildfires in the West, severe storms and tornadoes in the South, intense hurricanes along the coasts, and extreme rainfall and flooding in the Midwest and Great Plains. As more and more people personally experience severe and extreme weather events, they are increasingly likely to believe in climate change. Yet, many still deny or fail to understand how human activity, especially the burning of fossil fuels, is causing global warming and climate change. Thus, there is a need to educate today's students, tomorrow's leaders and decision makers, about global warming and climate change. It is, however, a challenging subject to teach. This is in part because: (1) climate change is an interdisciplinary subject; (2) it requires students to analyze scientific data and connect it to scientific models; (3) student learning is influenced by prior knowledge and experiences; and (4) it lacks a well-developed conceptual framework and learning progression.[1]

In this article, we outline five critical topics about global warming and climate change that secondary students should learn and that every adult should understand: (1) weather, climate, and climate change; (2) the earth's climate system; (3) the earth's energy budget and the greenhouse effect; (4) energy use and carbon emissions; and (5) climate change debate or not. For each, we articulate key concepts and provide some pedagogical suggestions in an attempt to promote the teaching and learning of global warming and climate change. But first, let's review the science and what students know.

Global Warming and Climate Change

The scientific community agrees that the earth is warming and that this is due to human activity, primarily the burning of fossil fuels (coal, oil, and natural gas), which alters the atmospheric composition of greenhouse gases.[2] Greenhouse gas emissions, particularly carbon dioxide (CO_2), from energy use has increased global atmospheric concentrations of CO_2 to historic levels, 412 parts per million.[3] This, in turn, has resulted in an increase in global radiative forcing, caus-

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ing the earth's average surface temperature to increase by about 1.6 degrees Fahrenheit since the late 19th century (see Figure 1). This global warming has caused regional changes in temperature, precipitation, and extreme weather events.[4] In other words, the earth's climates are changing. Natural climate variations alone, whether due to changes in the sun's radiance, the earth's orbit, or volcanic eruptions, cannot account for the degree of warming measured over the last 50 years. A changing climate impacts the earth's oceans, snow and ice, and ecosystems.[5] For example:

- Oceans are warmer, more acidic, and rising;
- Arctic sea ice and glaciers are melting;
- Snow cover and snowpack has declined; and
- Growing season length, insect infestations, and bird migrations have changed.[6]

Furthermore, climate change will likely have human health and socioeconomic consequences.[7]

We should note that global warming and climate change are two distinct phenomena that are closely linked. Global warming refers to the measured increase in the global average temperature of the earth, and this warming is causing the earth's climates to change. Climate change is the statistically significant change in the atmospheric conditions due to human activity, of which global warming is one factor.*

Students' Understanding of Global Warming and Climate Change

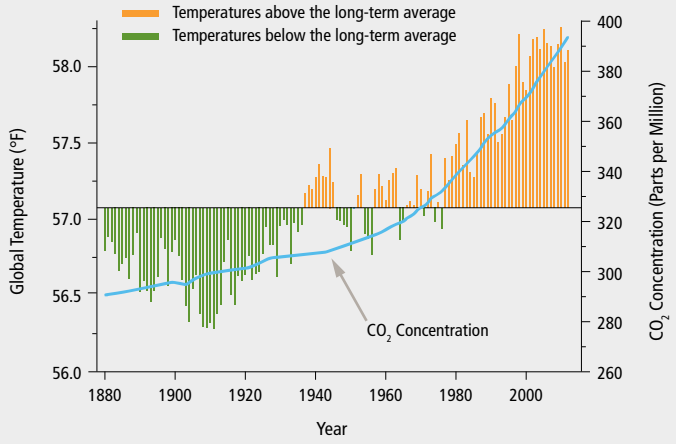
From our reviews of the research on secondary students' understanding of global warming and climate change, we developed a general model of students' understanding, as shown in Figure 2. We should note that some students think the greenhouse effect and global warming are the same, and that some students think the greenhouse effect is caused by humans. Our work and the research of others have also shown that secondary students lack an understanding of:

- The relationship between the biogeochemical cycles, the greenhouse effect, and the earth's energy budget;[8]
- The impact of the greenhouse effect on global warming and its effect on the climate;[9] and
- The impact of climate change on the earth's spheres or components (e.g., oceans, weather, animal and plant distributions/diversity, and land).[10]

Our review of science textbooks and laboratory manuals found that many isolate or separate the climate from climate change, and that few foster students' conceptual understanding about global warming and climate change. In fact, some may promote misconceptions about the greenhouse effect.[11] Science textbooks may also be promoting doubt about the scientific conclusion that recent changes in the climate are primarily driven by human activity. An analysis[12] of several middle school science textbooks found that the textbooks' grammatical choices expressed uncertainty about whether climate change was happening at all and about

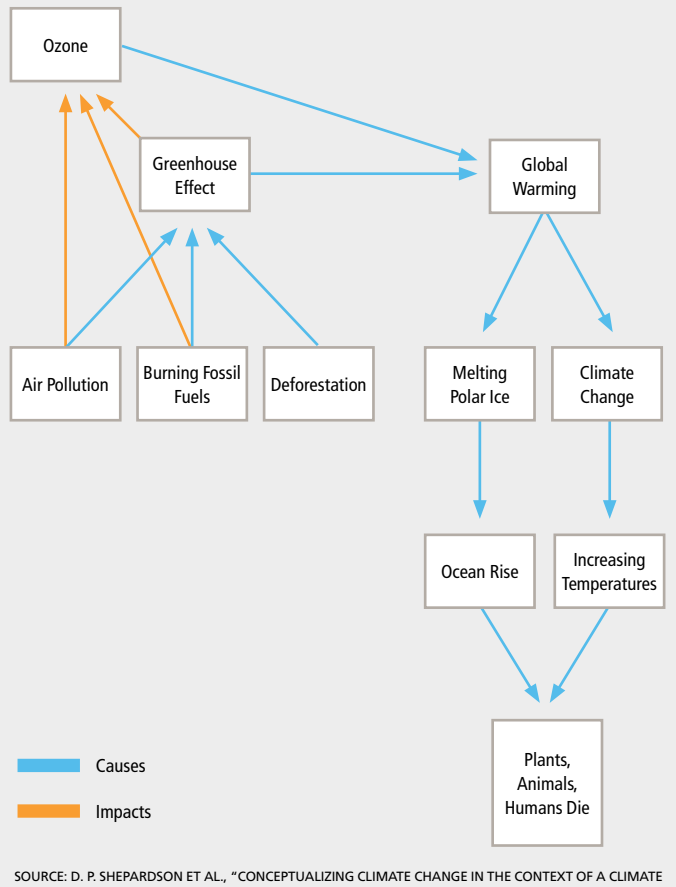
*For more on climate change data, visit https://science2017.globalchange.gov and https://nca2018.globalchange.gov.

Figure 1. Global Temperature and Carbon Dioxide Levels



SOURCE: U.S. GLOBAL CHANGE RESEARCH PROGRAM, *CLIMATE CHANGE IMPACTS IN THE UNITED STATES*, THIRD NATIONAL CLIMATE ASSESSMENT, 2014, 23.

Figure 2. Model of Secondary Students' Understanding of Climate Change



SOURCE: D. P. SHEPARDSON ET AL., "CONCEPTUALIZING CLIMATE CHANGE IN THE CONTEXT OF A CLIMATE SYSTEM: IMPLICATIONS FOR CLIMATE AND ENVIRONMENTAL EDUCATION," *ENVIRONMENTAL EDUCATION RESEARCH* 18, NO. 3 (2012): 323–352.

whether humans were responsible. Thus, textbooks add to the challenge of teaching students about global warming and climate change.

The Five Critical Topics Every Student Should Understand

1. Weather, Climate, and Climate Change

Many students struggle to understand the relationship between weather and climate, and the related concept of climate change. Therefore, it is important that students first learn about weather and then investigate weather events in the context of climate data to learn about climate change. The difference between weather and climate is a matter of scale. Weather is the short-term (hours, days, weeks) conditions of the atmosphere described in terms of temperature, precipitation, humidity, wind, cloudiness, visibility, and air pressure. Weather is inherently variable, changing from day to day and season to season, with atmospheric conditions fluctuating naturally within a given range for a specific time and place.

Climate is the average of this variability in weather for a 30-year or longer time period. It is the "smoothing" of the variation in weather. While the "average" climate is most often talked about, long-term climate data also help us describe the range of expected conditions for a location, the frequency of extreme weather, and the likelihood of certain types of weather events. Climate data are essential for understanding patterns, trends, and changes in our long-term climate. To reiterate, climate change is the statistically significant change in atmospheric conditions due to human activity.

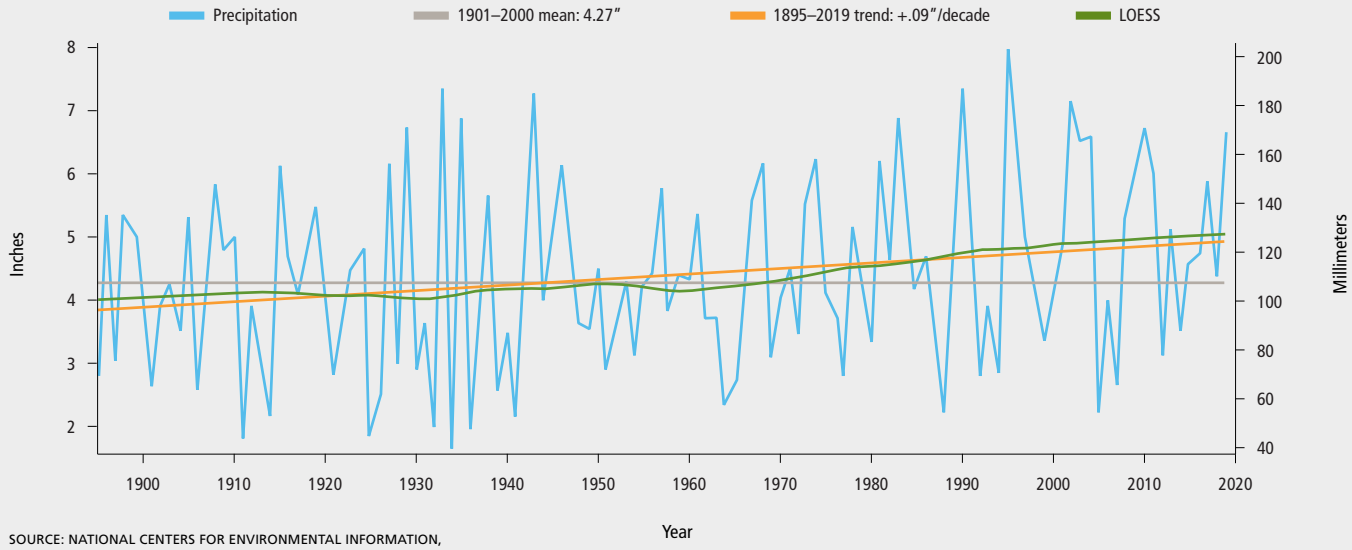
One of the challenges in teaching about climate change is that it cannot be directly experienced or measured in the timescale of a classroom lesson. Students can measure the daily weather or an extreme weather event, but what they are observing might be climate change or it might be natural variability in the atmosphere. Comparing weather data to climate data helps us put the weather in context, but attributing a weather event to climate change is difficult. There is an entire field of climate science research that explores extreme weather event attribution to climate change. Still, comparing weather and climate data, students can begin to understand the connection between extreme weather events and climate change, on a basic level, by exploring the patterns and trends in past climate data.

The aftermath of Hurricane Dorian in Abaco, Bahamas.

To teach about weather and climate, teachers might have students collect daily temperature and precipitation data for a period of time and then compare that data to the National Oceanic and Atmospheric Administration's (NOAA) climate data for the United States or their region or state. Teachers and students may access this data at NOAA's "Climate at a Glance" web page: www.ncdc.noaa.gov/cag. Here, teachers and students can manipulate and analyze a variety of climate data (e.g., temperature, precipitation, cooling and heating degree days, and drought indices).

For example, given the extreme precipitation events that occurred this spring, we were interested in comparing May 2019 precipitation with climate data for the Ohio Valley region. Using the online tool, we generated a time series graph for the month of May starting with 1895 and ending in 2019 (see Figure 3), but we could have selected any time period, as long as it was 30 years or more, and any location in the United States. The tool is easy to use, and with the

Figure 3. Precipitation Record for the Ohio Valley Region



SOURCE: NATIONAL CENTERS FOR ENVIRONMENTAL INFORMATION, "CLIMATE AT A GLANCE," WWW.NCDC.NOAA.GOV/CAG.

online version, you can zoom in and out on the graph, making it easier to interpret, and you can download the raw data, which is also shown online. Interpreting the graph, we can see that May 2019 precipitation was above the average (normal) for the time period identified and is in line with the increasing precipitation trend over the last century. Students can also see the year-to-year variability in precipitation; that is, some Mays are wetter and others drier, but overall May precipitation is increasing in the Ohio Valley region.

Teachers and students may also use climate data to answer questions they might have about the climate and climate change. For example, students might want to know if other U.S. regions experienced the same extreme May precipitation as the Ohio Valley region, and, if so, if there is an increasing trend in precipitation for those regions. Or students might want to know how May precipitation for the Ohio Valley region has changed over time periods, generating a series of 30-year time period graphs (e.g., 1899–1929, 1929–1959, 1959–1989, and 1989–2019). In this way, students are engaging in more authentic science by asking their own questions about the climate and climate change and by using "real" data to answer their questions.

If teachers lack classroom computers, they could generate data sets from the website for students to analyze on paper. These approaches to learning about weather, climate, and climate change are aligned with the Next Generation Science Standards (NGSS),[13] which stress the importance of student engagement in science practices: asking questions, analyzing and interpreting data, constructing explanations, and evaluating and communicating information.

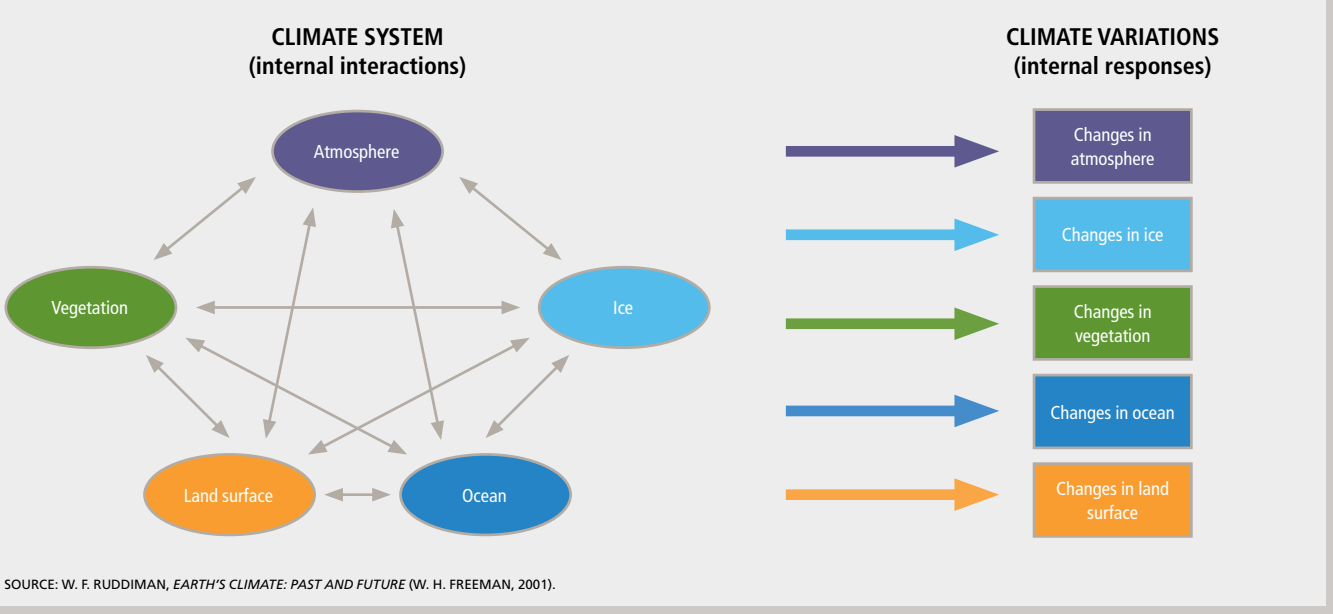
> Many students struggle to understand the relationship between weather and climate.

2. Earth's Climate System

The climate of any given region on earth is determined by the climate system, which consists of five components: atmosphere, oceans, land, vegetation (life), and ice (as shown in Figure 4). A change in a region's climate system results in a change in that region's climate. A climate-literate individual understands how humans influence the earth's climate system, and vice versa.[14] At the same time, the NGSS[15] stress the importance of science instruction that engages students in analyzing, modeling, and thinking about systems in terms of their components and interactions. Therefore, it is important that students learn about the earth's climate system and use a conceptual model of the earth's climate system (e.g., Figure 4) as a tool for thinking about the climate and climate change. This approach focuses on looking at the components of the climate system (atmosphere, oceans, land, vegetation, and ice) and how they interact, going beyond simple cause-and-effect relationships, to think in terms of interdependence and feedbacks.

By using such an approach, students can diagram the movement of matter (e.g., CO_2) and the transfer of energy within and between components and "trace" the path of CO_2 and the sun's energy through the system, component by component. Students can use the conceptual model to answer questions and solve problems about the climate and

Figure 4. Climate System and Climate Variations



SOURCE: W. F. RUDDIMAN, *EARTH'S CLIMATE: PAST AND FUTURE* (W. H. FREEMAN, 2001).

climate change. For example: How would a warming ocean impact the climate system and climate? How might deforestation impact them? How does carbon move through the climate system, and how might that impact the system and climate?

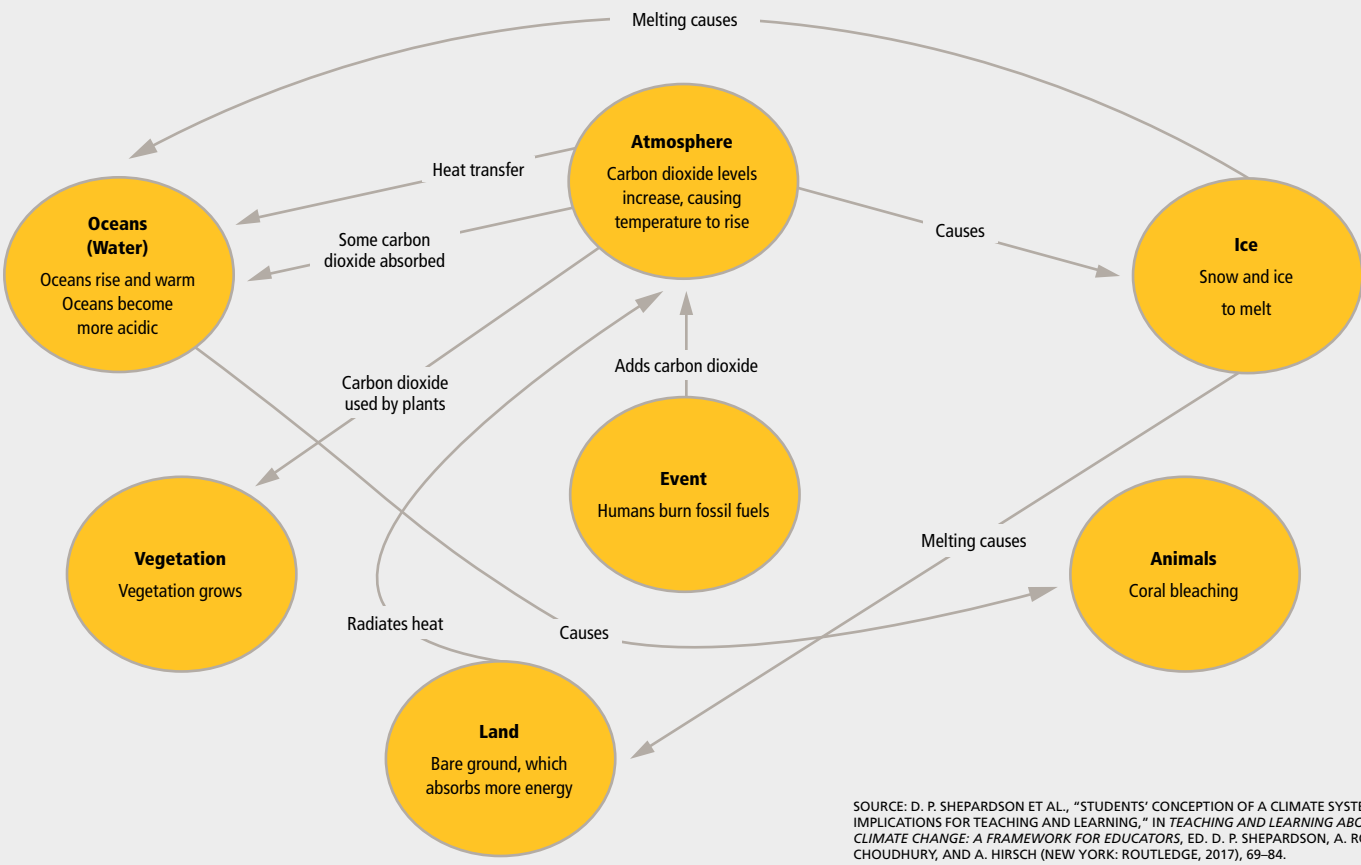
We have found success in eliciting students' ideas about the climate system by having them draw a climate system, label its parts, and explain their drawing. Students, in small groups, then share their drawings and explanations, discussing the similarities and differences. Next, students use a conceptual model (diagram) of the earth's climate system to compare and contrast their drawings (ideas) to the conceptual model. Again, they discuss the similarities and differences between their ideas and the conceptual model. As a result, the conceptual model becomes a tool that students use to reflect on their ideas and to think about the earth's climate system. Alternatively, teachers could have students in small groups create a climate system poster that is tacked to a display board and shared with the class and compared to the conceptual model.

Drought-withered crops in Texas.

Another tool to engage students is having them draw an event diagram, which is a means for thinking about the interactions between and among components of the climate system (see Figure 5). For example, students use the event diagram to think through how the burning of fossil fuels impacts the climate system. Students connect the various components as needed, identifying relationships, feedbacks, and interactions among components, thinking spatially and temporally. The event diagram scaffolds their thinking and makes their thinking visible.

Teachers might want to use a physical model of the climate system to demonstrate how different earth surfaces (e.g., ice, water, vegetation, and land) absorb and reflect sunlight (albedo), and then compare the demonstration to the climate system diagram. Teachers could model the climate system by using different colored sheets of construction paper to represent the different components of the climate system (e.g., white = snow/ice/clouds, green = vegetation, blue = water/oceans, and brown = land; note: black could be used to represent asphalt and gray concrete).

Figure 5. Example of an Event Diagram



SOURCE: D. P. SHEPARDSON ET AL., "STUDENTS' CONCEPTION OF A CLIMATE SYSTEM: IMPLICATIONS FOR TEACHING AND LEARNING," IN *TEACHING AND LEARNING ABOUT CLIMATE CHANGE: A FRAMEWORK FOR EDUCATORS*, ED. D. P. SHEPARDSON, A. ROYCHOUDHURY, AND A. HIRSCH (NEW YORK: ROUTLEDGE, 2017), 69–84.

To conduct the demonstration, place the different colored sheets of construction paper on a table under a light source. Using a light meter, measure the incoming light and then turn the light meter face down and measure the reflected light from each colored piece of construction paper. To determine the albedo of each colored paper, divide the reflected light reading by the incoming light reading. Surfaces with high albedo are reflecting more of the light energy, whereas surfaces with lower albedo are absorbing more of the light energy. Therefore, surfaces with high albedo will have lower temperatures than surfaces with low albedo. Surfaces with low albedo will be warmer and emit (radiate) more heat (infrared radiation).

Next, discuss with students how changes in the earth's components (different colored paper) might impact the earth's climate system. Changes in vegetation, land cover, or ice would impact albedo, increasing or decreasing the earth's temperature. For example, as polar snow and ice melt (white), more water (blue) and land (brown) are exposed to solar radiation. Because water and land have lower albedos than the snow and ice that melted, they reflect less and absorb more solar radiation, causing the earth to warm. The point here is that the earth's temperature may be changed by changing the earth's surface, which impacts the earth's albedo. Global warming is not restricted to changes in greenhouse gases; changes in albedo also impact global warming.

These approaches address what researchers[16] have identified from a review of the literature as key characteristics of systems thinking:

- The ability to identify the components and processes of the system;
- The ability to identify simple relationships between and among the components of the system;
- The ability to identify dynamic relationships within the system;
- The ability to organize the components, processes, and interactions of the system within a framework of relationships;
- The ability to identify the cyclic nature of the system;
- The ability to understand patterns and relationships within the system;
- The ability to generalize based on an understanding of the system; and
- The ability to think temporally, to think in terms of the past, present, and future.

As teachers develop and incorporate lessons and activities, they should integrate these eight aspects of systems thinking. By embedding them into the teaching of global warming and climate change, students would better understand how climate change is a result of a change to the climate system, how the components of the climate system interact to determine the climate, and how changing one component of the system impacts other components of the system.

3. Earth's Energy Budget and the Greenhouse Effect

The greenhouse effect is the driver of global warming, which causes the earth's climate to change. Thus, understanding the greenhouse effect is a key principle of climate literacy.[17] At the same time, it is difficult and challenging to teach students about the greenhouse effect.[18] Secondary students generally hold one of five mental models of the greenhouse effect that influences their thinking and learning (see the box below).

Understanding the greenhouse effect is a key principle of climate literacy.

As a side note, we have informally assessed university students and found similar mental models, with the exception of Model 1. In addition, some students believe that the greenhouse effect is caused by humans, equating global warming to the greenhouse effect. To clarify, the greenhouse effect is a natural atmospheric phenomenon that warms the earth's surface (see Figure 6). Human activities such as the burning of fossil fuels and deforestation (land surface changes) add extra greenhouse gases, particularly CO_2, to the atmosphere, increasing the warming effect, causing global warming. This is often referred to as the enhanced greenhouse effect.

Although the emphasis here is on teaching the greenhouse effect, we recommend that teachers start by teaching about the earth's energy budget, of which the greenhouse effect is a component. By doing so, we believe that students can develop a richer understanding of the physics of the greenhouse effect: the absorption, reflection, and radiation of the sun's energy, and the differentiation between solar radiation and terrestrial radiation.

Students' Mental Models of the Greenhouse Effect

Model 5. The sun's rays are "bounced" or reflected back and forth between the earth's surface and greenhouse gases, heating the earth (they may or may not identify specific greenhouse gases).

Model 4. Greenhouse gases "trap" the sun's rays, heating the earth (they may or may not identify specific greenhouse gases).

Model 3. There are greenhouse gases, but no heating mechanism; simply gases in the atmosphere.

Model 2. Greenhouse gases cause ozone depletion or formation, causing the earth to warm.

Model 1. "Greenhouse" stands for growing plants.

SOURCE: D. P. SHEPARDSON ET AL., "SEVENTH GRADE STUDENTS' MENTAL MODELS OF THE GREENHOUSE EFFECT, *ENVIRONMENTAL EDUCATION RESEARCH* 17, NO. 1 (2011): 1–17.

The common textbook activity used to teach students about the greenhouse effect is to have students set up a physical model. In general, this investigation requires students to set up two glass jars, one with a lid, and place a thermometer in each jar. They then expose the jars to a light source and record the temperature of the jars over time. The students describe their observations and explain their data, learning how the greenhouse effect traps heat and warms the air over time.

However, we[19] and others[20] have been critical of this physical model because of its limitations. For instance, this approach models a "greenhouse," not the "greenhouse effect." The critical difference is that in a greenhouse, the glass prevents the warmed inside air from mixing with the cooler outside air, preventing heat transfer or convection, thus warming the greenhouse. (Note: this is similar to why your car's interior heats up when parked in the sun.) This warming is due to the suppression of heat transfer by convection, versus radiative forcing that occurs in the greenhouse effect. We believe this physical model reinforces students' misunderstandings as represented in mental Models 1 (greenhouse) and 4 (heat-trapping).

Our suggestion for teachers who wish to use this physical model to teach the greenhouse effect is to engage students in using a conceptual model (as shown in Figure 6) of the earth's energy budget and greenhouse effect to discuss the limitations of the physical model. Teachers should engage students in identifying the ways that the physical model did and did not match the conceptual model.

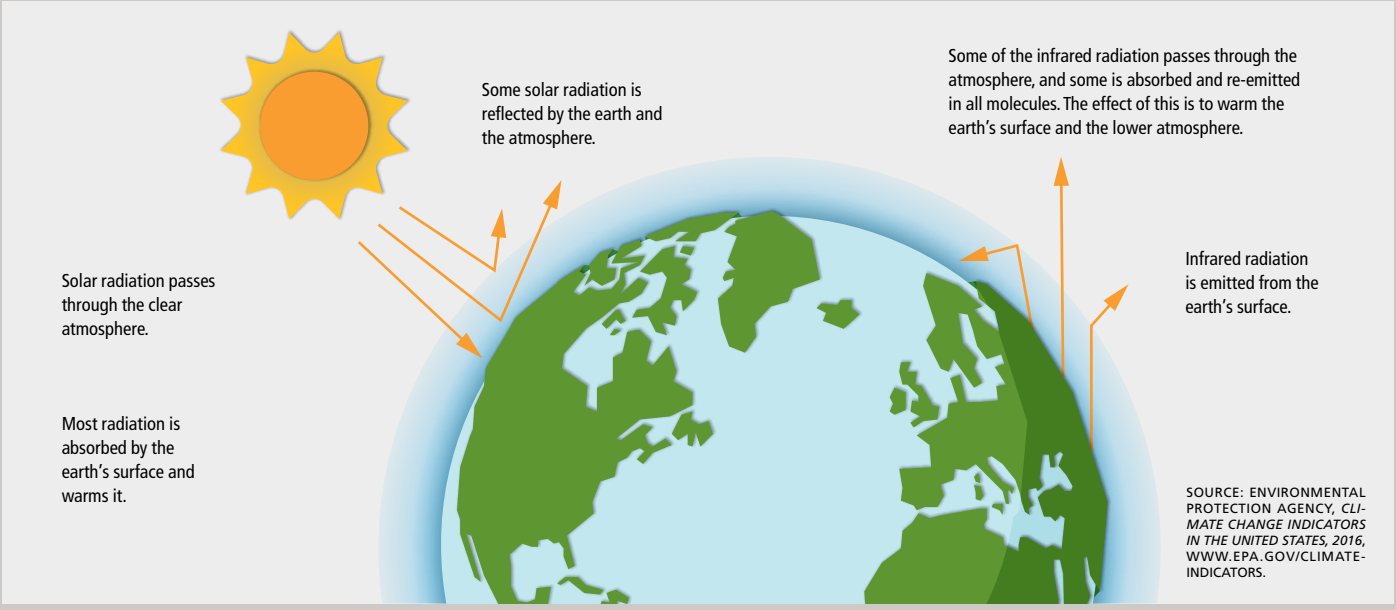
Additionally, we suggest that teachers elicit students' ideas by having them draw a picture of the greenhouse effect and label and explain their drawing. In small groups, students then share their drawings and explanations, discussing the similarities and differences. The teacher might even post the drawings on the board to facilitate a class discussion. Students then use a conceptual model of the earth's energy budget and greenhouse effect to compare and contrast their drawings and ideas (mental models) to the conceptual model. Again, they discuss the similarities and differences between their ideas and the conceptual model. The conceptual model becomes a tool that students use to reflect on their ideas and to think about the earth's energy budget and the physical model.

Fish kill in Redondo Beach, California.

Alternatives to the physical model of the greenhouse effect are two excellent PhET (Physics Education Technology) computer models or simulations from the University of Colorado. One (available at http://phet.colorado.edu/en/simulation/molecules-and-light) simulates the interaction of light with matter, while the other (available at http://phet.colorado.edu/en/simulation/greenhouse) simulates the effect of greenhouse gas concentration in the atmosphere on temperature through the absorption and emission of infrared radiation. Again, students should use a conceptual model of the earth's energy budget to explain how the computer models reflect the conceptual model.

One final point we would like to make is the importance of the language used to talk about the physical and conceptual models and student drawings (mental models). Students' initial ideas will likely reflect "everyday" language like "trapping heat" or "heat is trapped" or "light or heat bounces." This everyday language is a necessary first step to understanding the greenhouse effect; however, it is important to eventually

Figure 6. Greenhouse Effect



SOURCE: ENVIRONMENTAL PROTECTION AGENCY, *CLIMATE CHANGE INDICATORS IN THE UNITED STATES, 2016*, WWW.EPA.GOV/CLIMATE-INDICATORS.

differentiate and link this everyday language to the scientific ideas of absorption and emission or radiation of energy. The continued use of everyday language versus scientific language essentially reinforces or develops misunderstandings, such as the heat-trapping mental model.

4. Energy Use and Carbon Emissions

When it comes down to it, human-driven climate change is really an energy problem. The use of fossil fuels as an energy source results in the emission of CO_2 into the atmosphere. As previously mentioned, CO_2 is the key driver of global warming and climate change. Thus, to mitigate global warming, we must address our use of fossil fuels. We must understand how carbon is moved through the earth's climate system, how exactly we use fossil fuels, and what specifically are the major emitters, or sources, of CO_2.

> To mitigate global warming, we must address our use of fossil fuels.

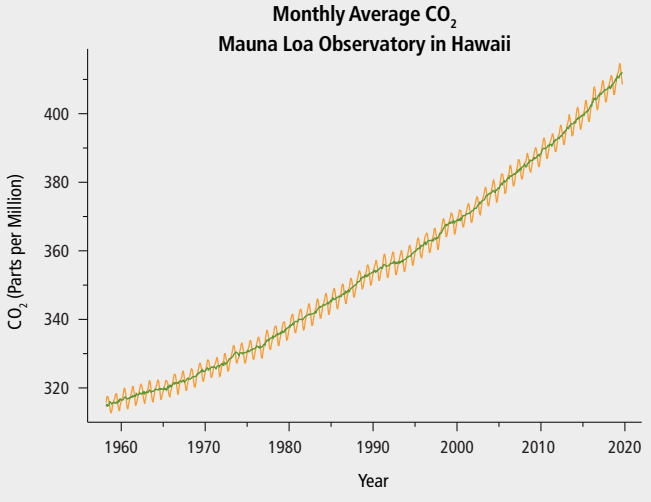
The atmospheric concentration of CO_2 is regulated by the global carbon cycle, the movement of carbon between the components of the climate system. Although this movement or flux of CO_2 is dominated by natural processes that cycle carbon between the atmosphere, land, vegetation, and oceans, human use of fossil fuels adds "extra" CO_2 to the atmosphere. This human-emitted CO_2 exceeds nature's capacity to absorb it, and as a result, atmospheric concentrations have increased over time.

The now-famous Keeling curve, a graph of the accumulation of carbon dioxide in the earth's atmosphere, shows this increase in atmospheric CO_2 levels (see Figure 7). When we burn fossil fuels, we release stored carbon into the atmosphere as part of the carbon cycle. Much of this carbon is stored in the atmosphere, where it may remain for 100 years, but some moves between the atmosphere, oceans, vegetation, and land. The atmospheric concentration of CO_2 has increased by about 40 percent since the 1800s.[21] (For the general movement of carbon, see Figure 8.)

One activity that simulates the movement of carbon and how human activity has impacted the global carbon cycle is "The Carbon Cycle, Then and Now," created by the Peggy Notebaert Nature Museum in Chicago. In this activity, students learn about the carbon cycle by becoming carbon atoms and moving to various stations that represent the components of the carbon cycle. Students complete the activity twice, once as carbon atoms prior to industrialization and once as postindustrialized carbon atoms. It is helpful to link this activity to the conceptual models of the carbon cycle and the earth's climate system by having students trace the movement of carbon through the conceptual models.

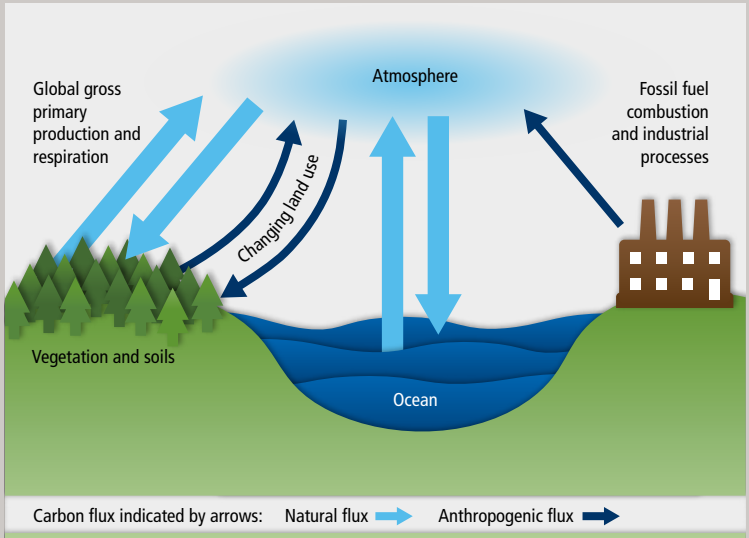
In 2016, fossil fuels provided about 81 percent of the energy used in the United States, and accounted for about 94 percent of CO_2 emissions.[22] A number of activities engage students in using carbon footprint calculators to help them determine their own carbon contributions to global warming and to engage them in thinking about the decisions they make and how they might personally reduce their carbon emissions. Although this is an important activity for students to learn about their carbon footprint, we agree with researchers[23] who contend that students must also understand the social,

Figure 7. Keeling Curve



SOURCE: NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, "TRENDS IN ATMOSPHERIC CARBON DIOXIDE: MONTHLY AVERAGE MAUNA LOA CO2," EARTH SYSTEM RESEARCH LABORATORY, GLOBAL MONITORING DIVISION, WWW.ESRL.NOAA.GOV/GMD/CCGG/TRENDS (RETRIEVED JUNE 2019).

Figure 8. General Carbon Cycle



SOURCE: ADAPTED FROM INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, *CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS*, FIGURE 7.3 (CAMBRIDGE UNIVERSITY PRESS, 2007).

political, and economic aspects of energy use and carbon emissions—the big picture, if you will.

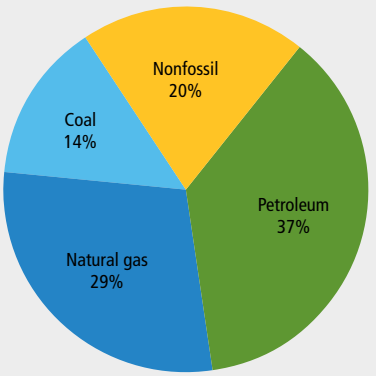
While individual action is important, it is likely that the solution to global warming will only be achieved at the policy level—through government action. Such action will likely be driven by individuals through economic and political activity. And this requires that students have a firm understanding of energy use and carbon emission data in order to make evidence-based arguments for policy change.

To help students understand how we use energy and emit CO_2 into the atmosphere, we suggest that students analyze energy and CO_2 emission data. Teachers and students may access this data from the U.S. Energy Information Administration's website: www.eia.gov. By investigating these data, students can learn about the relationship between fossil fuel use and CO_2 emissions (as shown in Figure 9), energy use and CO_2 emissions by sector (as shown in Figure 10), and other energy use data. Using this information, students can make data-based policy recommendations that aim to reduce carbon emissions at the regional, state, and national levels. Through this process, students consider the pros and cons of their policy decisions, and they consider how energy prices, weather, and current government policy might impact energy use and carbon emissions. The key here is that students are engaged with analyzing and explaining data in order to make evidence-based policy decisions or arguments.

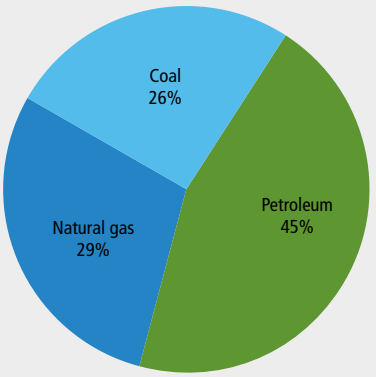
For sample classroom activities on energy use and CO_2 emissions, teachers can review the "Activities for Conceptualizing Climate and Climate Change" found on the Purdue Climate Change Research Center's website: www.ag.purdue.edu/climate. Secondary science teachers interested in a comprehensive curriculum that emphasizes the carbon cycle may want to review "Carbon TIME (Transformations in Matter and Energy)," a program funded by the National Science Foundation and led by Michigan State University: http://carbontime.bscs.org.

Figure 9. Energy Use and Carbon Dioxide Emissions

U.S. energy consumption by major fuel type, 2017



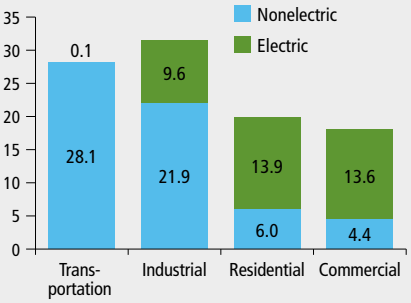
Resulting U.S. energy-related carbon dioxide emissions by major fuel type, 2017



SOURCE: U.S. ENERGY INFORMATION ADMINISTRATION, *MONTHLY ENERGY REVIEW*, TABLES 1.3 AND 12.1, JUNE 2018, PRELIMINARY DATA.

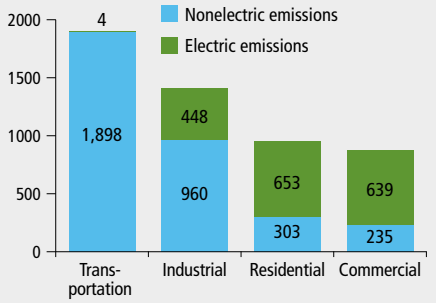
Figure 10. Energy Use and Carbon Dioxide Emissions by Sector

U.S. energy consumption by end-use sector, 2017
Quadrillion British thermal units



NOTE: ELECTRIC IS RETAIL ELECTRICITY PURCHASED FROM THE ELECTRIC POWER SECTOR; NONELECTRIC IS PRIMARY ENERGY.

Carbon dioxide emissions by end-use sector, 2017
Million metric tons of CO_2



NOTE: ELECTRIC EMISSIONS ARE FROM THE GENERATION OF RETAIL ELECTRICITY PURCHASED FROM THE ELECTRIC POWER SECTOR; NON-ELECTRIC EMISSIONS ARE FROM PRIMARY ENERGY CONSUMPTION.

SOURCE: U.S. ENERGY INFORMATION ADMINISTRATION, *MONTHLY ENERGY REVIEW*, TABLES 2.1 AND 12.1 TO 12.6, JUNE 2018, PRELIMINARY DATA.

5. Climate Change Debate or Not

Unfortunately, climate change doubters and deniers provide challenges to educators who teach about climate change, influencing how teachers present climate change in ways that compromise the scientific accuracy of their lessons. Researchers[24] found that some teachers, with good intentions, teach climate change in three inappropriate ways. One approach is to teach both the scientific perspective on climate change and the skeptics' perspective on climate change. But doing so suggests there is not a scientific consensus on the cause of climate change, and it gives credibility to perspectives that are not supported by the scientific community and climate data. A second approach is to encourage students to come to their own conclusion about the cause of global warming and climate change. And the third approach is to engage students in debating climate change. These approaches promote doubt and denial about climate change and suggest that it is a scientific controversy, which it is not. They also contradict the scientific community and the climate data and give credibility to science skeptics and their nonscientific data.

Given the scientific consensus on the cause of global warming and climate change, teachers should teach the scientifically accepted perspective on global warming and climate change—not debate it. The debate and controversy lie in the social, economic, and political approaches to mitigating and adapting to global warming and climate change. Teachers can engage students in debating these various approaches and solutions to climate change and making policy decisions about energy use.

A starved polar bear in Svalbard, Norway.

Teaching and learning about global warming and climate change is not easy. Students cannot directly monitor climate change due to time and spatial scale issues. Thus, in order to learn about climate change, it is necessary for them to interpret, analyze, explain, and evaluate climate data, model-based data projections, and conceptual models. Students need opportunities to think systematically about the earth's energy budget, climate system, and climate change. They need opportunities to investigate and consider energy use and carbon emission data. And it is important that students be given the opportunity to make informed decisions concerning their own personal actions and behaviors, as well as those of the societies in which they live.

Although we provided several examples of classroom activities, it is essential that teachers design a curriculum that is coherent, that reflects continuity, that builds from students' ideas and experiences, and that aligns with the scientific consensus. Thus, the time needed to teach about global warming and climate change and the curricular constraints and educational policies related to these topics further complicate such teaching. However, schools, school districts, state superintendents, and politicians must come to realize the impact of climate change and support the teaching of global warming and climate change for the betterment of our students and the future of our planet. ☐

Endnotes

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12. D. Román and K. Busch, "Textbooks of Doubt: Using Systemic Functional Analysis to

(Continued on page 40)

Classroom Resources on Climate Science

U.S. Global Change Research Program
www.globalchange.gov/resources/educators/climate-literacy

Purdue Climate Change Research Center
www.ag.purdue.edu/climate/education/for-k-12-teachers

Office of Energy Efficiency and Renewable Energy
www.eere.energy.gov/education/energy_literacy.html

Environmental Protection Agency
www.epa.gov/climate-indicators

NASA, "Global Climate Change: Vital Signs of the Planet"
http://climate.nasa.gov

National Center for Science Education
www.ncse.com/climate

National Climate Assessment
https://nca2018.globalchange.gov

National Oceanic and Atmospheric Administration
www.climate.gov

National Science Teaching Association
www.nsta.org/climate

Climate Literacy & Energy Awareness Network
http://cleanet.org/clean/literacy

Science Teachers in the Hot Seat

Climate Change Education in a Polarized Society

PHOTOS COURTESY OF THE NATIONAL CENTER FOR SCIENCE EDUCATION

By Glenn Branch

After its construction in 1879, the Connecticut state Capitol building was rhapsodically described by the *New York Times* in terms of a climatic conflict: "In the dazzling sunshine of a New-England Summer noon it sparkles like a fairy palace of frost-work."[1] One hundred and forty years later, there was again a climatic conflict in Hartford, when, on a chilly January day, Connecticut legislators began a heated tussle over the treatment of climate change in the state's public schools.

On January 19, 2019, Christine Palm, a new state representative who had previously worked as a high school teacher for a decade, introduced a bill to require "that the science curriculum of the prescribed courses of study for public schools include the teaching of climate change and that such teaching begin in elementary school." If House Bill 5011 had been enacted, Connecticut would have become the first state to require the teaching of climate change by law.

A scant five days later, a rival bill was introduced to "eliminate climate change materials" from the Connecticut state science standards, describing climate change as "a controversial area of information." The sponsor of House Bill 5955 was John E. Piscopo, a veteran representative serving as the chief whip for the House Republicans. On the same day, he also introduced a bill to rescind the standards altogether and require the state to revert to a previous set of standards.

The contest between Palm's bill and Piscopo's bill exemplifies the conflicts surfacing not only in state legislatures but also before state boards of education, in local school districts and individual schools, and even within the minds of science teachers, over what is taught about climate change to students in the nation's public schools. But none of these conflicts is as simple, unified, or easy to control as the Connecticut legislators seem to have thought.

The science is clear. Over 97 percent of climate scientists accept that recent climate change is the result of human activity, as multiple studies, relying on independent lines of evidence, have independently demonstrated.[2] The nation's leading scientific organizations, including the National Academy of Sciences and the American Association for the Advancement of Science, have assessed, reported, and endorsed the scientific consensus on climate change.[3]

Following the lead of the scientific community, the science education community is increasingly emphasizing the importance of climate change education. A 2018 position statement from the National Science Teaching Association acknowledges the overwhelming scientific consensus on anthropogenic

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(human-caused) climate change and calls for climate change to be taught "as any other established field of science"—and for proposals to downplay it, such as Piscopo's, to be resisted.[4]

What Do State Science Standards Say about Climate Change?

Ultimately, science teachers are guided mainly by the science standards of the state in which they teach. Science standards are triply relevant to curriculum and instruction: they dictate the content of textbooks; they provide the basis for high-stakes statewide testing; and, most importantly, they supply the framework on which local school districts construct their science curricula and on which individual science teachers base their day-to-day lesson plans.

Over the last 15 years, climate change's presence in state science standards has increased dramatically. As of 2005, according to a study by Kim Kastens and Margaret Turrin, of the 49 sets of state science standards then in use, only 30 mentioned any aspect of anthropogenic climate change whatsoever. Only 15 discussed its causes, whether specifically, by discussing fossil fuel use and changes in land use, or nonspecifically.[5]

Today, however, the science standards of 36 states (plus the District of Columbia) explicitly acknowledge the reality of anthropogenic climate change. These include the 20 states (plus the District of Columbia) to have adopted the Next Generation Science Standards (NGSS), which include global climate change as part of a so-called Disciplinary Core Idea of the earth and space sciences.[6] Connecticut, as Palm and Piscopo were aware, adopted the NGSS as its state science standards in 2015.

> Over 97 percent of climate scientists accept that recent climate change is the result of human activity.

Of the state science standards in the remaining 14 states, five (Alabama, Florida, Georgia, Oklahoma, and Virginia) mention anthropogenic climate change as a mere possibility, without acknowledging its reality; four (Montana, Nebraska, Ohio, and Pennsylvania) simply fail to mention it; and—worst of all—five (Mississippi, South Carolina, South Dakota, Texas, and West Virginia) mention it but misrepresent it as a matter of scientific debate.

Legislative efforts, such as Piscopo's, to undermine the treatment of climate change in state science standards are not uncommon. Over the last four years, for example, a series of bills was introduced in the Iowa legislature to reject the NGSS and then to rescind their adoption, largely over climate change. Similarly, in 2016, 2017, and 2018, the Idaho legislature attempted to block the adoption of new state science standards, again largely over climate change, and succeeded in doing so until 2018.

Sometimes the resistance is elsewhere in state governance. In West Virginia in 2015, the state board of education took it upon itself to tamper with the treatment of climate change in a newly adopted set of state science standards, while in New Mexico in 2017, the state department of education removed references to human activity as the primary cause of climate change from a set of draft standards. New Mexico ultimately adopted the NGSS, but West Virginia's standards on climate change remain subpar.

Overall, though, the arc of state science standards is clearly bending toward including climate change as the scientific community understands it. But is that enough? Clearly Christine Palm thought otherwise. Recognizing that Connecticut's state science standards already included climate change, she told *Grist* that she nevertheless felt that climate change education "needs to start earlier"—her bill provided "that such teaching begin in elementary school"—"and it can't be optional."[7]

These ambitions were arguably realized already. While climate change is not explicitly mentioned in the NGSS at the elementary level, the foundations for a later understanding of climate change are present. And while state science standards lack the force of law, compliance is expected: the standards establish a certain set of practices through the state's educational system that generally ensure that topics contained in the standards will, in fact, appear in the classrooms.

But there is still cause for concern. In general, the treatment of anthropogenic climate change is most explicit and most complete in the state science standards for high school classes in earth sciences and environmental sciences. But such classes are usually not required for graduation from high school—a 2015 study found only two states in which they are, Connecticut not among them—and are often not even offered, rendering these standards largely inert.[8]

To be sure, the connection between the science standards and the science classroom is loose. Even in states where the standards fail to explicitly acknowledge the reality of anthropogenic climate change, there are teachers who succeed in teaching about climate change within the structure of the standards anyhow. By the same token, however, there are teachers who fail to educate—or who miseducate—their students about climate change even in states with science standards excellent on climate change.

What Are Science Educators Teaching about Climate Change?

To ascertain what, in fact, science educators in public schools are teaching about climate change, and how they are teaching it, the National Center for Science Education (NCSE) and researchers at Pennsylvania State University conducted a rigorous national survey in 2014–2015, administering a detailed questionnaire to a random sample of 1,500 science teachers in public middle and high schools in all 50 states.[9] In the results, there was good news and there was bad news.

The good news was that climate change is taught. Only a few of the science teachers—less than one in 20—reported encountering overt pressure not to teach climate change. Only a tiny few—about one in 50—reported allowing students

to "opt out" of learning about climate change. The survey asked whether climate change was covered at all in the teacher's school: climate change is apparently taught in about 90 percent of all public middle schools and about 98 percent of all public high schools.

Overall, three in four science teachers reported devoting at least one hour to teaching climate change, with the average amount of time about four hours: almost all high school earth science teachers reported doing so, for about six hours on average. Topics essential to understanding climate change, such as the greenhouse effect and the carbon cycle, were usually discussed; so were the observable consequences of climate change and possible ways of mitigating and adapting to climate change.

But there was bad news too. Particularly worrisome was the fact that four in 10 science teachers reported that they emphasize that many scientists believe that recent increases in temperature are probably due to natural causes. A minority of those teachers emphasized *only* that claim, with the majority reporting that they *also* emphasize what is in fact the scientific consensus—as if miniatures of Palm and Piscopo were perched on their shoulders, whispering contradictory advice into their ears.

Misconception-based learning is particularly important for topics where misconceptions are rampant.

Also worrisome was that the science teachers tended to use pedagogical techniques that conveyed doubt and denial to their students. Six in 10 said that they encouraged students "to come to their own conclusions about the causes of global warming"; almost as many said that they encouraged students "to debate the likely cause of global warming"; and almost three in 10 said that they gave "equal time to perspectives that raise doubt that humans are causing climate change."

Why are so many teachers failing to present the scientific consensus on climate change straightforwardly and without compromise? Part of the reason is clearly a lack of knowledge on their part. More than half of the teachers reported having never taken a course in college that devoted even a single class session to climate change. Such teachers were less likely to emphasize the scientific consensus and more likely to present supposed alternative perspectives as scientifically credible.

A telling result from the survey involves awareness of the extent of the scientific consensus. Asked to estimate what proportion of climate scientists think that global warming is caused mostly by human activities, only 39 percent of the teachers (45 percent of high school teachers and 30 percent of middle school teachers) selected the correct quintile, 81–100 percent. The teachers outperformed the public—in 2016, 21 percent of registered voters selected the correct quintile—but not by a huge margin.[10]

But the NCSE/Penn State survey also found that the personal beliefs of the teachers—especially those associated with their religious and political values—were also relevant. Those who regarded the Bible as the actual word of God to be taken literally, those who identified as Republicans, and those who favored libertarian and small-government views were all less likely to emphasize the scientific consensus on climate change and more likely to present supposed alternative perspectives.

The religious and political values of the communities in which the teachers work also proved to play a role. For example, teachers in counties that tend to vote Republican were less likely to be aware of the extent of the scientific consensus on climate change than teachers in counties that tend to vote Democratic, regardless of their own political views. And awareness of the extent of the scientific consensus was correlated both with acceptance of the consensus and willingness to present it as such in the classroom.

Of course, it is not surprising that teachers will tend to feel uncomfortable in teaching the scientific consensus on climate change insofar as they believe that the communities in which they teach reject that consensus. But their responsiveness to community sentiment suggests a possible further motive for legislation like Piscopo's in Connecticut: a widely publicized allegation that climate change is "a controversial area of information" may in itself discourage educators from teaching the topic properly.

How Is NCSE Supporting Science Educators in Teaching Climate Change?

In the NCSE/Penn State survey, it was clear that the science teachers were comparatively unprepared to teach climate change in accordance with the scientific consensus. A majority of teachers rated their knowledge of climate change models as average or below average. Encouragingly, however, they are clearly open to learning about climate change. A majority of teachers indicated that they would be interested in taking a continuing education course entirely focused on climate change.

Climate change deniers are trying to take advantage of the situation. In 2017, a right-wing think tank called the Heartland Institute mailed unsolicited packets of climate change denial propaganda to tens of thousands of public school science teachers across the country.[11] (Piscopo is allied with the Heartland Institute, reportedly working with a Heartland Institute staffer in 2017 to call for a review of the Environmental Protection Agency's 2009 Endangerment Finding that greenhouse gas emissions endanger public health and welfare.[12])

The Heartland Institute's campaign was not welcomed by teachers, whose most common response was to deposit the packets in the nearest recycling bin. A few teachers took the opportunity for a teachable moment with their classes on the nature of propaganda, reveling in the jujitsu irony of using the efforts of climate change deniers against their cause. Particularly charming was the description of the material from a Massachusetts elementary student: "Stupid Book of Wrongness."[13]

In contrast, the National Center for Science Education is currently disseminating a pioneering set of lesson plans specifically geared to help science teachers present the scientific consensus

NCSE's lesson plans are freely available at www.ncse.ngo/supporting-teachers/classroom-resources.

on climate change effectively. In these field-tested lesson plans, students are guided in hands-on, data-driven, real-world engagement with the evidence for climate change to construct a scientific understanding of climate change for themselves.

The focus on the evidence for climate change makes the lesson plans eminently customizable, particularly with regard to location. In studying the relationship between extreme weather events and climate change, for example, students in upstate New York can focus on lake effect snow, while students in western Wyoming can focus on wildfires and students in coastal Texas can focus on flooding. Nothing brings home climate change like climate change at home.

But what makes the lesson plans pioneering is their use of misconception-based learning. As John Cook, who helped to develop the plans, explains, "In misconception-based lessons, misconceptions are first activated then immediately countered with accurate information or inoculating refutations." He adds, "Misconception-based learning has been found to be one of the most powerful ways of teaching science," engaging students better and producing stronger enduring gains in learning.[14]

Misconception-based learning is particularly important for topics where misconceptions are rampant, such as climate change. In today's ideologically polarized society, with conflicting messages about climate science vying for attention and credibility among the public, it is important for students not only to understand the scientific consensus and the evidence on which it is based but also to understand the ways in which it is commonly misunderstood and misrepresented.

Accordingly, the lesson plans—developed by teams of master teachers aided by scientific experts—are intended to help students overcome five central misconceptions that they are likely to bring to the classroom: that scientists disagree about climate change; that scientific models of the climate are not reliable; that climate change is a natural and unstoppable process; that extreme weather is not attributable to climate change; and that there are no meaningful solutions to the climate crisis.

Throughout, students learn to debunk these misconceptions using a fact-myth-fallacy structure. First, the facts of the science—not the misconceptions—are emphasized. Only then is the misconception, clearly indicated as such, introduced. And then the fallacy used to support the misconception and distort the facts is identified, enabling the student to understand why the misconception reflects a myth. There is increasing experimental evidence for the effectiveness of such a procedure.[15]

NCSE is supporting master teachers in widely disseminating these lessons through professional development workshops to their colleagues. In the meantime, NCSE continues to offer one-on-one advice and support to teachers facing challenges to climate change education—as well as to evolution education, its original focus—and to help communities organize, both to support science education and to resist campaigns, such as Piscopo's, intended to undermine it.

What happened with the dueling legislation in Connecticut? Christine Palm's original bill died in the Joint Committee on Education, but not before a similar provision was added to a different bill that was passed by the same committee. That bill then died in the Joint Committee on Appropriations. A proposal was then introduced on the House floor to amend yet a different bill to include the provision, which elicited "vehement opposition" from none other than John Piscopo.

"There's a very rigorous debate going on now among scientists," Piscopo reportedly argued, displaying, whether sincerely or not, a sadly common misconception about climate change. "If you mandate that they teach one side of a scientific debate, … the teachers lose that freedom to be able to use it as a teachable moment, to teach that there is a debate. Let's go through it in class, let's study both sides of the issue here. If you teach one side, it becomes indoctrination. It's not teaching anymore."[16]

Ultimately, Palm's proposal was included in a fourth bill that was passed by the House of Representatives but was not considered by the Senate before the legislative session ended. Piscopo's bill, in contrast, died in the Joint Committee on Environment without receiving a hearing. In a generally uncritical piece in his hometown newspaper reviewing his activities in the Connecticut legislature for 2019, he declined to comment on his attempt to strip climate change from the state science standards.[17]

Surveys suggest that Palm, not Piscopo, is in touch with public opinion on the issue of climate change education. According to the Yale Program on Climate Change Communication, in 2018, a whopping 83 percent of Connecticut residents strongly or somewhat agreed with the statement that schools should teach our children about the causes, consequences, and potential solutions to global warming. The statistic for the nation—at 79 percent—lags only slightly behind the statistic for Connecticut.[18]

But overcoming the obstacles to climate change education in public schools is not, it seems, simply a matter of the legislature passing a bill, such as Palm's, with only symbolic effect. A better model is located at the opposite end of the country in Washington state: in 2018, the legislature there passed a bill that provided $4 million for professional development for science teachers on the NGSS (which Washington adopted in 2013)—specifically including climate science.

Increasing opportunities for preservice and in-service teachers to learn about climate science and ways of teaching it effectively, developing and disseminating effective instructional materials and lesson plans, and boosting the profile of earth and environmental science classes in high school—these are steps that will genuinely help to ensure that today's students are equipped with the knowledge and know-how necessary for them to flourish in tomorrow's warming world. ☐

(Endnotes on page 40)

Climate Change in the Classroom

A Natural Part of English Language Arts

ILLUSTRATIONS BY KASIA BOGDAŃSKA

By Richard Beach, Jeff Share, and Allen Webb

With every sunrise and rotation of the earth, humans are more interconnected through reading and writing. We are using more tools for communicating than ever before, creating increasing opportunities for people across the globe to share, organize, and solve all kinds of problems, from attacks on democracy to a warming planet. These changes have moved the role of the English teacher to center stage. Humans have always been storytellers, and it has long been known that those who tell the stories control the future. It is by critically understanding the messages and engulfing them, and learning the skills to take action, that our students can create alternate discourses to change the present and shape the future. As English teachers, we have the ability and responsibility to excite, inspire, and empower students to recognize this potential and become involved in the issue of our age, climate change and environmental justice.

Our planet has already irrevocably changed as a result of human-made emissions of carbon dioxide, methane, and other gases. Today, in line with predictions made for decades, we are seeing increasing temperatures, dramatic weather swings, devastating droughts, wildfires, huge storms, flooding, sea-level rise, warming and acidic oceans, enormous animal and plant extinctions, and more.[1] Our planet has warmed at least 1 degree Celsius (1.8 degrees Fahrenheit) since the pre-industrial period, with 2016—the year we wrote *Teaching Climate Change to Adolescents: Reading, Writing, and Making a Difference*, from which this article is excerpted—the hottest year in recorded history.

Recorded research indicates that global temperatures may increase by 4 degrees Celsius (7.2 degrees Fahrenheit) as early as the 2070s and perhaps even sooner.[2] A rise of 4 degrees Celsius would permanently devastate U.S. food production, not to mention food production in other countries. The Antarctic and Greenland ice sheets have already begun to melt and break apart. No matter what humans do now, sea levels are going to rise, and rise substantially. Much of Florida and the East Coast of the United States will first be subjected to storm surges, and then inundated, as will many of the largest cities in the world.[3]

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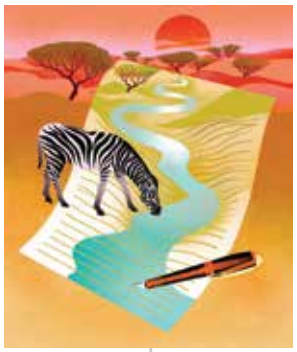
There is no going back. Each gallon of gasoline burned represents 100 tons of ancient plants[4] and the carbon they captured being returned to the atmosphere. When carbon dioxide is released into the air, it continues to affect the climate for hundreds, even thousands, of years. We are currently on the trajectory to 4 degrees Celsius and more. It is imperative to change what we are doing and limit temperature rise to 2 degrees Celsius. It is not certain that even with focused world attention on greenhouse gas reduction that 2 degrees is still possible. For the sake of the human race and life on earth, we must, nonetheless, do all within our power to limit global warming as much as possible and as soon as possible. As one of the world's most influential climate scientists puts it, "the difference between two and four degrees is human civilization."[5]



Whatever happens, climate change will be the defining feature of the world our students inhabit. Addressing climate change is everyone's responsibility, and that includes English teachers.

We and our students can and must make a difference. We have the opportunity and obligation to educate our students about climate change; fire their imaginations, their talents, and their energies; inform our local and larger communities; and join with others across the globe to demand and participate in one of the largest and most urgent transitions in human history.

The Urgency of Climate Change

In a simple model, humans impact the climate by releasing gases that accumulate in the atmosphere and bounce solar energy back to the earth, as in a greenhouse, making the earth grow continually warmer. Indeed, our planet is absorbing a lot of heat, warming all ecological systems. Scientists have calculated that in recent years, the earth has been gaining as much heat every day as would be released by 400,000 Hiroshima atomic bombs.[6] Human emissions cause the increased warming, and natural feedback loops speed it up even faster. Ice and snow reflect 70 percent of solar energy, while the open ocean absorbs 95 percent. So as polar ice caps melt and expose more oceans, a great deal more heat is absorbed and global warming is accelerated "naturally." Warming by human emissions releases methane, a greenhouse gas, from tundra and ocean beds, again accelerating warming.

Global warming will have a devastating impact in every country. Current understanding indicates that a catastrophic world of mass starvation, mass flooding, mass migration, and mass death of hundreds of millions, perhaps billions, of people may happen much sooner than most expect, particularly in developing countries. An entire lake in Bolivia, which was twice the size of Los Angeles, is now bone dry, resulting in residents having to flee. The largest city in the western hemisphere with 20 million residents, Sao Paulo, Brazil, is close to running out of water. Due to rising sea levels, many of the Marshall Islands and coastal regions of Bangladesh are under water or soon will be.

Some of the first to suffer and endure the worst effects will be the poorest countries, nations that have the least responsibility for the pollution that causes climate change. Poorer countries and poorer people have fewer resources to defend themselves, so the impacts of climate change will be unfair and unbalanced. The U.S. military considers climate change a threat multiplier that will cause hunger and disease, increase instability, undermine governments, and intensify conflicts and terrorism. It is already doing so in the Middle East and Africa. While climate change will be disastrous for the poorest regions of the world, it will also have horrific consequences for wealthy countries, the United States included.

> Global warming is a topic that should and does matter to young people.

We know about Hurricane Dorian in the Bahamas, Hurricanes Harvey and Maria in Houston and Puerto Rico, Hurricane Katrina in New Orleans, Superstorm Sandy in New York and New Jersey, droughts and wildfires in southeastern Texas and western states, and polar vortices in the Midwest and Northeast. And we are only at 1 degree Celsius above average so far. There are displaced Americans and refugees from drought-caused conflict in Syria, Africa, and Central America in our communities and in our schools who have climate disaster and climate refugee stories to tell. English students can investigate and help tell these local stories.

Global warming is a topic that should and does matter to young people. A survey by the Yale Program on Climate Change Communication found that the vast majority of parents (79 percent) support teaching climate change in schools.[7] Yet, the education students do receive is limited. While 57 percent of teens understand that climate change is caused by human activities, only 27 percent say they have learned "a lot" about global warming in school.[8]

If, in the public sphere, informed and reasoned discussion about climate change does not always take place, in our classrooms we and our students can openly inquire into new realities, engage in civilized discussion, and imagine and begin to enact change. Students can script and rehearse conversations with family or friends who may be less knowledgeable. As young people work to inform others, new understandings and behavior can come about quickly through social and new media, and through our students' modeling of behavior and enthusiasm.

Our students can learn about and consider joining young people's efforts to address climate change. Since we wrote our book, the American Sunrise Movement has begun to mobilize young people. In October 2018, 15-year-old Greta Thunberg, at first alone, engaged in a "school strike" climate protest in her native Sweden. As her protest became an example, thousands, then millions, of middle school and high school students worldwide joined her and started an ongoing school strike movement.[9]

Climate Change in English Language Arts

English language arts students are transported across the globe, back in time, and into the future as they engage with the imaginations of poets, playwrights, novelists, journalists, advertisers, filmmakers, lyricists, and the best storytellers the world has encountered. English classrooms are spaces of discovery, possibility, and participation where students learn to empathize with experiences of people like and unlike themselves. They are places of moral and ethical reflection about new ideas and complicated human realities. In English language arts classes, students can read about the devastating effects of global warming, comprehend its human-made causes, and understand the creative ways people in all corners of the globe are responding to this challenge. And it is also in this space of possibility where students can learn to write with many tools to express their ideas, voice their concerns, and contribute to the environmental justice movement.

Learning to critically read their world, English language arts students can draw on informational texts and documentaries to understand climate change and examine portrayals of the effects of climate change in literary, nonfiction, and media texts. They can critically examine the influence of human economic, political, agricultural, transportation, and housing systems impacting ecological systems. ELA students can explore creative utopias and dystopias, climate fiction, and film to imagine the social consequences of the climate crisis as well as different futures and a safe, healthy, just, and environmentally sustainable world. Students need to be critical of the claims that deny the science, skeptical of the people who assert nothing can be done, and empowered to act with the kind of courage we have seen in the past when humans have risen together against overwhelming odds.[10]

We believe that a purely science-oriented approach to climate change can miss the social, historical, ethical, and human realities that are critical to the problem. Climate change is an accelerator that exacerbates economic, racial, and social inequality. The study of English language arts involves understanding the experience of others, including those experiencing the climate emergency, through language, texts, and media. Professor Pieter Maeseele[11] explains that framing climate change primarily in the discourse of science limits consideration of the politics of how humans understand and relate to the environment and to each other, and how and whose voices are heard.

Fostering civic engagement can also shift the overall focus of English from positioning students as autonomous individuals or consumers set apart from the world to students as social participants whose ways of being and acting directly affect the local and global ecology.[12] This shift involves redefining academic success based less on individual achievement and test scores and more on one's social and collaborative relationships with others and how our actions can contribute to sustainability and environmental justice.

As teachers of English, we offer a specific perspective and a set of values for teaching about climate change.

As teachers of English, we offer a specific perspective and a set of values for teaching about climate change. Our approach emerges from an understanding of the Anthropocene era in which we now live, when environmental, geological, and ecological systems are profoundly altered by human activity. Our beliefs are based in world citizenship, the rights and well-being of all, and the recognition of connections between the diverse members of the world family.

Adopting this climate change perspective involves:

1. Foregrounding the climate crisis as the most important issue facing life on earth.
2. Understanding the causes and effects of climate change locally and globally, as well as the efforts to deny them.
3. Overcoming individualism and nationalism, and adopting a system-based, global perspective.
4. Creating solidarity with the oppressed and exploited, addressing the unequal impacts of climate change, and striving for social justice.
5. Envisioning and enacting transformational changes through individual and collective action, in which everyone is accountable for their actions and inactions.

Challenges Teachers Face

There are plenty of pressures on English teachers that make it challenging to develop and implement new ideas and new curriculum. Our book includes examples of English teachers

describing their efforts to meaningfully address climate change in their classrooms.

Many states have adopted the Common Core State Standards (CCSS) for English language arts,[13] which for the most part are not content based but skills based. That is, the standards do not require specific curriculum, specific literary works, specific topics, or specific themes. As the introduction states, "A great deal is left to the discretion of teachers." Part of the very idea of the CCSS is to free teachers and curriculum developers to identify meaningful, engaging content that will raise academic and intellectual expectations. Climate change can provide this kind of content.

Instruction about climate change relates to a number of the CCSS anchor standards. The standards encourage bringing more "informational texts" into English classes. They emphasize close and careful reading, persuasive writing, and developing arguments. They expect students to "demonstrate the cogent reasoning and use of evidence that is essential to both private deliberation and responsible citizenship in a democratic republic." In English language arts, the standards explicitly foster an integrated model of literacy, using research, developing technology and media skills, and understanding other cultures and perspectives. The standards encourage an understanding of literacy across disciplines and, when appropriate, building bridges between content areas—climate change offers many opportunities for this type of interdisciplinary teaching.

Another challenge that English teachers confront is obtaining the texts they need to do the teaching they believe in. Our book provides classroom-tested examples of a wide variety of current materials, including climate fiction short stories and novels, "informational texts," young adult fiction, film, documentaries, websites, and so on. (For examples of short stories, see page 22.) We share stories about entire English language arts courses devoted to climate change as well as significant units on the subject. At the same time, we remain conscious of the challenges many teachers face in changing the curriculum, finding time for new approaches, and obtaining new materials.

Throughout our book, we tell stories about English classes that address climate change in ways that worked in their context. We describe teachers who use shorter works, stories, poetry, essays, novellas, and movies that fit easily into crowded curricula and help develop important climate change teaching. We draw on new approaches in climate fiction that can be brought to almost any literary work in your curriculum and allow you to address climate change in your class with the works you are currently teaching. We talk about instructional strategies that are effective in working with limited resources, including choice reading, literature circles, and jigsaw approaches. We point to a variety of information from essays, images, videos, and websites that are available for free online. The wiki we have created to accompany our book, www.climatechangeela.pbworks.com, has many more suggestions and links; because it is a wiki, teachers can post and continue sharing ideas on it. (Also, visit our blog, *English Teachers Concerned about the Climate Crisis*, at www.etcccsite.com.)

Sometimes teachers or administrators are reluctant to address "controversial" topics. As we have learned, there is, in fact, no legitimate controversy in the scientific community that climate change is happening, is caused by humans, and poses a frightening challenge to life on earth. The "controversy" is in fact bogus, a sham created by climate change deniers often funded by carbon companies that stand to lose money in the short run if necessary actions are taken to protect the planet. English teachers have never let Holocaust deniers stop us from teaching about the Holocaust. Climate change deniers are not denying something in the past; they are denying something in the future that we can now act to prevent or ameliorate, thus saving millions of lives. Not so long ago, we were told that tobacco was good for you and doctors were seen on television promoting their favorite brands of cigarettes.

However, the general public has since learned what the tobacco companies knew for years: tobacco is devastating to human health. Some of the same public relations firms and pseudo-scientific experts that distorted the truth about smoking are now at work spinning public discourse to doubt the science of climate change.[14] In the case of climate change, we are talking about human health—and much more. If our society fails to address climate change, it will ensure the destruction of a livable world for all of us. English students can investigate these media distortions. The stakes could not be higher.

Our approach is to engage students by tapping into their concerns, questions, and interests. We have found that rather than taking away time and energy, teaching about climate change inspires and empowers students to use literacy as a meaningful tool for change. ☐

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Teaching a Short Story (or Stories) about the Climate Crisis

Here we share our teaching ideas for four short stories you could use as starting points for addressing climate change. These four stories are all examples of climate fiction, "cli-fi" as it is popularly known, and come from two excellent collections: *I'm with the Bears: Short Stories from a Damaged Planet* and *Winds of Change: Short Stories about Our Climate.**

The 12-page short story "How Close to the Savage Soul" in *Winds of Change* by environmental writer John Atcheson depicts a frightening near future altered by climate change. A grandfather, a young father in our present day, takes his grandson from the fortified community where they live to an Atlantic Ocean beach that had been beautiful and restorative. However, the water has risen and become acidic, increasing temperatures have devastated agriculture, and, outside their protected community, "adolescents without hope were turning the whole country into a real-world *Lord of the Flies*."

If "How Close to the Savage Soul" is intense and frightening, a climate change short story that uses humor to make a serious point is "Hermie" by Nathaniel Rich in *I'm with the Bears*. This nine-page magical realist story works well with any grade level, from upper elementary through high school. The premise is that a marine biologist is about to give a lecture at an international conference when, in the hotel bathroom, he somehow encounters Hermie, the very hermit crab that he used to play with at a Florida beach when he was a boy. Of course Hermie can talk, and he reminds the narrator of the times they had together in childhood and informs him about how the beach and sea life have been devastated by rising sea levels, poisoned water, and worsening storms, resulting in loss of species.

The story personalizes the impacts of environmental degradation and provides an entry point for learning about global warming. It can also serve as a mentor text for place-based creative writing: students could write about either real or imaginary interactions with a place or wildlife that they knew as children, and then, in a realistic or perhaps magical realistic way as inspired by the story, project into the future and explore possible impacts of climate change.

A third story, "The Audit," by Rachel May in *Winds of Change*, is also set in the near future. International agreements mandate "audits" to reduce everyone's "climate footprint." The story focuses on an upper-middle-class American family with three teenage children living in the suburbs. Their audit informs them:

"Your carbon footprint is 3.4 times the acceptable global mean. If everyone generated your level of greenhouse gases, 3.4 planet Earths would be required to accommodate the emissions. The terms of the Global Climate Accord require that you reduce your footprint as follows..."

"The Audit" is a perfect impetus for students to examine ways to learn about their own carbon footprint. There are several websites where students can have their carbon footprint calculated. Thus, the story is a starting point to research the "carbon budget" that scientists tell us must be adhered to in order to avoid the worst impacts of climate change. The story also shows students methods for addressing climate change in their lives. It opens discussion about how to make values-based choices, and creates opportunities for both self-reflective writing and writing to influence others.

Margaret Atwood's two-page "Time Capsule Found on the Dead Planet" in *I'm with the Bears* is climate change flash fiction. Found in a cylinder of brass on a dry lake shore by travelers from a distant world, the time capsule tells of a civilization that worshiped money and created feasts and famine, towers of glass, and "ate whole forests, croplands, and the lives of children."

The story presents a disturbing vision of where our planet might be if climate change is not addressed. It considers the natural environment in the long view, and invites young people to think about behavior and values from a climate change perspective. The story inspires discussion for additional learning about climate change, as well as serving as an inspiration for your students writing their own climate change flash fiction!

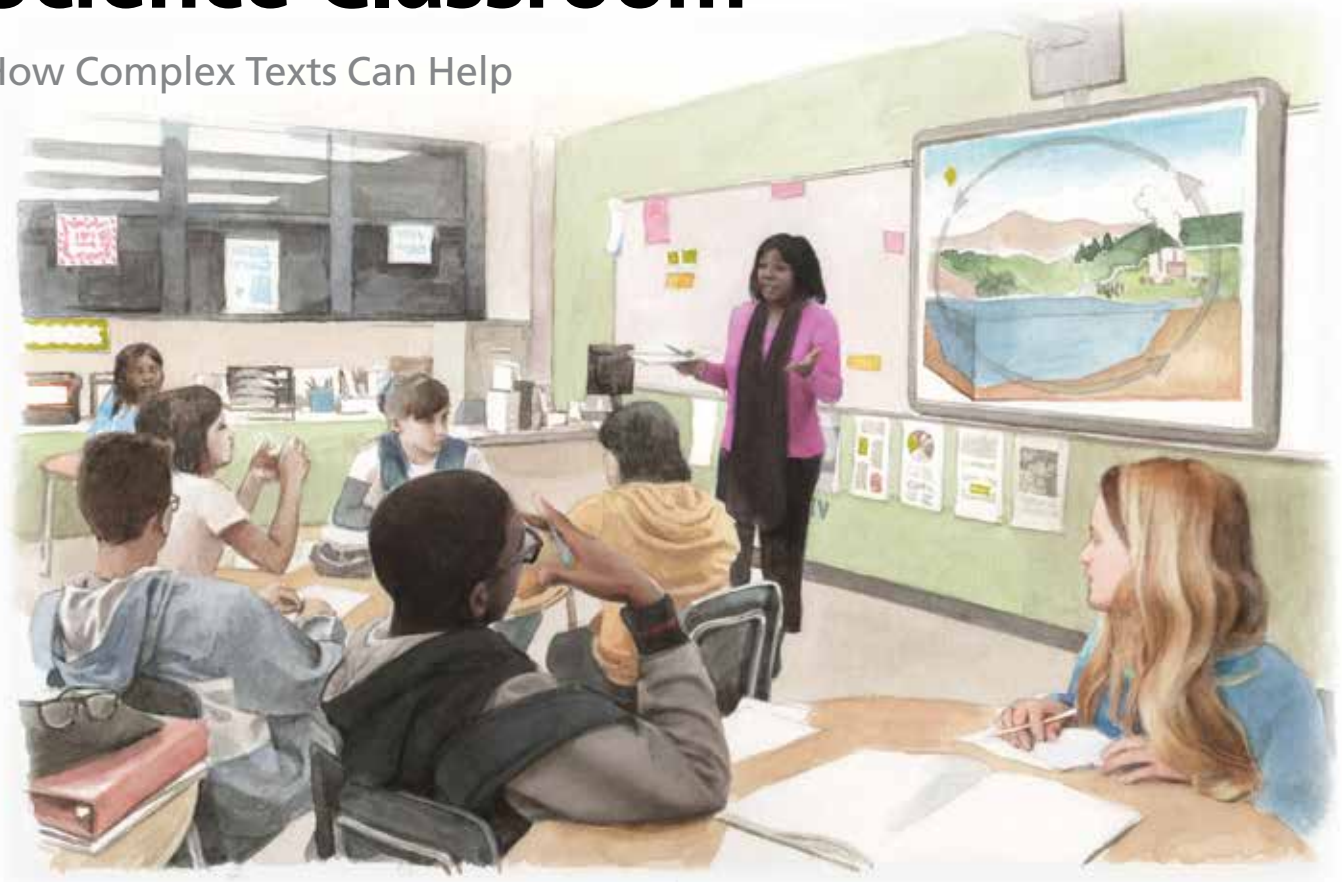
–R. B., J. S., and A. W.

"The Audit" is a perfect impetus for students to examine ways to learn about their own carbon footprint.

*The stories from *Winds of Change* are available for free at www.dragonfly.eco/how-close-to-savage-the-soul. For a 30 percent discount on *I'm with the Bears*, from Verso Books, go to www.tinyurl.com/Y4QZE7R5.

Bringing a Literacy Focus into the Science Classroom

How Complex Texts Can Help



By Linda Friedrich, Willard Brown, and Heather Howlett

Biology teachers at Fordson High School in Dearborn, Michigan, have developed and now teach an annual climate change unit. They support students in understanding the overarching scientific concept of cause and effect by inviting students to explore people's impact on climate change.

To that end, teachers engage students in using a broad range of scientific and popular texts to support their scientific learning. Students analyze existing data sets to understand trends in temperature over time. They study diagrams of the carbon cycle in order to deepen their understanding of the scientific mechanisms that drive climate change. And they watch *Before the Flood*, Leonardo DiCaprio's popular film about climate change, to make connections between scientific understandings and their own observations. In this unit, texts play a crucial role in developing students' understanding of biology and the practices of scientific inquiry.

Linda Friedrich is the director of the Strategic Literacy Initiative at WestEd, where Willard Brown and Heather Howlett are senior program associates.

Understanding and addressing climate change sits at the nexus of science, ethics, politics, and democratic deliberation. In each area, deep content knowledge and strong literacy skills—comprehension, critical reading, and synthesis of multiple texts—are essential. Both inside and outside of school, adolescents are presented with complex texts that demand specialized ways of thinking and reading.[1] This is particularly true for science and scientific inquiry. Scientists engage with texts written for a range of explanatory purposes (e.g., problem and solution, and process and sequence). They convey meaning through multiple forms (e.g., diagrams, graphs, schematics, and texts) and make use of discipline-specific grammatical structures as well as technical and specialized expressions.[2] By providing biology students multiple opportunities to grapple with the range of texts used by scientists, educators at Fordson have brought a literacy focus into the science classroom that does not detract from their teaching of content—but actually bolsters it.

Why Teaching Literacy Matters in Science

The Next Generation Science Standards (NGSS)[3] outline eight practices core to how science works: asking questions and defining problems, developing and using models, planning and carrying out investigations, analyzing and interpreting data, using

ILLUSTRATIONS BY ENRIQUE MOREIRO

mathematics and computational thinking, constructing explanations and designing solutions, engaging in argument from evidence, and obtaining, evaluating, and communicating information. In our view, language and literacy play a key role in developing students' ability to engage in all eight practices.

Science teachers are uniquely positioned to help students build a deep understanding of what researcher Elizabeth Moje calls disciplinary literacy, which involves both apprenticing students into scientific ways of thinking and knowing, and teaching them the use of oral and written language to communicate about science. Moje rightfully argues that disciplinary literacy matters for civic purposes. By engaging all youth in authentic scientific inquiry, including the use of its language practices, youth are better able to understand how science works, question its assumptions, and be critical readers and users of the knowledge produced. The importance of scientific inquiry to understanding and offering potential solutions to climate change underscores Moje's perspective on the importance of disciplinary literacy.

Physicist Jay Lemke brings the specific and varied nature of scientific language and texts, such as diagrams, charts, and graphs, to life. "Science does not speak of the world in the language of words alone, and in many cases it simply cannot do so," he writes. "The natural language of science is a synergistic integration of words, diagrams, pictures, graphs, maps, equations, tables, charts, and other forms of visual mathematical expression."[4]

Literacy plays a central role in the day-to-day practice of science.

This article's opening vignette about Fordson High School illustrates science teachers putting a range of texts in play and engaging their students in science's "natural language." Lemke's insights highlight the complexity that science educators face when they teach scientific literacy. These forms of text and specialized language are simply not taught in elementary school reading or English language arts. As Lemke notes, they sit squarely in the province of science. Given that literacy plays a central role in the day-to-day practice of science, developing scientific explanations, making connections, and understanding interpretations rely on more than just knowledge of science. They fundamentally require disciplinary literacy.

How Reading Apprenticeship Supports STEM Literacy

The Reading Apprenticeship framework, developed as part of WestEd's Strategic Literacy Initiative, guides opportunities for cross-disciplinary teacher and student literacy and STEM (science, technology, engineering, and math) learning. Over the past 15 years, we have collaborated with science teachers to simultaneously support their students' science and literacy learning through text-based inquiries.

The Reading Apprenticeship framework includes four dimensions—social, personal, cognitive, and knowledge-building—that integrate the development of academic and social-emotional skills and dispositions to support learning in the content areas. Metacognitive conversation ties these four dimensions together by making both teachers' and students' scientific reading and reasoning processes visible. In Reading Apprenticeship classrooms, a wide range of texts are used as resources for learning.

To that end, extensive reading in the science classroom involves engaging students in interpreting and using authentic science texts the ways that scientists use them, to build explanations of scientific phenomena. For instance, the teachers at Fordson use multiple forms of text to support their students' scientific exploration of climate change: graphs, diagrams, journal abstracts, and videos explaining scientific mechanisms, along with journalistic accounts.

Sometimes students may see themselves as "not being good in science" or view science as irrelevant to their lives outside of school; engaging students in Reading Apprenticeship's social and personal dimensions supports students in shifting their view of themselves as readers and learners of science. For example, Fordson students work together as a class to develop a list of strategies for reading graphs like a scientist (see the box on page 25 for a sample student-generated list). Each time they approach a new text, say a graph of temperature change or a diagram of the carbon cycle, they review, add to, and reflect on the list of strategies for unpacking it. This type of collaboration is fostered by the climate of safety and trust that Fordson's faculty builds both inside and outside the classroom. Through this process, students experience success, build their confidence as learners of science, and ultimately change their identities.

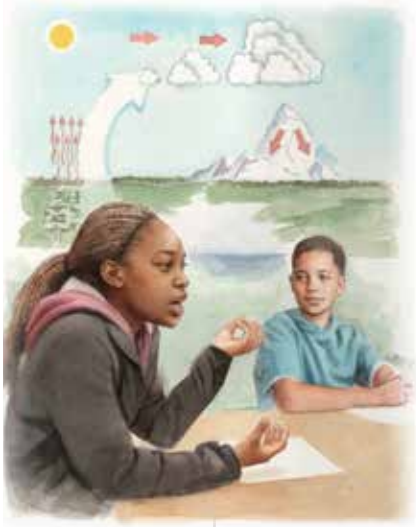
Reading Apprenticeship's cognitive dimension provides concrete approaches for supporting students to grapple with complex scientific texts, which, regardless of length, tend to be dense with information. Teachers at Fordson support students in breaking down chunks of complex text so that they can identify where they experience roadblocks and gradually work through challenges. This process is especially helpful for Fordson's large population of English language learners because it breaks complex texts into meaningful chunks and still gives students access to rigorous ideas often absent from simpler texts.

The knowledge-building dimension emphasizes the importance of surfacing prior knowledge, challenging misconceptions, building understanding of science's specialized texts and contexts, bridging common experience and scientific understanding, and, perhaps most important for the NGSS, engaging students in science's core practices. Fordson teacher Diana Mansour explains that she starts the process of reading in science with tables and graphs, "because as an expert reader of science, that's one of the first text features to which I'm drawn. … I let them know that when I look at graphs, I pay attention to two things: organization and patterns/relationships." Based on her example, students start

To learn more about the Reading Apprenticeship framework, visit www.readingapprenticeship.org/our-approach.

their reading of scientific texts with tables and graphs rather than avoiding them, and then move to deciphering explanatory text and other scientific representations.

While disciplinary literacy researchers offer a convincing rationale for integrating literacy into science classrooms, concerns about focusing on text remain. Traditional science instruction asks students to hunt for factual information in textbooks rather than provide learning experiences that approximate science's core work. As an antidote to the traditional approach, many science reforms emphasize the importance of engaging students in collecting, analyzing, and explaining data. Some scholars and science educators worry that bringing a literacy focus into the science classroom may reduce opportunities for hands-on scientific inquiry.[5] With the advent of the NGSS and state standards that emphasize reading in the disciplines, researchers and educators alike are increasingly seeking ways in which "text can support students' involvement in hands-on science, rather than supplanting their investigations."[6]



Text-Based Science Inquiries

Despite a growing consensus that integrating literacy and STEM learning is important, an authentic path forward isn't necessarily clear. WestEd's Strategic Literacy Initiative, which develops and expands the use of Reading Apprenticeship, created one model for approaching this challenge: text-based investigations. Like researchers, science teachers initially approached reading in their classrooms with skepticism, knowing how uninspiring traditional uses of science textbooks can be (e.g., assigning a 30-page chapter for homework and then giving a PowerPoint summary because no one has read it). But as one middle school teacher explained, when texts are approached as objects of inquiry for authentic science investigation and explanation, students become deeply absorbed in the work.

Text-based investigations engage students in authentic scientific literacy and inquiry practices to learn science concepts. Students engage in constructing explanations and models of phenomena in the natural world and support these constructions through scientific argumentation. These investigations are designed to complement, not replace, hands-on experimentation. Both types of investigations involve NGSS-aligned scientific practices: asking questions; gathering, analyzing, modeling, and interpreting data; developing explanations; arguing from evidence; and obtaining, evaluating, and communicating information.

Reading Apprenticeship's text-based investigations, developed collaboratively with teachers, frame scientifically grounded guiding questions and provide relevant texts. In developing the investigations, we deliberated over how to sequence texts in ways that enable students to construct increasingly robust explanatory models for scientific phenomena, while simultaneously deepening students' reading strategies.

One module, "How Are Humans Impacting Water?,"* developed for eighth-graders in collaboration with science teachers, illustrates the architecture of a text-based investigation module. The module focuses on the flow of water under storm conditions and normal weather conditions, and where sources of pollution might be in the flow of clean and unclean water. This investigation foregrounds two NGSS crosscutting concepts for cause and effect: mechanism and explanation, and systems and system models. Given this module's focus on human impact on the environment, it serves as a potential model and jumping off point for developing climate change models.

Throughout the module, students are invited to pose questions and engage in investigation through reading to identify and accumulate data and find answers. They develop explanations and models and critique how well their models hold up. The lesson sequence invites students to share not only what sense they were making of the texts, but how they go about it, thereby making their reading and reasoning processes public. Metacognitive conversation routines such as teacher modeling, thinking aloud, annotating text, and small-group sharing support students in making their reading and reasoning more scientific and evidence-based over time.

The investigation includes data graphs, diagrams, and other visual forms of science communication as well as science reports from newspapers and nonprint media for a variety of compelling "cases" of human impact on water. Ten texts present information and data on the science of the water cycle. Students transform information from one representation into another—from words to graphs and models, and from graphs and models to words—simultaneously building their conceptual understanding and flexibility with textual forms in science.

*The complete module is available for free at www.readingapprenticeship.org/research-evidence/readi-curriculum-modules.

Sample Student-Generated List for Reading Charts and Graphs, Fordson High School

How Is It Organized?

1. Circle keywords in title, headings, axes, caption (source info), etc.
2. Identify the type of graph and its connection to the purpose.
3. Make connections between the specific data points and the keywords.
4. Ask clarifying questions about how it is organized.

What patterns and relationships can be drawn?

1. Identify patterns of increasing and decreasing numbers.
2. Identify high/low points, outliers, and points that stand out.
3. Ask questions about the patterns and other unclear points.

As a culminating task, students are asked to apply what they have learned about the water cycle by developing a scientifically grounded recommendation to manage the environmental challenge posed. Specifically, students work in teams to:

- Identify a **problem** in their community related to human impact on water;
- Determine a **course of action** for their community that addresses the problem;
- Make a compelling **scientific recommendation** for the course of action by preparing an explanation of how and why the action would be effective; and
- **Present the recommendation** to the class in a science seminar.

Text-based investigations require that students build an understanding of science phenomena from evidence in source materials as well as from developing and justifying their explanatory accounts for these phenomena. By using the practices of science to inquire into real-world topics of interest, students can simultaneously learn science content and the literacy and inquiry practices of science.

Considerations for Selecting Texts

The texts included in "How Are Humans Impacting Water?" were selected because they support students in developing specific types of scientific knowledge. The Reading Apprenticeship team collaborated with reading researcher Susan Goldman to develop a series of five constructs to consider when choosing texts to support scientific inquiry: scientific epistemology; scientific inquiry and reasoning; overarching concepts, principles, themes, and frameworks; forms of information representation/types of texts; and discourse and language structures. By analyzing what disciplinary knowledge texts offer, science teachers can ensure that selected texts help students make connections between science and the world, expand their understanding of how science texts work, develop scientific vocabulary and syntax, and participate in scientific discourse and practices. The following questions, which are adapted from the research of Goldman and her colleagues, are particularly important to consider when science teachers take up a multifaceted topic like climate change, which also includes social policy and ethical considerations.[7]

Science teachers can ensure that selected texts help students make connections between science and the world.

Scientific epistemology: Texts build understanding about the nature of science.

- How does the text portray how scientists know what they know?
- How does the text illustrate processes for developing and revising scientific models and for understanding their limitations (e.g., findings are tentative and scientific knowledge is constructed incrementally)?

Scientific inquiry and reasoning: Texts demonstrate how inquiry and reasoning are used to establish, link, and validate claims and evidence.

- How can the text support planning and carrying out firsthand investigations?
- How can the text support the development of coherent, logical explanations, models, or arguments from evidence?
- How can the text support the evaluation of explanations, sources, and evidence?

Overarching concepts: Texts provide general concepts and enduring understandings as a basis for warranting or connecting claims and evidence.

- How does the text articulate the role of theory in interpreting evidence and warranting claims?
- What concepts, principles, themes, and frameworks explained in the text support interpreting evidence and warranting claims?

Types of texts: Science texts use different structures and multiple representations, sources, and genres to convey meaning.

- How does the explanatory purpose of the text align with the content taught (e.g., correlation and causation, cause and effect, proposition and support, and definition and description)?
- What representations does the text use to convey meaning (e.g., diagrams, equations, charts, videos, and models)?
- How does the text's purpose and audience shape its content and structure (e.g., bench notes, refereed journal articles, and textbooks)?

Language structures: Science texts use distinctive grammatical structures, specialized language, and language signals about the degree of certainty. Once texts are selected, teachers can think through how to use the text to support student learning.

- How does the text communicate the author's purpose?
- What technical and specialized expressions does the text use?
- How is the degree of certainty, generalizability, and precision of statements signaled in the text?
- How are claims advanced through argumentation in the text?

See Table 1 for an application of this framework for the texts included in "How Are Humans Impacting Water?"

Does Integrating Literacy in STEM Make a Difference for Student Learning?

Perhaps science teachers' biggest concern about integrating a literacy focus into their classrooms is that it will draw attention away from doing and learning science. Independent researchers have investigated the impact of Reading Apprenticeship's work with science teachers on students' literacy and science outcomes. Four studies demonstrate positive effects of integrating a strong literacy focus into STEM classrooms on both reading and science outcomes. All four studies employed a randomized control design,

comparing classrooms with teachers who participated in Reading Apprenticeship professional development to business-as-usual classrooms. Collectively, these studies involved more than 2,000 teachers across multiple subject areas working in 466 schools in four states. All of the schools served high proportions of African Americans, Latinos, and English language learners.

The first study focused exclusively on integrating reading into biology classes. At the end of one year of instruction, treatment students were more than a year ahead of control students on standardized tests in biology, reading comprehension, and English language arts.[8]

The second study focused on improving disciplinary literacy teaching in U.S. history and biology classrooms. At the end of one year of instruction, students in treatment classrooms were more than a year ahead of control students on standardized tests in history and biology.[9]

The third study focused on a multiyear, national project with teachers from multiple disciplines. Students in Reading Apprenticeship classrooms reported significantly greater opportunities to share reading processes and problem solving and indicated that reading instruction was more integrated into their content-area learning. This project demonstrated a positive and statistically significant impact on student literacy in science classes.[10]

The fourth study engaged biology teachers in using text-based inquiries following the same content sequence as teachers in the control group. Students in intervention classrooms scored significantly higher on the comprehension of science information from multiple texts than those in control classrooms.[11]

Teaching literacy and teaching STEM have the potential to be mutually supportive endeavors. Through incorporating texts into STEM classrooms, science teachers can build student understanding of texts that are central to how scientists communicate with one another. They also can engage students in the authentic practice of science—drawing on data sets to replicate findings, developing explanations and models based on data analysis and an understanding of scientific theory, and situating findings in the broad base of scientific investigation.

For teaching climate change from a science perspective, the authentic use of scientific texts is particularly valuable. It supports science teachers in helping students understand questions bandied about by the press and politicians from a scientific lens. And it provides a concrete reason for students to build their understanding of abstract scientific concepts like systems and causal relationships. ☐

Endnotes

1. T. Shanahan and C. Shanahan, "Teaching Disciplinary Literacy to Adolescents: Rethinking Content Area Literacy," *Harvard Educational Review* 78, no. 1 (2015): 40–59.

2. S. Goldman et al., *Explanatory Modeling in Science through Text-Based Investigation: Testing the Efficacy of the READI Intervention Approach*, Project READI Technical Report #27 (Chicago: Project READI, 2016), https://readingapprenticeship.org/wp-content/uploads/2017/03/Project-READI_RCT-Technical-Report-27_2017.pdf.

3. NGSS Lead States, *Next Generation Science Standards: For States, by States* (Washington, DC: National Academies Press, 2013).

4. J. Lemke, "Teaching All the Languages of Science: Words, Symbols, Images, and Actions" (paper presented at La Caixa Conference on Science Education, 1998), 6.

5. G. N. Cervetti and J. Barber, "Text in Hands-On Science," in *Finding the Right Texts: What Works for Beginning and Struggling Readers*, ed. E. H. Hiebert and M. Sailors (New York: Guilford, 2009), 89–108.

(Continued on page 40)

Table 1. Texts for "How Are Humans Impacting Water?": Types of scientific knowledge addressed and text types represented

Title	Reference	Type of Scientific Knowledge Addressed	Text Type
What's in Our Water?	Students' Own Collected Data	Scientific Epistemology Scientific Inquiry and Reasoning	Data Table
The Water Cycle	www.usgs.gov/media/images/water-cycle-natural-water-cycle	Overarching Concepts	Diagram
How Are Humans Impacting Water?	"Diagram of Unhealthy Water System," *World Book*, 2011	Overarching Concepts	Diagram
Third Creek Unsafe for Swimming	Tennessee Journalist, January 12, 2011	Scientific Inquiry and Reasoning	Photo and Caption
Chicago River Contaminated	Chicago News Cooperative, May 17, 2011	Scientific Inquiry and Reasoning	Photo and Caption
No Day at the Beach	Adapted from Jason Gorss, "No Day at the Beach," *Scientific American*, July 19, 2004	Language Structures	Article
Where Does Water Come From? Where Does It Go?	https://wested.box.com/s/1umdoa6foytruv82mu16mhommuw08ryh	Overarching Concepts	Article with Diagram
Non-Point Source Pollution	http://water.epa.gov/polwaste/nps/outreach/point1.cfm	Scientific Inquiry and Reasoning Language Structures	Article
Our Polluted Beaches	www.emagazine.com/magazine-archive/our-beleaguered-beaches	Scientific Inquiry and Reasoning Language Structures	Article

sharemylesson
By Educators, For Educators

Teaching about Climate Change

Addressing climate change is everyone's responsibility, including educators. But even if you're a teacher who believes in the importance of students learning about climate science, you may not have taken the first step toward implementing lessons on climate change because you don't feel that it fits in with your existing curriculum. Whether you teach science or humanities classes, climate change can and should be a topic of learning and discussion with your students, and Share My Lesson is here to help.

Weather and Climate

Students can learn more about weather and climate research by watching the movie *The Aeronauts*. Inspired by true events, the father of meteorology, James Glaisher (Eddie Redmayne), and his fictional daredevil balloon copilot, Amelia Wren (Felicity Jones), break the world altitude record in a hot air balloon. This action-packed film lays the groundwork for any study on climate change. The AFT Science Cadre partnered with Amazon Studios to develop lessons for the film on hot air balloons, weather, layers of the atmosphere, and women in science, among other topics.

In English Language Arts

Reading literature and articles about climate change is a great way to begin addressing this topic. The Morningside Center for Teaching Social Responsibility, a Share My Lesson contributor, offers a variety of resources. One helpful introduction is the lesson "Climate Strike: Images and Voices," which allows students to examine the words and pictures of people their own age who participated in the worldwide climate strikes in September. If your students need more context, the resource "Youth Lead a Climate Strike" provides important background information. Additionally, students can read Kindred Spirits' interview with climate change activist and artist Lindsay Carron to see how the environment and climate change affect her work.

In Social Studies

To effectively approach the topic of climate change in a social studies classroom, turn to current events in Share My Lesson's "Today's New, Tomorrow's Lesson" section. For example, students can learn about young climate change activist Greta Thunberg thanks to a current events activity from PBS NewsHour Extra, a Share My Lesson partner. This resource also provides guiding questions that can help teachers engage in discussions about climate change with their students.

In "Living with Less Water," from the Global Oneness Project, another Share My Lesson contributor, students can learn how climate change affects various communities within the United States. For instance, students can explore the impact of climate change on California's droughts and wildfires. In another lesson, "At-Risk Communities," students can study the impact of rising sea levels in Alaska. As an extension, students can then explore how climate change is affecting their own local areas.

For more of a global focus, "What is Climate Change?" is a resource in which students learn what climate change is, how it affects them and the world, and what different countries can do to counteract it. Students can also learn about the risks of climate change to certain countries in particular, such as those in South America, with the lesson "Communities on the Threshold of Change."

In Science

Of course, science class is the most obvious fit for lessons on climate change. Share My Lesson's partner the Alliance for Climate Education offers "Our Climate Our Future," a resource featuring videos paired with lessons on the origins of climate change, as well as climate justice impacts and potential climate solutions. Another lesson, "Climate Change as a Scientific Theory," engages students in studying climate change through glaciers and sea ice melt, which scientists examine in their work.

We hope these resources empower you and your students in understanding climate change and addressing its effects. If you have additional ideas or requests, please reach out to us at content@sharemylesson.com.

–THE SHARE MY LESSON TEAM

Recommended Resources

Climate Strike: Images and Voices
http://go.aft.org/ae419sml1

Youth Lead a Climate Strike
http://go.aft.org/ae419sml2

Lindsay Carron, Environmental Activist and Artist
http://go.aft.org/ae419sml3

Communities on the Threshold of Change
http://go.aft.org/ae419sml4

Climate Crisis: Greta Thunberg on the Urgency to Act
http://go.aft.org/ae419sml5

Living with Less Water
http://go.aft.org/ae419sml6

At-Risk Communities
http://go.aft.org/ae419sml7

What Is Climate Change?
http://go.aft.org/ae419sml8

Our Climate Our Future
http://go.aft.org/ae419sml9

Climate Change as a Scientific Theory
http://go.aft.org/ae419sml10

AFT Member-Created Lesson Plans for *The Aeronauts*
http://go.aft.org/ae419sml11

Gdansk shipyard strike in Poland, 1980.

Teachers, Public Education, and Organized Labor

Helping Democracy Thrive

ALAMY/ERAZM CIOLEK/FORUM

By Fred van Leeuwen

When I first became involved in the trade union movement, the world was divided into democracies of varying purity and dictatorships of varying brutality. Elected authoritarians were rare. It was not that dictators had never come to power, directly or indirectly, through elections. After all, that is what happened in places like pre–World War II Italy and Germany, but that was before my time. The closest that I came was with the free election of Ferdinand Marcos in the Philippines, who later declared martial law and became a dictator; something that is, once again, a danger with the ascendance of President Rodrigo Duterte to power.

Trade unionists were instrumental in bringing down Marcos and in supporting the democracy that followed. That is part of a long and proud history of organized labor resisting repression. This was the case with WWII in Europe, in particular for transport workers, teachers, and journalists because of their respective strategic positions. The struggle after the war in Central and Eastern Europe against another brand of totalitarianism also often meant intimidation, incarceration, and death. It was only the birth of the Polish trade union Solidarnosc in the strike in the Gdansk shipyards in 1980 that set change in motion. In just a few years, it ended Soviet control as marked by the fall of the Berlin Wall in 1989.

Trade unionists have struggled against dictatorships in all forms and on all continents, from Augusto Pinochet's Chile to apartheid South Africa and, more recently, in Tunisia, Iran, China, and Brazil, among others, with the resurgence of populist authoritarianism and the election of leaders nostalgic for military rule.

Although the trade union movement as a whole has always been a target of dictators and would-be dictators, there are two professions that are privileged targets: journalists and teachers. Their disproportionate murder, imprisonment, and disappearances are because their professions are so closely linked to democracy, and are, therefore, considered particularly threatening by tyrants.

Today, as in the past, trade unionists are fighting for democracy and risking their lives and freedom in many countries. We know about some of their struggles, but others are shrouded in darkness. Their courage should inspire more than admiration. They should also motivate those of us who already have democracy to hold on to what was won by previous generations, also at a heavy price.

Countries where democracy may be in danger include some of the oldest, most deeply rooted, most stable democracies in the world, like the United States and the United Kingdom.

The election of President Donald Trump was a shock for most Americans. Those shock waves, however, were felt around the world. His victory inspired others, many of whom seem to be using the same playbook: deception, disinformation, nationalism, and fear and hatred.

It is discouraging and disheartening to see so many elected leaders—whether it is through political opportunism or selling out or both—devoted to destruction rather than construction, and to witness the emotional manipulation blinding people to the real issues and diverting them from recognizing and defending their interests, common or individual.

In a 1958 television interview with Mike Wallace, Aldous Huxley, the author of the dystopian novel *Brave New World*, spoke of the totalitarianism that he and George Orwell had both described, and speculated

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Protest of Betsy DeVos' nomination as education secretary, 2017.

AFT STAFF

Educators and their trade unions are central to building a future for democracy.

that the same propaganda techniques, technologically enhanced, might work in democracies and destroy them. He said, "They will do it by bypassing the sort of rational side of man and appealing to his subconscious and his deeper emotions, and his physiology even, and so, making him actually love his slavery. I mean, I think, this is the danger that actually people may be, in some ways, happy under the new regime, but that they will be happy in situations where they oughtn't to be happy."

Safeguarding Democracy

When the world's governments gathered in September 2015 in New York to adopt the Sustainable Development Goals and came together a couple of months later to adopt the Paris Agreement on climate change, there was renewed optimism. It was a commitment toward building not only a sustainable future, but also a future grounded in the vision of shared democratic values. Today, four years later, we are in the middle of a crisis that is challenging the resilience of our public and democratic institutions. A crisis undermining our public schools and our education unions. A crisis also, if you will, of half-truths and outright lies.

Given the historic role of America's global leadership, Trump's America First approach has also shaken the international order. A couple of weeks after Trump's inauguration, the head of a United Nations agency confided in me that the situation within the U.N. system was "politically rudderless." I felt a bit uneasy, to say the least, when I imagined the heads of the U.N. agencies coming together, sitting around the table, looking at each other in silence, not knowing what to do next. "So?" I asked this person. "Should I start getting worried when you as world leaders are not sure which steps to take?" The person pointed at me and said that the solution ultimately had to be found in what and how we teach our children, and that, therefore, the teaching profession and its representative institutions, Education International and its members, were key.

It reminded me of the words of Franklin D. Roosevelt, who said: "Democracy cannot succeed unless those who express their choice are prepared to choose wisely. The real safeguard of democracy, therefore, is education." By education, Roosevelt was referring to America's public schools, and he must have meant that the people should be able to make an educated, responsible choice, separate fact from fiction, and distinguish true political leadership from rabble-rousing. Imagine if this was the standard by which we measured the success of our school systems: a citizenry making responsible choices. International rankings would look a lot different.

Fading Principles and Understandings

We should ask ourselves whether our school systems are still Roosevelt's safeguard of democracy, or if they are gradually becoming the safeguard of markets, shaping future consumers rather than active and critical citizens able to assert their rights while respecting the rights of others. Many of the fundamental principles and understandings about the institutions central to democracy seem to be fading or in doubt. This is true globally as well as nationally, and it embraces the entire political spectrum. Among these fundamentals are support for a robust public school system, an independent trade union movement, a vibrant civil society, and a free press. They are almost as essential to democracy as free elections.

For example, we see public authorities in democratic nations increasingly confuse isolated voices expressed in social media with representative organizations. In some cases, they deliberately undermine their country's representative institutions, especially trade unions.

The minister of education of a Latin American country told me some time ago that he had 50,000 teachers as "followers" on Twitter, suggesting that he did not need to talk to the education trade unions. One conversation would not concern me, but several education unions have reported that their representative role is not being respected and that they are being "replaced" by people who represent nobody or, worse, who act on behalf of private companies and vendors.

Another example is the growth of market obscurantism, where the market and its rules and customs and the prerogatives of market actors are treated as articles of faith rather than subjects for legitimate debate, which is affecting everything, but especially public school systems. Some of the worst "reforms" in education are based on measurement and evaluation techniques developed by the private sector for widgets, not people. More fundamentally, such "reforms" create a stifling intellectual environment. They place low priority on the competencies for life, including participation in democracy, while placing high priority on the supposed needs of the economy.

Market-Style Innovations

It is telling that in the past three decades, the international education agenda has not been set by the organization that was established for that very purpose, UNESCO, but by the World Bank, the largest source of education loans, and by the Organization for Economic Cooperation and Development, one of the most influential policy bodies providing advice for industrial countries. In other words, not education philosophers but bankers and economists have been guiding education and teacher policy development. Their policy frameworks too often leave little room for our public education systems as the best guarantors of democracies that remain alive and fit.

But it is worse: some of the market-style "innovations" are intrinsically and directly anti-democratic. For example, voucher and so-called school choice programs, regardless of whether they involve private school operators, replace democratic, collective choices with individual decisions by parents. If parents choose schools like they choose laundry soap, citizens are no longer connected to education because there is no collective control. Where is education for democracy? In extreme cases, like Education Secretary Betsy DeVos' home state of Michigan, there is no longer even a "system" of education to grapple with such questions.

The shift to a market, entrepreneurship mentality in education did not strike like a bolt of lightning, and it was not limited to education. Just as the New Deal in the United States and postwar recovery in the 1940s and 1950s influenced generations and affected attitudes about the role of government, the value of public services, and the importance of full employment, social insurance, and fair taxes, a later neoliberal consensus has determined policy and altered attitudes—not only economic and social policy, but on democracy itself. The emergence of this new dogma has had a profound impact on society. The damage it has brought cannot rapidly be undone.

Educators and their trade unions are central to building a future for democracy. So is respect for the profession and its practitioners. If teachers and students are chained to standardized tests and placed under pressure to perform in a limited number of subjects—those that are easily measured—teaching and learning are robbed of their joy and much of their value. Young people coming out of such systems are not likely to creatively and actively participate in life beyond holding down a job. They will not be equipped to shape their futures, their societies, or their governments.

Education Is Not a Commodity

Education International (EI), the world's largest professional trade union organization, is mobilizing education unions around the world to halt the shift of public schooling to edu-businesses. Studies on for-profit schooling in Africa and Asia show that for-profit providers fall short of meeting educational standards. For example, in Kenya and Uganda, Bridge International Academies, a U.S.-based international education business, runs K–12 schools where they employ unqualified teachers, strictly directing their performance in the classroom through standardized scripts. They have these teachers read text prepared in the United States that appear on screens of tablets. The classroom teachers are not expected to use their own words or to alter or add to the text, and they are instructed to avoid class discussion.

In Western industrialized nations too, public authorities are increasingly tempted to open their national school systems to the market, whether pushed by conservative, free-choice ideologues, blinded by the empty promises of private education entrepreneurs, or influenced by the latest global education fashions.

But education is not a commodity. It is an individual as well as a collective right that can only be protected by governments. Public schooling is one of the few instruments of society to build social cohesion and to achieve equity. It is the first line of defense for nations against attacks on their democratic system, whether coming from outside or from within. Outsourcing that defense system is irresponsible, if not a symptom of being unbalanced.

Throughout history, organized labor has championed free, universal public education. In many countries, including the United States, the labor movement has been its strongest supporter. At its founding meeting in Philadelphia in 1827, the first American intersectoral trade union organization, the Mechanics' Union of Trade Associations, called for "a system that will fit the children of the poor as well as the rich to become our future legislators, a system that will bring the children of the poor and the rich to mix together as a band of Republican brothers."

A Moral Purpose

The shift toward an economic, market purpose for education has, in too many cases, meant that teachers have lost much of their professional autonomy. The standardized testing frenzy is only one example of what keeps them from educating young people in the original sense of the word. Educators are not just instructors.

Being a teacher is about moral purpose, about a commitment to making a positive difference in people's lives. And that commitment is on display every day around the world. But too often, teachers are boxed in to situations that reduce them to content-delivery agents and test-score attendants rather than educators.

There is a social, human dynamic at the core of quality teaching and learning. Teachers are part of the glue that holds society together. They create bonds within groups and create the bridges across groups and communities. Nation building, but also promoting peace and democracy, are essential mandates and functions for education.

Obviously, this makes teachers vulnerable. Sometimes they are squeezed between political groupings, caught between ethnic, linguistic, and religious rivalries, or targeted by public authorities, like in Turkey, where, since the attempted military coup in 2016, thousands of teachers have been dismissed. At an international education conference in Ottawa in 2017, two high officials of the Turkish education ministry said that teachers were government employees and that public authorities could dismiss them at any time if they were believed not to support government policy. At the beginning of the 2017 school year, the Turkish government decided to remove from the curriculum the teaching of evolution in science classes in all public schools.

Turkey is no longer an anomaly. In Europe, where we thought that there was a shared belief that teacher professionalism and academic freedom are essential to quality teaching and learning, there are jurisdictions, such as Poland and Hungary, that have recently begun restricting that

25 Lessons from the Teaching Profession

1. Educate for democracy.
2. Shape global citizens.
3. Do not be the obedient servant of the state.
4. Be aware of the thin lines between patriotism and nationalism.
5. Stimulate critical thinking.
6. Build resilience when inequality muffles voices.
7. Protect education for the common good.
8. Keep the market at a safe distance.
9. Don't let politicians interfere in the classroom.
10. Question standardized testing.
11. Keep schools safe sanctuaries of learning.
12. Refuse to bear arms or wear police badges.
13. Open the school to the community.
14. Embrace new technologies with prudence.
15. Burst Internet bubbles and value privacy.
16. Oppose segregation.
17. Fight discrimination on the grounds of gender, religion, race, ethnicity, disability, social background, and sexual orientation.
18. Do not deny undocumented children access to schools.
19. Advocate for gender equity, diversity, and inclusive classrooms.
20. Protect the right to learn in one's native language.
21. Stand up for your rights.
22. Defend and extend your collective bargaining rights.
23. Protect your democratic organizations and institutions.
24. Insist on the application of international standards.
25. Be proud of your profession.

Jasmine Revolution in Tunisia, 2011.

KYODO VIA AP IMAGES

freedom—for example, by imposing one particular history syllabus that glorifies disgraceful chapters of the national heritage. In Japan, "patriotism" has reentered mandatory school programs, while in a number of U.S. schools, the teaching of creationism is allowed or even encouraged. In Brazil, teachers are forbidden to address "political issues" in their classrooms, while the government is trying—unsuccessfully—to erase the renowned education philosopher Paulo Freire from the country's educational heritage.

Where ideology creeps into the curriculum, where teachers' professional autonomy is being challenged, democracy is at stake and alarm bells should ring.

Regaining Control of the Teaching Profession

While in some parts of the world, politicians are forcing their way into classrooms and dictating to teachers what and how to teach, in other parts, private enterprises are entering the education sector hoping to make a quick buck in the huge, largely untapped "education market." Suffice it to say that when and if these two worlds continue to expand, the teaching profession, as we know it, may be crushed between them, which would leave teachers disarmed, stripped from professional freedoms, and unable to deliver meaningful, quality education.

Many teachers in the United States and around the world see their work as being in line with John Dewey's seminal text, *Democracy and Education*, where the role of the profession is to ensure that students grow up to be critical-thinking and informed citizens who make decisions based on facts and not on political ideology. They take this responsibility even more seriously in the face of rising populism and moves to undermine or control the free press in some countries. Therefore, teachers and their unions must claim the right to use their professional discretion to interrogate and to reject curricular directives that defy facts, falsify history, or lead to xenophobia and hate. There is a professional and ethical responsibility that may outweigh the authority of education employers, or even of governments, where responsibility for democracy and human rights has been abdicated. Beyond left and right, there is true and false. It is the responsibility of educators to prepare future generations to know the difference.

Consequently, one of the main challenges for Education International and its member unions around the world is to regain control of their profession. Albert Shanker, former president of the AFT and founding president of EI, often reminded us that a strong profession implies that its members—within agreed parameters set by public authorities—determine their own professional standards, like lawyers, architects, and doctors do. Surgeons would never accept politicians or pharmaceutical companies stepping into their operating rooms telling them where and how to cut.

"We Do Not Count Them"

Some time ago, I visited a school in Berlin that, I was told, included many refugee children from Syria. "How many refugee students do you have?" I asked the principal. "I have no idea," she said somewhat irritably. "We do not count them." It then occurred to me that this is one of the characteristics, if not the very soul, of the teaching profession—the yearning to build equity—in the classroom, in the school, and, yes, in society at large.

Educators and schools can provide safe, comfortable, and caring places for diverse groups to learn about, understand, and appreciate others. Education enables migrants and refugees to adapt to their new homelands. However, many of our member organizations are discovering that they have to contend not only with the adjustment of those from other cultures, religions, and ethnic groups, but also with a hostile environment in the community.

That antagonistic environment comes, in large part, from the manipulation of voters by irresponsible, destructive leaders. For example, Trump has referred to the arrival of migrants from south of the border, often escaping extreme violence and poverty, as an "invasion." He has even called out the troops. Is it any wonder that Patrick Crusius, the white supremacist terrorist who attacked the El Paso Walmart, used the same term?

In Italy, Matteo Salvini, the former deputy prime minister and minister of the interior, and his Lega party also refer to desperate migrants, often in danger of drowning in leaky, overcrowded boats, as invaders. The "duty to rescue," established by international law and a matter of simple decency, is now in conflict with Italian law.

Words can be used to bring people together, or they can be used as weapons to divide and destroy. Restoring the richness of language, including nuances, and the connection with its meaning (as opposed to disinformation and fake news*), and making it compatible with our values, is also part of teaching.

Reducing Hatred and Bigotry

Trade unionists and educators can and do play a positive role in reducing hatred and bigotry. They can foster understanding, acceptance, and social coherence. They are responsible forces for the nonviolent resolution of conflict and for healing. There are numerous examples.

In Northern Ireland, conflict between Protestants and Catholics had deep roots and generated hatred, fear, and violence, up to and including terrorism. The Northern Ireland Committee of the islandwide Irish Congress of Trade Unions was fully recognized by the government authorities in 1964. Ten years later, its members courageously led a back-to-work march against a Loyalist political strike. Similarly, they opposed religious-based industrial action and violence by the Republicans. The Northern Ireland Committee was a rare organization with both Catholic and Protestant members, and the only representative one. It was a "safe place" for workers to come together on workplace issues before they went home to their separate neighborhoods. They showed

*For more on helping students with civic reasoning online, see "The Challenge That's Bigger Than Fake News" in the Fall 2017 issue of *American Educator*, available at www.aft.org/ae/fall2017/mcgrew_ortega_breakstone_wineburg.

that both democracy and peace were possible despite the conflict that was ravaging the region. They did not negotiate the Good Friday peace agreement in 1998, but they paved the way for it by struggling against sectarian violence on the job, breaking down barriers, and providing hope.

In Tunisia, the relatively nonviolent "Jasmine Revolution," which began in December 2010, led to the Arab Spring. Organized labor was the main and most powerful force behind that revolution. During all the years of repression, which included greater or lesser attacks on union leadership, internal trade union democracy was maintained. Members may not have known political democracy, but they tasted democracy in their trade unions. The trade union umbrella organization, the Tunisian General Labor Union, in which teacher leaders played a major role, was an actor in the economy, was respected by employers, and had a large enough base and power that even autocrats had to negotiate with them. When people went to the streets in Tunisia during the uprising, region by region, they used the union's infrastructure. This is one of the reasons that change has been more advanced and profound in Tunisia than elsewhere in the region. Later, when liberty was endangered by Islamic fundamentalists, the trade unions, joining with others, were again able to help save democracy. They were recognized for that contribution in 2015 with the Nobel Peace Prize.

American educators and their organizations are facing the urgent challenge of the 2020 elections. They will do everything they possibly can to support a candidate who is a true democrat, someone who has the will and capacity to pull the country together rather than tearing it apart. Organizations elsewhere are facing similar life-and-death struggles. Some have ties to political parties. Some support candidates. Others have a policy of avoiding organizational participation in partisan politics. But all share a strong stake and interest in democracies that function and make this world a freer and fairer and more peaceful place to live and work.

Building new generations who are willing and able to fight for democracy, human rights, and social justice may seem distant. However, winning elections, while important, is only part of constructing more democratic societies, in and out of the voting booth. As John Dewey, the famous American educator and philosopher and proud member of the AFT, wrote: "Democracy has to be born anew every generation, and education is its midwife." ❑

Education and Democracy

It is hard to understand why education has so rarely come into the public debate about the future of democracy. Perhaps, many do not see the intimate link between the teaching profession, organized labor, and democratic governance. Or, it may be because we live in a short-term world afflicted with severely limited attention spans. Some may find it difficult to address a future beyond the next election or the next paycheck or the next standardized test.

On the occasion of Education International's 25th anniversary, Susan Hopgood, the president of EI, and I thought we should try to help fill this vacuum. We felt that we might be able to stimulate discussion and action in our ranks by drawing some lessons education unions and their members have learned throughout history in defending public education and democracy. To that end, we wrote *On Education & Democracy: 25 Lessons from the Teaching Profession*, which highlights examples of truly heroic struggles of the past and present.

Some of those stories take your breath away, like in occupied Poland during World War II, when the Nazis outlawed the teaching of history, literature, and art. These were subjects they believed could thwart their goal to create a Polish slave labor force for the Third Reich. However, thousands of teachers, part of a "secret teachers group" supported by the education union, refused to let down their students and, clandestinely, continued teaching the forbidden subjects throughout the war, sometimes at great personal cost. In Nazi-occupied Norway, teachers also refused to indoctrinate students as instructed by the Nazi occupation government. The authorities finally backed down, but not without detaining hundreds of teachers in camps in the far north.

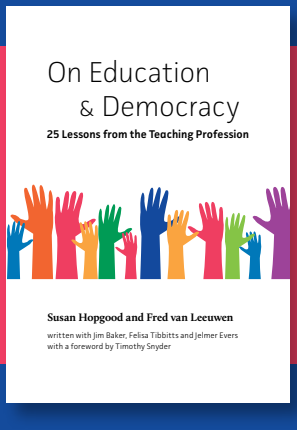
There are other fascinating examples of the lengths that educators and their unions have gone to fight for their professional freedoms and democracy. Today, in Turkey, Iran, Bahrain, Djibouti, the Philippines, and Brazil, teachers are rejecting the transformation of their schools into transmission belts of state ideology or religion. They are refusing to teach lies, let down their students, and betray their profession. They are setting examples for educators around the world.

In places where authoritarian rulers try to get a grip on the teaching and academic professions and on what is being taught in schools and universities, and where the rule of law does not exist or is only on paper, teachers' assignments are difficult and dangerous but relatively uncomplicated: organize, mobilize, and resist. In the established and emerging democracies, where free elections are taken for granted, democratic standards may fade away, sometimes without people realizing it. That is, until they wake up one morning to discover their professional and trade union freedoms amputated, to find their public services pared to the bone and sold to the market, to realize that their media have become concentrated in the hands of a few tycoons, and to witness their politicians shamelessly exploiting racist and xenophobic sentiments.

On Education & Democracy shows that democracy is a process that is reversible, that it can easily slip away.

The purpose of the book is to raise the priority of public education and the role of teachers and their unions in helping democracy prosper. It describes threats to democracy, the role of social media, and the challenges of overcoming the effects of organized and targeted disinformation, often called "fake news," stressing that technology will never be able to solve that problem through new algorithms or other technological tweaks. Education is all about human interaction and iteration. Teachers are central to this dynamic process.

–F. v. L.



To download an e-book version of *On Education & Democracy: 25 Lessons from the Teaching Profession*, visit https://go.ei-ie.org/EduDem.

Understanding Chronic Absenteeism

What Research Tells Us about Poor Attendance at School

By Valerie L. Marsh

Since the beginning of compulsory education in this country, absenteeism has been a concern, one that educators identify as among the most persistent challenges schools face.[1] Yet, it wasn't until 2016 that the U.S. Department of Education issued a report that raised awareness of chronic absenteeism as a serious problem.[2] Based on the 2015–2016 Civil Rights Data Collection survey of 95,000 schools across the nation, more than 7 million students are missing 15 days or more of school a year, the defining criterion of *chronic absenteeism*. These 15 days or more translate to missing over three weeks of school; the absent 7 million equates to 16 percent of the U.S. student population, approximately one out of every six students. Moreover, 2 percent of students are missing a lot more—at least 25 percent of school days, which represents 45 days or more of school a year. These statistics reveal huge numbers of young people existing on the margins of learning, school community, and educational opportunity.

Monitoring students who are chronically absent originated with the Every Student Succeeds Act, the federal education law passed in 2015, which also provides federal funding for training that reduces absenteeism. Since then, 36 states and the District of Columbia have shifted to an accountability measure of chronic absenteeism as an indicator of school quality. This past school year (2018–2019) was the first year these schools disclosed a chronic absenteeism rate in their end-of-year school report cards.

Chronic absenteeism is a particular way of monitoring attendance, more powerful than *truancy* or *average daily attendance*, two previously applied methods.[3] Unlike average daily attendance, which counts how many students show up on a given day, or truancy, which measures unexcused absences only, chronic absenteeism identifies how many students miss at least 15 days for any reason, excused or unexcused. Chronic absenteeism enables schools to see patterns of student absences that, when they accrue, significantly impede achievement.[4] With these new attendance measures in place, chronically absent students are less easily lost in daily attendance snapshots. Many believe moving to chronic absenteeism as a measurement is a more specific and useful data point to properly address school attendance and the myriad risk factors tied to absenteeism.

Why Students Miss School

Both race and income are predictors of absenteeism; Pacific Islander, American Indian, black, and Latinx students have the highest rates of absenteeism. English language learners (ELLs) and

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children with disabilities are also more likely than their peers to be chronically absent. Poverty is also indicative of a greater risk of missing school in significant percentages.[5] And since urban schools comprise more students of color and low-income students, we know that absenteeism is a pressing issue in such schools, and that it is more severe in larger schools than smaller ones.[6]

Students miss school for various reasons; for students of color, ELLs, students with disabilities, and students who live with poverty, those reasons multiply.[7] A primary deterrent to attendance is an inhospitable school culture. Students often refuse to attend school to avoid conditions they perceive as unsafe, such as bullying, harassment, and embarrassment.[8] These deterrents correspond to a chaotic school atmosphere, where students and their families feel disconnected to other adults and children in the community.[9] A dilapidated facility can also make students feel unsafe and affect their sense of belonging and desire to spend time in school.[10] Young people understand that broken water fountains, mold-infested classrooms, or missing bathroom tiles that go unfixed communicate a lack of concern for them.

Student mobility (families moving in and out of school districts) also lowers attendance. Incidents of student mobility are more common in low-income areas, where low-wage earners tend to move more often for work or where immigrant families travel back to their home countries for extended stays.[11] Other challenges families confront that contribute to chronic absenteeism include illness, family responsibilities, and limited transportation.[12]

How Absenteeism Relates to Student Outcomes

Absenteeism links to low achievement in urban districts.[13] And since urban schools comprise a higher percentage of students of color and students living with poverty, absenteeism can be understood as contributing to the achievement gap between students of color and their white counterparts. Thus, reducing absenteeism is a move to reduce inequity. Beginning in the early years, students who are chronically absent are much less likely to read at grade level by third grade,[14] making them four times more likely to be pushed out of high school, compared with their peers.[15] In other words, low attendance in elementary school predicts low attendance throughout schooling.[16] This trend culminates during the high school years, when nearly 20 percent of students are chronically absent, compared with 12 percent in middle school and 11 percent in elementary school. Ninth grade is a particularly vulnerable year for low attendance, and it correlates strongly with achievement for students in urban schools.

While the connections between low attendance, low academic achievement, and pushout rates are well supported in research, such outcomes are indicative of other factors that relate to a child's health and well-being. Therefore, when schools look to increase attendance, they expect that achievement will improve. Just as important, an effort to systematically improve attendance can influence positive changes in school culture and student wellness.

Approaches That Work

In this article, we focus on the students who are absent the most by studying the schools they attend, which are commonly located in urban settings. Through reviewing research and studying successful practices of other urban schools, we argue that teachers and schools can improve the attendance patterns of vulnerable students.

When we began our research in 2016, we had a special interest in studying best practices in attendance, as the University of Rochester, where I work, was at the beginning of a five-year effort to revitalize East High School, our city's oldest, largest, lowest-performing school. At the time this university-school partnership began, East was experiencing widespread absenteeism, low graduation rates, and low academic achievement, thus facing closure by the state. As part of our revitalization effort, we reviewed research that documented the problem of absenteeism as well as successful interventions. For the latter, we also sought out other urban schools in New York state with similar demographics of high poverty (at least 85 percent) and underserved populations (at least 80 percent) that demonstrated exemplar attendance (90 percent or higher). These high attendance figures distinguish these schools. At the time we were seeking out such schools, the state required a reporting of average daily attendance, rather than the more specific measurement of reporting chronic absenteeism; thus, we used the data that was available to identify schools.

Reducing absenteeism is a move to reduce inequity.

Once we found several such schools, we visited them. They are all located in and around the urban centers of Rochester and New York City—the only urban areas where poverty reaches similar depths. Through our visits, we learned that urban schools where students show up, day in and day out, prioritize four main practices:[17]

- A welcoming school culture;
- Personal contact with parents and families;
- Programs and systems to address and improve attendance; and
- Record keeping and logistics;

These components are supported not only in research but also by the practical experiences of people working in schools that have achieved success with attendance.

A Welcoming School Culture

The schools we visited credit a welcoming culture as the most influential factor in their success in improving attendance. Specifically, they foster close relationships with adults and peers, offer a safe school atmosphere, and provide engaging curriculum and instruction.[18]

Several schools incorporate time into the school day dedicated to building relationships, through an advisory period, when students gather with teachers to discuss a variety of topics, such as college and career readiness, or explore hobbies. Through such class periods or in less structured ways, students

feel cared for by their teachers, administrators, and counseling team. Students with whom we spoke may not have always liked the decisions, curricula, or policies of their school, but they respect them because they understand the purposes and caring behind them, established through relationships.

At East, we approached the strengthening of relationships and enhancing school culture by implementing restorative practices throughout staff and teacher training, student support and counseling, academic interventions, and behavioral and disciplinary protocols.[19] Gaining popularity in schools throughout the country, restorative practices are based on building and repairing relationships within the school community.* Our school incorporated a 30-minute class period called "Family Group,"[20] where a small group of students meet daily with each other and at least two teachers (whom they call "Carents") for the purposes of relationship building. Family Group relies on restorative practices like circling and intentional listening. According to East teacher and Family Group coach Annaliese Wilmarth, "We like to say that Family Group is 80 percent fun, 20 percent work." Family Group coaches design lesson plans for Carents, which align with the school's vision and mission. In this way, not only do students connect with each other and their teachers, but they do so with East's guiding principles in mind, thus strengthening their connection to their school's identity. Family Group activities are often celebratory (e.g., recognizing someone's birthday) and promote social connections (e.g., bake-off competitions).

With caring relationships in place, absent students are less likely to go unnoticed.

East teacher and Family Group Carent Gloribel Arvelo-Park explained how relationships formed in Family Group can affect attendance: "We circle up every day, and so if a student hasn't been present and they've been absent, the rest of the group will come after them. It's like, *Why were you not here? Don't you understand you're not going to graduate? You have to come.* So that's good peer pressure, and it's worked for some of them."[21] East student Glerizbeth explained her specific experience of what Arvelo-Park described: "We have one scholar [in our Family Group], and all of a sudden in the middle of the school year, he would just not come to school anymore. So we were like, oh my God, where is this student at? Like, he would say that he's been at East for longer than we could ever imagine. And we didn't even know about him. So that's a change that you can tell, because maybe [before Family Groups] you were a student that nobody knew, but [now] at least 10 people in the school know who you are. One teacher in the school *knows* who you are. We can make sure that we *notice* when there's somebody in the school that's missing."[22] With caring relationships in place, absent students are less likely to go unnoticed.

A welcoming school culture also involves cultivating an environment that feels safe. As one principal told us, "The biggest thing I've found is, you make the school safe, the kids show up."[23] Safety is fostered not only through maintaining the physical condition of the school building and facilities,[24] but also in the aforementioned relationship building. Principals greet students at the front of school every morning, believing this gesture sends an important, welcoming message.

Additionally, some schools provide food for students who attend weekly open library nights to study. Buildings are noticeably clean, and teachers and other staff are highly visible in hallways and interacting with students regularly.

At East, we rely on restorative conferences or "peace circles" to foster an atmosphere of safety, and we follow—or sometimes intercept—a conflict when repair is needed. During a restorative conference, everyone involved sits together in a circle with a mediator. Each participant has an opportunity to tell his or her side of the story, while everyone else listens. Consequently, conflicts are often headed off before escalating to physical altercations. The less fighting, the more safe students feel. As a result, at East, we have seen a significant reduction in the overall number of suspensions. The suspension rate dropped 80 percent between the 2014–2015 school year (2,468 suspensions) and the 2018–2019 school year (486 suspensions).

A related safety component is school-based health centers (SBHCs), which offer health services (such as primary, oral, and vision care) to students and families during the school day.† While we did not observe SBHCs at the schools we visited, East provides one, which has been expanded through the university-school partnership and the university's medical and dental centers. The school's health clinic works to limit absenteeism by facilitating access to services on campus, thus limiting illness and time spent visiting doctors.

Providing engaging and rigorous learning experiences is another way schools offer a welcoming culture. One principal believes that what happens in the classroom is the "biggest component" to his school's successful attendance effort. Indicating the interplay between engaging curricula and relationship building, he explained, "If the kids don't like you, they don't want to learn from you, so you'll see our teachers have great rapport with kids."[25]

Schools communicate high expectations by offering courses that enable students to earn college credit, which also helps them financially, as it lessens the number of credits they need to take in college. Teachers support students striving to succeed, some by offering weekly afterschool help sessions and posting their availability, so students know when they can get help. Schools

*For more on restorative approaches to school discipline, see "Learning to Switch Gears" in the Winter 2015–2016 issue of *American Educator*, available at www.aft.org/ae/winter2015-2016/dubin.

†For more on how partnerships with health centers can connect families and schools, see "Where It All Comes Together" in the Fall 2015 issue of *American Educator*, available at www.aft.org/ae/fall2015/blank_villarreal.

support afterschool learning by providing free bus passes for later departures. Students say that knowing their teachers are willing to stay late helps them remain motivated.

At East, we approached curriculum and instruction with a combination of culturally relevant pedagogy and the Understanding by Design[26] planning framework, and, like the schools we visited, plenty of opportunities to receive help and support, with a focus on relationships. Each student's schedule includes at least one daily period in the "support room," when East provides teacher-generated academic interventions and learning plans based upon student assessment data. The school offers a weekly Saturday school option as well as lunch opportunities to meet with teachers, providing academic support in more relaxed, less intense atmospheres that are conducive to relationship building.

Personal Contact with Parents and Families

Schools with exemplar attendance recognize families as a resource to improving attendance and work to strengthen connections with them. Teachers, attendance aides, social workers, counselors, and administrators "give a human quality to corrective action."[27] A consistent—even dogged—personal approach to communicating with families of chronically absent students is a hallmark of successful attendance programs.

At some schools, teachers call home within 24 hours for each student who misses class. They communicate their priority on attendance in conjunction with their care for students. In turn, students respond. While teacher involvement in outreach to families is suggested by research,[28] it has also been noted that teachers need support and training in order to successfully take on this added responsibility.

The schools we visited have a regular, specific practice of home visits[‡] for chronically absent students. Some dedicate a family liaison focused on monitoring and encouraging attendance, a component of a comprehensive attendance program that strengthens home-school connections.[29] Families often perceive the liaison as their primary connection to the school, especially if that person is part of their community—living in the neighborhood, speaking their home language. Once the liaison gains families' trust, parents will initiate contact with them when they need help finding their child or ensuring they are on their way to school.

At East, we have developed an approach to building home-school connections that resembles those of the schools we visited—regular contact with families, home visits, and language interpreters. The attendance team meets weekly to discuss each chronically absent student. Not only do staff members attend these meetings, but partner agencies are also invited. As such, community organizations like the Ibero-American Action League, a dual language service agency that supports local families, collaborate with school staff at these meetings. Often, partner agencies have prior relationships with families, thus another point of connection that is often necessary to reach and support a child's attendance.

Like most of the schools we visited, East also employs a family liaison, Dana Michaud, dedicated to attendance. Like other effective liaisons, she develops relationships with families that spans years. She approaches families with an attitude of caring, explaining, "Once you talk to them and they see that you're really there because you care—and I really do—then they come to see you as a resource."

For home visits, which Michaud regularly conducts, the school also provides an opportunity for teachers who can volunteer to spend a weekend visiting families whose children are starting to accrue absences. The visits are focused on sharing the good work these students are doing when they do attend, rather than the absences.

The quality of the contact matters as well. Simply calling home multiple times is not enough, and in fact can alienate families, depending on how the conversation goes. Therefore, school staff members are trained in restorative practices and in understanding trauma when working with families. This training affects the quality of the interactions, which are characterized by compassion, rather than disappointment. As former East assistant principal Lia Festenstein explained, "It means a lot to families when you notice little things that might be a struggle or a barrier to them, like parent participation in an event, and you ask parents to come. Taking the bus in January to come to an event is a real pain in the backside. I get that. If I say, 'Listen. Why don't I just drive you home?' People appreciate that." Again and again, we see that meaningful family connections are made with caring attitudes and a widely woven safety net of school personnel and community partners.

Programs and Systems to Address and Improve Attendance

Schools successful in improving attendance translate this priority into positively oriented incentive programs (rather than punishments). These incentives can look like posters mounted around the school communicating the importance of good attendance, awards for attendance, and sometimes contests that encourage attendance. Some schools use monetary rewards when students enact the school's mission statement (e.g., being focused, being accountable). Students can use their rewards to purchase items from the school store, to enter raffles to win gift cards, or to contribute to, and thus alleviate, part of the cost of a class trip.

At East, we too post messages around school showing off attendance numbers and incentivizing graduation goals, and

[‡]For more on the importance of home visits, see "Connecting with Students and Families through Home Visits" in the Fall 2015 issue of *American Educator*, available at www.aft.org/ae/fall2015/faber.

provide awards along with celebrations for students with good attendance. While at the beginning of the university-school partnership, the school provided material incentives, like a new hoodie for perfect quarterly attendance, the focus has evolved over time. According to Festenstein, these types of incentives are "a little bit less necessary [because] I think it's somewhat more culturally understood at this point—like the culture of East—that attendance is important. We talk about it all the time." Therefore, incentives are more focused on recognition of learning. During monthly grade-level town hall meetings, for example, select students share a piece of work that they're particularly proud of with the whole class. According to Festenstein, this practice provides a forum for the school community to see and value excellent work and encourage attendance.

If students are not present, they can't learn.

Record Keeping and Logistics

The schools we visited have a committed, systematic approach to the logistics and the recording of attendance. Some have instituted electronic systems, where students might swipe an ID card as they enter the building, or apps that track attendance. These techniques give schools immediate information about who is present at the start of the day. These systems can also generate letters to parents at specific intervals or send texts immediately. Sometimes parents are surprised their child hasn't made it in yet, and shortly after receiving notice via text or phone call, the student will arrive at school. Schools are diligent about comparing period attendance against the morning attendance report, and they often find that students who were initially marked absent are actually present.

Similarly, schools are careful to identify students who are officially on their enrollment rosters but who have moved out of their school or district, and therefore should not be included in their absent figures. For period-to-period attendance, we visited a school that plays music, rather than a bell, to signify the end of a class period and the transition time to the next period. Once the music stops, halls are expected to be empty. This is followed by hall sweeps, when remaining students are sent to their classrooms or a separate location. Students prefer the music, describing it as less institution-like than bells.

Another way to monitor attendance is through coordinated, weekly counseling meetings that include attendance issues. School psychologists and counselors consider 10 or more days absent (and also chronic tardiness) as an indicator of other issues—often mental health issues. Sometimes schools make changes to their master schedules in order to improve attendance, like changing the start of the school day to coincide with the city bus schedule.

At East, most of these systems—such as automatic letters sent home, tracking period-to-period attendance, automatized alerts for a home visit, and weekly attendance team meetings—are in place. The school has bolstered some of these approaches as well. The weekly attendance team meetings, referenced earlier, include not only school staff (social workers, teachers, counselors, administrators, and family liaisons) but also representatives from community and county agencies that have unique access to information and relationships with families. The team approach also relies on teachers, particularly in their roles as Family Group "Carents." Together, the team members provide a more robust way of supporting students and their families, and improving attendance.

Schools in urban communities with high concentrations of poverty and ethnically diverse student populations have demonstrated that a combination of a welcoming school culture, personal contact with parents and families, programs and systems, and record keeping and logistics helps move the needle to increase attendance. Now, more than four years into our partnership with East, we are starting to see encouraging signs that our efforts are making an impact. Over the past five years, East has gone from an average daily attendance figure of 77 percent in grades 7–12 to 90 percent in grades 6–8 and 82 percent in grades 9–12. And, its chronic absenteeism rate has dropped 12 percentage points, from 57 percent to 45 percent.

While these numbers are trending in the right direction, they are not enough. Like at most urban schools, the effort to improve and maintain good attendance is a long-term, ongoing commitment that remains at the top of the school's priorities. We know that no matter how thoughtful and research based the curricula, no matter how dedicated and well trained the staff, no matter the overall mission of the school, if students are not present, they can't learn. ☐

Endnotes

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CHICAGO TEACHERS AND SUPPORT STAFF WIN HISTORIC FIGHT FOR STUDENTS

This fall, after months of negotiations and an 11-day strike, the Chicago Teachers Union reached a contract agreement that was about much more than pay. "This historic fight for what students deserve—nurses and counselors in every school, librarians, class-size caps, and additional investments in special education—represents a paradigm shift: it wasn't simply a fight to mitigate the damage of austerity, it was a fight to create the conditions that both students and educators need," said AFT President Randi Weingarten. Read more at http://go.aft.org/ae419news1.

GLOBAL CLIMATE STRIKE

On September 20, cities and towns across the globe swelled with millions of activists demanding their governments address climate change. Led by students and supported by hundreds of organizations, including the AFT, the uprising, held days before the United Nations Climate Action Summit in New York, is thought to be the largest demonstration for climate action in history, and it underscored young people's passionate commitment to saving the planet.

"From students walking out in solidarity against gun violence, to young people marching for action on climate change across the world, we see powerful examples of what happens when young people take action for change," said AFT President Randi Weingarten, who marched with members in New York City. "If we can help students learn about the science of climate change, help them understand free speech and citizen advocacy as part of civic education, and encourage their belief in themselves, we've done our job in helping the next generation secure their future." Read more at http://go.aft.org/ae419news2.

COMMUNITY SCHOOLS IN ROME, NEW YORK

In October, AFT President Randi Weingarten visited Rome, New York, where the AFT Innovation Fund is providing a $350,000 grant to expand community schools. Rome's community schools program includes two in-school food pantries; an emergency closet with clothing, household goods, and hygiene products; five satellite mental health offices in schools; homework help; healthy cooking classes for adults; and a referral network to outside agencies. "This really fits in the strategic plan of how you turn around rural America," Weingarten said. Read more at http://go.aft.org/ae419news3.

PARAPROFESSIONALS BRING BOOKS AND JOY TO STUDENTS

It truly was an OMG moment—first, when the Springfield (Massachusetts) Federation of Paraprofessionals won a $30,000 OMG (Offering More Great) Books grant from AFT partner First Book, and next, when thousands of kindergartners attended a read-aloud party held at schools October 4 across the city—and also got to take home free books. The Books for Kindergarten Joy program, a labor-management partnership by the paraprofessionals and the Springfield Public Schools, is just one way the AFT supports programs that help students and educators in all schools thrive. During the event, AFT Secretary-Treasurer Lorretta Johnson read the story of a Korean immigrant girl, *My Name Is Yoon*, to children at Boland Elementary School—many of whom come from immigrant families themselves. Before reading to them, Johnson introduced herself to the kindergartners and told them the significance of the number 5 million: "That is the number of books my union, the American Federation of Teachers, has given to parents, paraprofessionals, librarians, and teachers all across the country, thanks to our partnership with First Book." Read more at http://go.aft.org/ae419news4.

PHOTOS BY AFT STAFF

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