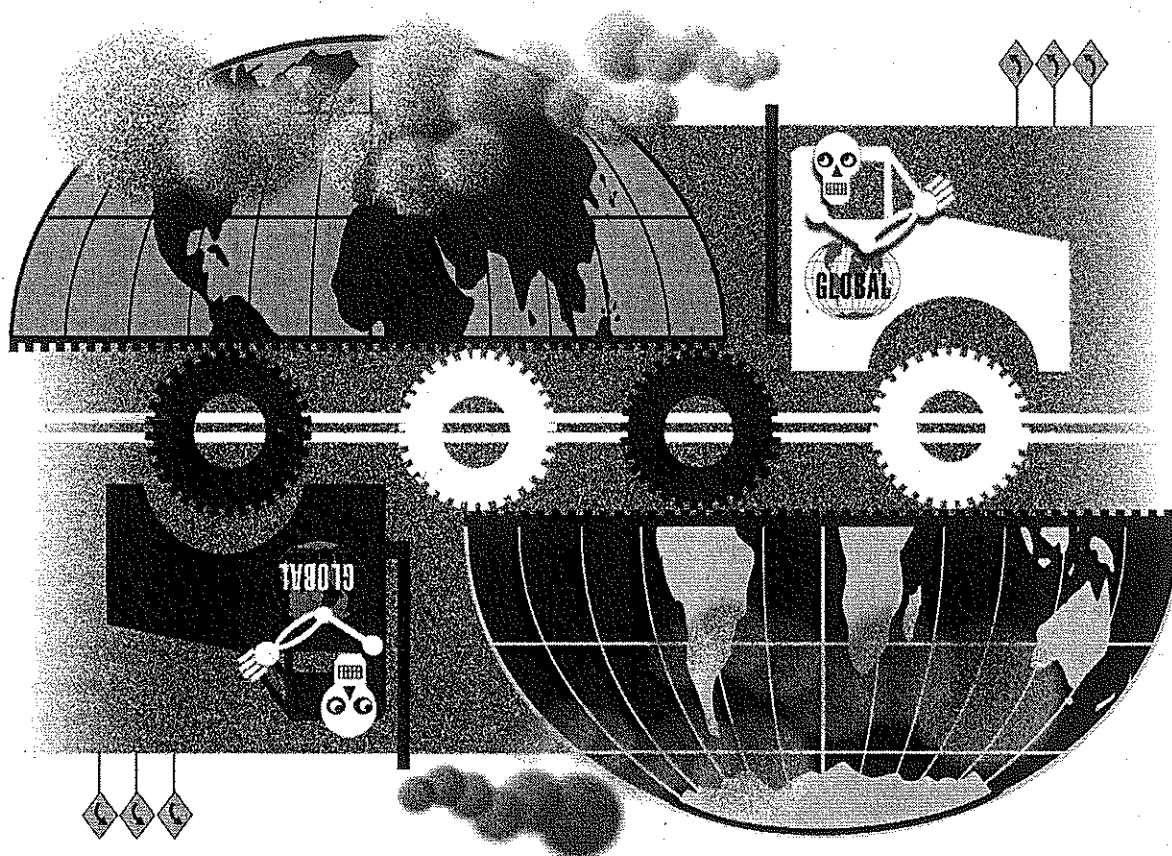


Teaching About Global Warming in Truck Country

By Jana Dean



Ms. Dean, are you trying to tell me I can't drive a truck?"

Alex, an 8th grader, leaned back until he was perched on two chair legs, his arms crossed defiantly. It was the end of a class period, the second day of our class's study of climate change. I knew Alex expected he'd someday drive a big truck like his father.

"Not necessarily," I answered, "but together we are going to learn enough science to understand global warming. Then we'll do something about it."

Global warming is a subject most of us don't like to think about. Worst-case scenario: Ocean currents come to a rolling stop, resulting in a domino effect of chain reactions and a climate unlike anything in the collective memory of humanity. In other words, the ecosystem as we know it is a goner, and it isn't going to be pretty. Among the predictions are wars over water and total economic and social collapse.

What's creating this change? Measurable increases in gases such as meth-

ane and carbon dioxide that absorb and hold heat radiating from the surface of the earth. What's worse, the global thermal balance that drives ocean currents reacts gradually. We've only begun to see the impact of changes that occurred in the atmosphere years ago. We may not feel the real global impact of atmospheric change until it's too late.

In the unit I taught, I wanted my students to understand the physics and chemistry that explain the anthropogenic (human-produced) causes of

climate change. I also hoped my students would reflect on their own lives and consider how their own behavior could change to become more "climate friendly." I entertained the possibility of a broader political response, but accepted at the outset that I might

few private schools, and the district has only two middle schools, both of which serve a similar mix of suburban and rural areas: We get the wealthy students along with the poor.

When I first moved here in 1989, logging trucks still rumbled in from

*It is hard to imagine change when it
disrupts your sense of identity.*

not have time to build enough background in global economics and trade to expose the politics behind global inaction as the earth heats up. As a science teacher operating within the constraints of a bell schedule, I decided to prioritize the science.

And I had another motive, which was embedded in my answer to Alex's challenge two days into our study: Together we would do something about global warming. I wanted my students to join together to create change. For them, uniting across socioeconomic, racial, and political differences can be uncomfortable territory. Yet that's just what needs to happen as humanity faces a global environmental crisis.

I teach in a public middle school on the edge of Washington State's capital city. While mostly white, my students are socioeconomically diverse. To the north, Tumwater's middle- and working-class neighborhoods of houses and apartments merge with the city of Olympia. To the south, junkyards and machine shops set among small industry and warehouses gradually fade into a rural mix of wood lots, farms, subdivisions, and trailer parks. Many students spend an hour on the bus getting to school in the morning. The homes they leave behind range from upscale new houses to trailer parks in some of the most underserved neighborhoods in the county. Our community offers

the surrounding forests to dump logs by the millions at our port. Many of those trees were hauled out of the woods by the relatives of my students. Even though the economy has changed, a rural cultural relationship to the land remains intact. Most families still have plenty of practical uses for a truck. They cut and haul firewood. They pull stumps. They keep livestock. Even many families that don't actively use a truck for work choose to drive one because on weekends they haul and hunt. I teach in truck country.

As the daughter of a gas station owner, I have many stories about trucks and a father who always smelled of grease and gasoline. I learned to drive my father's Ford when I was still too small to shift it without using both hands. Many of my students and I have truck culture in common.

Jimmy comes to school a few times a month hobbled after trying to lift "a tranny with guts in it." Kylie drives her quad ATV into ditches. Justin stays home some school days to help his dad with the fifth-wheel trailer. I figured our knowledge of fossil-fuel-powered internal combustion engines would support us in understanding the causes of global warming.

But when Alex first crossed his arms, I began to realize that indicting our beloved motors for global warming before building a ton of background

would be like petting a cat in the wrong direction. At the same time, it was a sign that I was going in the right direction: Change doesn't happen without resistance. As auto-dependent rural people, we love the ease, convenience, and speed of the open road. My upfront commitment to action had activated in my students a fear of losing a way of life they'd been raised to inherit. Alex's statement, echoed by many of his classmates—yeah, what about my quad, my motorcycle?—worried me, and I had to talk myself into pushing past the resistance. But I would have to proceed carefully since fearful people have a hard time thinking critically.

Carbon Dioxide Would Have to Wait

I decided to carefully sidestep any mention of the causes of global warming until we thoroughly understood the effects.

To get a handle on the effects, we did two projects using a curriculum developed by the Union of Concerned Scientists. (See resources, p. 61.) The first involved following links on a world map to learn about scientifically proven signs of rising temperatures. The map is based on measurable data and climate models that predict increased flooding, drought, heat waves, and wildfires, along with more catastrophic weather events. The second had students studying the transmission cycle of tropical diseases and their vectors.

We learned that changes in climate are severely affecting the polar regions. In many parts of the arctic, sea ice has decreased by 50 percent or more. For the first time, scientists have observed open water at the North Pole. The population of penguins in the Antarctic has declined by one third. Large sinkholes have developed in Alaska as permafrost melts and the ground collapses. Glacial ice in Olympic National Park will be gone by 2070 if it continues to melt

at the current rate. In tropical Africa, rising temperatures and rainfall have both increased the range, severity, and frequency of tropical diseases such as malaria and schistosomiasis.

I asked students to write about what concerned them most about global warming. As they shared aloud, I wrote down their worries on poster paper hung at the front of the class. The mood was somber. My students sat so still and silent we could hear each other swallow.

I learned that Ryan, who lives for hunting season, worried about elk that will suffer from diminishing alpine environments. Brandon loves penguins and lamented the loss of sea ice. Other students cited enormous wildfires attributable to warmer and drier trends in some parts of the world. Many of them felt deep concern about the spread of malaria and other tropical diseases.

Whenever I bring my students' awareness to big problems, I worry I will overwhelm them and short-circuit their potential for critical thinking. I knew that we'd be more likely to be able to push through to more learning if we took the time to talk about how we feel. Acknowledging feelings opens the way for clear thinking. Otherwise emotions and thoughts get muddled up in each other. But in my experience, asking 8th graders to name their feelings can be like trying to get a stone to talk.

I asked the class, "How many of you have ever had a time when things were going wrong and you felt there was nothing you could do about it?" Nearly every hand went up. "Turn to your partner and tell them the story you're thinking of. If you don't have one yet, go second." The room hummed with the noise of storytelling.

After five minutes of talking, I directed everyone to write down the incidents they had shared, and then we read to the class what we had writ-

ten. Jimmy wrote, "On Sunday night I was walking a friend home. Right as we walked in her driveway the cops had their spotlight on us. I got a ride back to my cousin's house in a cop car. It sucked." Kylie described being stuck in a ditch on her quad and not being able to get out. Julie read about being lost on a city bus. Warren read about moving: "I feel overwhelmed every time I have to move from house to house." Our stories helped us to see that when faced with an out of control situation—like global warming—we will feel angry, overwhelmed, stuck, confused, trapped, and scared.

I told my students, "As we continue to learn about global warming, expect to feel all of those feelings. We'll be learning and feeling together. In many of your stories you were alone. In the global warming story, we'll have each other."

Arctic Meltdown

I thought that by then we might have been ready to look again at the causes of climate change. *Arctic Meltdown, Rising Seas* (See resources, p. 61.) features stories and interviews of indigenous people in Alaska and in the Marshall Islands who are suffering as ice melts and sea levels rise.

Before showing the video, I asked students to listen carefully to the narrative for "Changes on the Ice" and "Changes on the Beach" and to take notes.

The video opens with footage of people in Alaska meeting with a scientist: "Polar bears are thin and hungry. Walruses are fewer and fewer every year, and we depend on them for our food."

The video continues with interviews of a family from the Marshall Islands who almost lost a baby in a rogue wave that swept in at high tide. With that story, feelings ran high. The class was silent. Interviews with Marshallese sci-

entists reveal that erosion due to higher sea levels is taking away their land and their way of life. The film then bombards us with a message about our cars, our trucks, our factories, our consumption.

As he put his notebook away, Ron slammed it shut and said: "I don't get it. What are we gonna do? Stop driving?" Consternation ran through the class. "What about my quad ... my motorcycle ... how will we get to school ... too far to ride my bike." I had no answer.

Even though I had previewed the film, and knew it would challenge their assumptions, I wasn't ready for the strength of their opposition. Students' responses reminded me of how much harder it is to imagine change when it disrupts your sense of identity. My students have grown up with the expectation that they will have the privilege of driving. They weren't ready to give up their dreams of the open road.

How could I teach about the fossil fuel causes of global warming and at the same time respect local identity? I knew from the outset that in proposing change I'd meet with resistance. I would have to proceed very carefully to build science background in a non-politicized manner. I decided to wait to thoroughly teach the causes of global warming until I could figure out how to do it effectively. At this point in our learning, the film was too confrontational for these heirs of truck culture.

During the next class I acknowledged that the film had made some students feel uncomfortable, and that some of them felt angry. I explained that understanding the message of the film would take more science background, and that I was ready to teach them that background so they could form a powerful reasoned opinion about the film's message.

We spent the next two weeks building science background. I demonstrated the expansion of water as it

heats by placing a flask with a stopper and a pipette over a candle. With a 5-degree rise in temperature, the water in the pipette rose more than 1 inch. The molecules in a warm fluid move more energetically and therefore occupy more space if they can. This is a factor in rising sea levels. Warm water takes up more space than cold water.

I created convection currents with smoke in a fish tank. Following the directions in the sourcebook *Physics Is Fun* (See resources, p. 61.) I cut holes at either end of a plywood lid, filled the tank with smoke and then started the current by placing a lit candle under one hole.

On a global scale, such rising and falling air and water currents are responsible for our climate as we know it. We then modeled the greenhouse effect with plastic bottles set on a sunny windowsill. One bottle had large holes cut in the side and the other had small ones. The second bottle simulated an atmosphere with more heat-trapping gases.

Charting Our Stuff

Finally, I felt we had enough background to learn about the anthropogenic sources of greenhouse gases. One of the problems with greenhouse gases is that they are invisible. Unlike the particles in the wood smoke that wafts through our neighborhoods all winter, the gases can't be seen. I wanted my students to connect these unseen gases to things they could see.

I told students they now had enough background to understand the science behind some of the causes of global warming that the film had quickly introduced. I told them we'd be starting with things they knew well: everyday items. They would find out what it took to make them. "For example," I said, "the materials to create one piece of paper weigh 98 times the paper itself, and 95 percent of the energy to make

The Science Behind Climate Change

The science behind climate change isn't hard: Burn carbon-based fuels (virtually all fossil fuels are carbon-based) and you add heat-trapping carbon to the atmosphere. Create oxygen-free conditions for decomposition, such as those in the still water behind a dam or in a landfill, and methane results.

Since pre-industrial times, the concentration of CO₂ in our

atmosphere has risen by about a third, from 280 parts per million (ppm) to 378 ppm. Methane has doubled its concentration from 0.78 ppm to 1.76 ppm. CO₂ and methane levels haven't been this high since the age of the dinosaurs. Current methane levels are the highest they've been in 420,000 years. The current concentration of CO₂ is the highest it's been in 20 million years.

an aluminum can is expended before the metal reaches the plant that makes the container."

I explained the assignment: "Pick a product and place it on the end of your roll of adding machine tape [that I'd distributed]. Then work together to brainstorm everything everyone in your group knows about what it takes to make that product. For each thing you can think of, make a labeled drawing. Trace what it takes for as long as you can, drawing arrows between each step."

Justin, Sarah and Angel worked on a poster together. Angel was bursting with questions.

"Ms. Dean, what does it take to make cans?" she asked.

"Electricity."

"Ms. Dean, where does electricity come from?"

"A dam, or a steam plant powered by coal."

"OK. A dam," she simplified. "What does it take to make a dam?"

"Concrete."

"What does it take to make concrete?"

"It comes from rock, which is mined."

She rushed back to her group, eager to have them include what she'd just learned on their chart. As soon as she

got them going, she was back at me, ready to take it further.

"What does it take to make a mine?"

"An excavator."

"What does it take to make an excavator?"

I don't like to spoon-feed students, even when they are excited about pursuing a topic. I realized that with this one, Justin probably knew more about excavators than I did. Justin's got a lot of big equipment in his life. He's quiet and often lets other people do the talking. Until then he'd been relying on Angel for the answers, so I told Angel, "Ask Justin. He knows better than I do."

Before they had finished, their chart included three different kinds of metal, hydraulic fluid, oil, and diesel. As they ran out of time, they'd moved on to the road it would take to drive the excavator to the mine and Justin was working on describing a grader to his group so they could figure out what it took to make one of those.

By the end of the day, the charts stretched for up to 20 feet around the room. They demonstrated how much we knew about the world around us and made visible a lot of the process behind manufacturing products. I told my students, "I think you now have

enough background to really understand the sources of greenhouse gases that the video introduced."

I was right. They were ready. Students listened and took notes attentively as I gave a half-hour lecture on the sources of the most common greenhouse gases. I provided for students 15 anthropogenic sources of these gases, including the extraction and production of fossil fuels, deforestation, hydropower, and livestock digestion. Also included on the chart were landfills, which account for 10 percent of anthropogenic methane, and fossil-fuel combustion, which accounts for 75 percent of anthropogenic CO₂.

Together students brainstormed a list of every fossil fuel they could think of. By the end of the period they saw greenhouse gases everywhere—in tailpipes of tractors, in stockyards, in the power behind the pump, in oil wells, in the manufacturing of hydraulic fluid, in the coal that powered the cement kiln.

I wanted to see if my students could apply what they finally seemed so eager to learn. The next day, I challenged them: "Show me how much you understand about the causes of global warming by making one more poster. Pick any product you want and show at least three ways CO₂ or methane results from its production." I can rarely claim universal success, but this time, every student in my class was able to make the connections I was looking for.

Taking Action

I polled my students on what action they wanted to take to combat global warming. I had them consider five levels of action by finishing sentence stems that read: "I can . . . My family can . . .

Our school can . . . Our country can . . . The world can . . ." At the individual level, most of them said something about walking or riding their bikes. They suggested their families could

turn off the lights. A few brought up the possibility of shorter showers. Many of them suggested reusing products and not buying anything they didn't need. A few mentioned looking for local producers to limit the transportation of goods to market. At the national level, they named efforts to support alternative fuels. Internationally, they wrote of treaties and a united global agenda to decrease dependence on fossil fuels. At the level of "our school" almost all of them named recycling as a way to make a difference.

This may have been the result of conventional and simplistic environmentalism that most students are exposed to. It's easy to believe that recycling is an easy way to solve environmental ills—sort paper, plastic, and aluminum and you feel like you've done something without changing the underlying patterns of consumption that create so much waste in the first place. But I had four reasons to pursue recycling as a collective action:

- I teach 8th graders, many of whom are at their best when they are moving.
- Our school didn't recycle at all.
- A push to have the school recycle on the basis of global warming would give my students a chance to teach oth-

ers about what they had learned, and teaching concepts goes a long way in strengthening them.

■ Landfills and the transportation of waste are a significant part of the problem.

I told the students they needed to find out exactly how recycling could reduce our contribution to global warming and how to set up a program in our school. They prepared questions and I invited the recycling coordinator from our local disposal company along with an educator from the county solid waste department to tell us what we needed to know.

Together, my students and I learned that our school currently produces two 10-yard dumpsters a week, most of which is paper. We learned that every resident of our county generates on average five pounds of waste per day, and that amount has increased by more than 15 percent over the past three years. The reasons? Increased packaging and consumption and reduced recycling. People are buying more stuff and throwing more of it away. We also learned that our waste goes from a local collection site into rail containers that make their way south to the Columbia River, then up the Gorge to Roosevelt Landfill. The trains depart daily and are

Resources on Global Warming

Arctic Meltdown/Rising Seas.

Video produced by Greenpeace, 2001, 32 min. Distributor: www.videoproject.com. The Video Project, PO Box 411376, San Francisco, CA 94141. 800-4-PLANET.

Early Warning Signs: Global Warming Curriculum.

Union of Concerned Scientists. www.climatehotmap.org/curriculum. The curriculum is downloadable as a PDF file and the map is an interactive student resource.

Physics Is Fun.

Octavo Editions, 1995. Order at www.awсна.org/catalog. This book is filled with easy-to-make and inexpensive demonstrations that show the beauty of the laws of physics.

Stormy Weather: 101 Solutions to Global Climate Change.

Dauncey, Guy. New Society Publishers, 2001. This is an especially helpful teacher resource. www.earthfuture.com/stormyweather

just about half a mile long. Almost all of western Washington's waste crosses the mountains for burial in the desert.

While my students asked their questions, I asked my own. "How does transporting waste create greenhouse gases?"

John asked, "What powers trains?"

"Diesel," I answered. "What gas will result?"

"Carbon dioxide."

Someone added, "Methane too when it's extracted."

We learned that the monstrous regional landfill is capped and lined with a thick rubber sheet that keeps the "garbage juice" from entering the ground water.

"Anaerobic decomposition," I said. "What gas comes from that?"

"Methane."

It turns out that over the course of 20 years methane is 62 times more powerful a greenhouse gas than CO₂ because it traps more heat radiated from the Earth's surface. Landfill operators have to do something with it, and usually, they burn it off. This environmental compromise results in more CO₂.

My students then took what they had learned and launched an incrementally growing schoolwide recycling effort. First they perfected a paper recycling system for our classroom and took responsibility for maintaining it. Students then set out to teach every 7th grader and the rest of the 8th graders in our building about the connection between waste and global warming. We visited 7th-grade science classes and the rest of the 8th-grade science classes and delivered recycling bins donated by the disposal company and posters depicting the connection between atmospheric gases and the catastrophes that so worried us when we first learned about the effects of global warming.

Students emphasized to others how important it was that everyone work together, and that we could only

keep the support of our custodian if we stuck with it and emptied the bins every single day. Our effort is slowly expanding to recycle all the waste our school produces in the classrooms. The lunchroom is next.

Looking Back

Thinking over what my students learned, I wonder how it might have played out differently if I hadn't made the commitment to action so early. The student resistance that resulted may have cost us valuable learning and time. On the other hand, that activated resistance may have created in my students a powerful need to know that kept them engaged until we decided on action. But early on, I gave up on indicting auto emissions as a key greenhouse gas contributor—unfortunate, because the statistics are so impressive. According to Dauncey (see resources), an average SUV emits about 13 tons of CO₂ per year, while more efficient hybrid cars reduce that to 3 tons. If I had built more background before introducing fossil fuel emissions at all, there's a chance we could have gone further.

Also, we started our recycling effort too late in the year. As summer approached, I took on the tasks of identifying teacher captains and securing administrative and custodial support for our efforts. If the students had done this work, they might have learned more about how to create institutional change.

But the recycling project helped my middle school students see with their own eyes how the actions we take collectively speak much louder than words. And I want my students to see themselves as agents in our world, rather than subject to it. They made a change in their school that will last much longer than their short stay in 8th grade. And they've established a climate of concern in their school that I can take further next year.

The Future

A few weeks ago, Alex popped a piece of gum into his mouth. When he got to the garbage with his wrapper, he stopped. He looked at it. He looked at me.

"Ms. Dean, what am I supposed to do with this?"

"I don't know, Alex."

"I have aluminum and paper here right?"

"Yes."

He didn't say anything more. He stuck around after the bell to separate the foil from the paper so neither would end up in the landfill. Maybe when the time comes for Alex to buy his first truck, he'll stop and remember what he learned in 8th grade about global warming.■

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