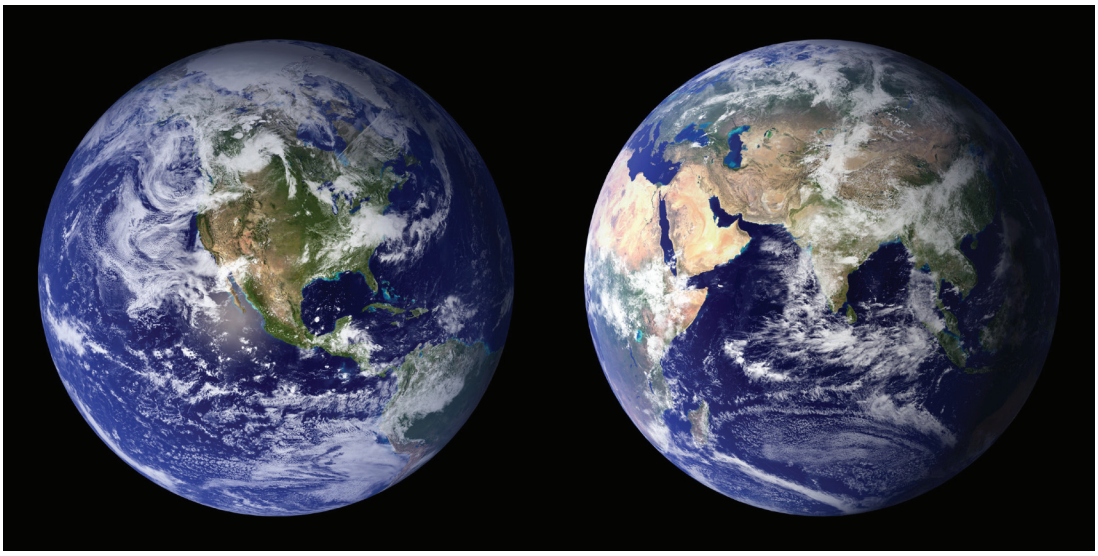
The Teacher-Friendly Guide™ to Climate Change



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On the front cover: the "Blue Marble." Composite images produced by NASA in 2001-2002.

On the back cover: Atmospheric CO_2 concentration at Mauna Loa Observatory from 1958 to 2014 (NOAA).

Chapter 10: Obstacles to Addressing Climate Change

1. Controversial Issues and Complex Systems

"The first principle is that you must not fool yourself and you are the easiest person to fool."

- Richard P. Feynman

"A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it."

- Max Planck

A third or more of Americans reject the scientific consensus that human-induced climate change is real and a serious threat to our economy and environment,[1] in spite of abundantly clear evidence to the contrary. Some people in leadership positions believe, or behave as if they believe, anthropogenic climate change is a hoax, confounding the problem. The question of whether climate change is real has become so politically polarizing that in some areas of the US it can be uncomfortable to discuss the subject in the classroom. How do we broach such a controversial topic with our students, and in fact how do we help create a generation of students more comfortable having meaningful dialogues than those of our current adult generation?

Responses to sociopolitically controversial topics, both those involving science (such as climate change, energy extraction, and evolution), and others such as the nature of K-16 education itself, have some patterns in common. These commonalities provide an opportunity to create some general rules of thumb for approaches in education to addressing controversial issues (see *Table 10.1*). The primary goal of this chapter is to uncover the shared roots of challenges to public acceptance of certain well-evidenced findings, to seek both deeper understandings of each problem and empathy for those with whom we disagree, in order to be more effective educators.

Part of the challenge in all controversial issues is that (1), the academic topics themselves (for example, the climate system and climate change) are generally interdisciplinary and complex, and (2), key findings from research on

[1] In a March 2017 Gallup poll, about 68% of Americans "believe global warming is caused by human activities" and 45% "worry a great deal about global warming." These numbers are among the highest recorded in the past two decades, thus public opinion may be changing. Half in US Are Now Concerned Global Warming Believers, by Lydia Saad, Gallup Politics, March 27, 2017, http://www.gallup.com/poll/207119/half-concerned-global-warming-believers.aspx.

CHAPTER AUTHOR

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Addressing Climate Change

Table 10.1: Rules of thumb for teaching controversial issues.

1. **Be nice (but there are limits).** Treating those who disagree as either idiots or evil people is unlikely to convince them that you're correct.
    a. **Know your audience.** "Nice" has different meanings with different audiences.
    b. **For the most part, people aren't lying.** They largely believe what they say. Default to the expectation that the people you are interacting with believe what they are saying unless you have good evidence to the contrary.
    c. **Advocacy *may* deepen convictions more than understanding.** Evangelism turns on people who agree with you and turns off many who don't. Being certain and being right aren't the same thing, and they aren't all that closely related. Put more faith in people and institutions that are pretty sure than those that are certain.
    d. **Don't let the bastards get you down.** Working on nurturing public understanding of controversial issues will make people angry, and angry people say and do nasty things. Have a support system you can turn to.

2. **Complexify the seemingly simple.** As educators (and like journalists and politicians), we are driven to simplify the seemingly complex. It's often important, but we do it *too* often. The world is complex.
    a. **Move from debate to discussion.** There are often ways to reframe away from false dichotomies.
    b. **Controversial issues are always interdisciplinary.** Pay attention to the tools and strategies of the most centrally related disciplines.
    c. **Don't forget the importance of the simple.** While acknowledging the issue's complexity is important, there are often simple ideas illuminated within that complexity.

3. **Evidence matters, but evidence alone is not enough.** All of us hold beliefs for which ample conflicting evidence exists.
    a. **Learn about cognitive biases (including your own)** and how to communicate more effectively in light of them. Warn learners in advance to avoid biased reasoning.[2]
    b. **State evidence clearly and directly, identifying a small number of key points.** Too many different points cloud the issue.
    c. **Mathematics matters.** Scale plays a central role in many controversial issues, and understanding really large or really small numbers brings special challenges. "Social math"[3] uses familiar examples to show volume, mass, or relative number.
    d. **Call out logical fallacies, and hold people accountable for (mis)using them.** There's a taxonomy of problematic argument types. Get to know it and put it to use.

[2] This article by Keith Stanovich has more information on decoupling prior beliefs: Stanovich, Keith E., Richard F. West, and Maggie E. Toplak. "Myside Bias, Rational Thinking, and Intelligence." Current Directions in Psychological Science 22, no. 4 (2013): 259–264.

[3] National Center for Injury Prevention & Control. (2008). Adding Power to Our Voices: A Framing Guide for Communicating About Injury (p. 40). Atlanta, GA. Retrieved from http://wwwn.cdc.gov/NCIPC-SuccessStory/Social_Math_Resources.html.

Table 10.1: Continued.

4. **Persistence matters.** Beliefs related to controversial issues are often closely tied to worldviews, and such beliefs do not change quickly or easily.
    a. **People do change their minds on things that matter.** A broad modern example is the change in acceptance of gay marriage. A more personal scale example is divorce.
    b. **Piling on evidence can bring beliefs to a tipping point.** Of course, not always.
    c. **Reflect on big changes in your own beliefs.** Chances are, it took either a long time or an immersion in the issue.
    d. **Social media may be a better venue for this than classrooms** because connections last more than a semester or a year.

5. **Use one's place in the world as a starting point** to engage in critical inquiry of the forces working to shape that place (geology, ecology, capital flows, law, etc.).

those topics have implications for equally complex societal systems (such as economic, energy, and political systems). It is common to say that a system such as the world energy system is "broken," because the system delivers problematic outcomes. But another perspective is that many systems still work more-or-less as originally intended – when developed decades or centuries ago – but yield numerous and substantial unintended consequences. Alternatively, they may "work" in a different sense in that they function as self-replicating systems, continuing to operate not because they satisfy their original goals, but rather they persist because they suit the system in some other way.

For example, the structure of the economy is not grounded in research on climate change. The economy took its basic form long before climate science became robust. Energy choices were made based on availability of known energy sources and the price per unit of energy long before the economics of environmental and health consequences were known. Some impacts of energy use became (relatively) quickly known at local scales, such as decline of air quality from coal burning in cities such as London and Pittsburgh, but awareness of global impacts by those making political and economic decisions remained a century away. Likewise, development of today's global coordination of extraction and distribution of fossil fuels did not take into account the eventual enormous cumulative environmental impacts and associated costs. The energy system to a large extent achieves its fundamental goals of making energy widely available and profiting those employed in the industry, and in this sense it doesn't need to be "fixed" so much as it needs to be re-envisioned to fulfill a broader set of goals. By analogy, jet planes did not originate from the improvement or repair of canal boats. Likewise, wind farms are not repaired coal power plants. If the wider ramifications of the interactions of human-made and natural systems had been understood from the start, some decisions about the construction of human-made systems *may* have been different and the world might look very different today.

In isolation and in hindsight, the idea of burning hundreds of millions of years of fossil fuels in just a few hundred years seems insane. After all, the chemical properties of carbon dioxide are well known, and evidence is strong that atmospheric carbon dioxide concentration has strongly influenced the temperature of other planets (e.g., Venus) and past Earth climates. And we

can quantify the amount of organic carbon sequestered in sedimentary rocks, of which a substantial fraction has been burned, well enough to know that it is significant relative to the amount of carbon in the atmosphere as carbon dioxide. It would, based on these observations, be quite surprising if the Earth's climate were *not* changing after burning so much organic matter, which had taken about a million times longer to accumulate over geologic time than the time it has taken to burn it.

But the infrastructure that makes possible heating our homes, transporting us, and creating large amounts of electricity was well-formed before and while these scientific understandings were developing. The lives of billions of people are now partially dependent on these big human constructs -- the infrastructure has grown to such a size and familiarity, that it has become nearly impossible to build new systems while the old ones are still running.

2. Creating Meaningful Dialog

The infrastructure of energy is tightly tied, of course, to our economic and political systems, and to the quality of our lives. How we prioritize jobs, rights to land and resources, degree of political control, importance of environmental protection, weighting of local versus global and national versus international concerns, among many other considerations, determines how we might react to recognizing human-induced climate change as a valid issue, and whether we should adopt policies to counter it. Our feelings about these issues are deeply rooted in our worldviews. Given this, how can we begin to productively relate to, and to teach, students with diverse and different views?

2.1 Developing Empathy

One way potentially to develop empathy for folks we disagree with is to identify areas of our own lives in which we might make assumptions or arguments about activities or beliefs in which we're immersed. For example, one area that most people reading this *Teacher-Friendly Guide* will have in common is teaching within the traditional educational system: schools organized into classes of about 20 students, sitting in a series of 50 minute classes of various subjects, about 40 weeks a year, for 13 years or so. If asked if the system works, most of us would defend it, even if we know it has flaws. It is the way we were taught, the way many of us were taught to teach, and, in most cases, the structure available to us for teaching (no matter what we might dream would be ideal). With time, we develop strategies within the system we use and recognize constraints that would make it difficult to achieve our most idealistic (or research-based) aspirations, and we grow weary of new "reforms" that we know will be hard to implement within the constraints of the existing system.

Given these constraints, it becomes difficult to enact a next generation of educational systems that results not merely in improvements to schools and classrooms, but rather in the replacement of these structures with something fundamentally different and better. How do we work effectively toward a new system that we can scarcely imagine? In this sense, might we sometimes be like climate change deniers, resistant to pushing for change because we are immersed in social groups whose goals have long been to excel within the current system, and inconvenienced and perhaps offended by pushes for

change from outside. (It's not a perfect analogy – for example, most climate change deniers are not climate scientists, while teachers are actively immersed in doing science education.)

2.2 Asking Deep Open-Ended Questions

Part of changing the culture of discussion may be asking questions that are rich and open-ended and seeking new solutions with common ground, instead of questions focused on "right" or "wrong," "do" or "don't." For example, arguments about permitting high volume hydraulic fracturing – a.k.a. "fracking" – are often framed around about whether to frack or not. Of course, that's a worthy question, but it fails to take into account that all *large scale* energy generation is bad for the environment. Therefore, worthier questions include, "By what combination of energies, in different times and places, can we get the energy we need with the least environment impact" and, even more importantly, "How can we use a lot less energy?"[4] Likewise, when we discuss the *Next Generation Science Standards* (NGSS), the question typically asked seems to be either, "Will the NGSS succeed or fail?" or, "How can we make the NGSS work?" where "work" is poorly defined. Again, these are worthy questions, but not nearly as important as, "How can we change schools (and science education) so that they prepare individuals for the responsibilities of citizenship?" With respect to climate change, rather than ask, "Is climate change happening?" or "How do we cut carbon emissions in our current activities," we might ask instead "How do we change the way we build communities in order to decrease the energy we need and take into account the climate change that is expected to occur?"

2.3 Resistance to Change is not Equivalent to Lack of Education

Research by Dan Kahan suggests that deeper knowledge often facilitates stronger polarization regarding these issues rather than broader acceptance.[5] Kahan has written that those with the highest degrees of science literacy were not necessarily the most concerned about climate change, but that these individuals on average were more culturally polarized. Thus one reason so many people in the public do not accept climate change is not lack of knowledge, but rather, according to Kahan, the presence of a "conflict of interest: between the personal interest individuals have in forming beliefs in line with those held by others with whom they share close ties and the collective one they all share in making use of the best available science to promote common welfare." Thus it's important to recognize that, while access to abundant and accurate evidence is necessary for an understanding of climate change, for many individuals this evidence is not by itself sufficient for them to accept human-induced climate

[4] See "Chapter 9: Teaching about the Marcellus Shale" in Duggan-Haas, R.M. Ross, & W. D. Allmon. Ross. 2013. The Science beneath the Surface: A Very Short Guide to the Marcellus Shale. Paleontological Research Institution, Ithaca, New York Special Publication No. 43, 252 pp. See also the Prezi by Don Duggan-Haas, There's No Such Thing as a Free Megawatt, https://prezi.com/emor03bprhy/theres-no-such-thing-as-a-free-megawatt-hydrofracking-as-a-gateway-drug-to-energy-literacy/?webgl=0.

[5] Dan M. Kahan, Maggie Wittlin, Ellen Peters, Paul Slovic, Lisa L. Ouellette, Donald Braman & Gregory Mandel, The polarizing impact of science literacy and numeracy on perceived climate change risks, Nature Climate Change advance on line publication, http://www.nature.com/doifinder/10.1038/nclimate1547 (2012).

change. This is because individuals make choices on what they accept using a variety of criteria, most especially the views of the peers with whom they associate and their own pre-existing world views. Thus it's important to know each other and our students as multidimensional people with social pressures, not merely as dispassionate analysts of data. All of us are susceptible to a wide variety of cognitive biases associated with these external pressures and other factors, including how our brains work, that impact our perspectives and what we accept as true.

3. Factors That Influence How We Think

> *"The most erroneous stories are those we think we know best – and therefore never scrutinize or question."*
>
> *- Stephen J. Gould*

Research in cognitive sciences has helped to distinguish many ways in which our thinking is influenced by a combination of factors in our environment (such as influence of our culture generally and peer groups specifically), plus the way our brains give priority to certain kinds of information and stimuli. **Cognitive biases** and **logical fallacies** lead us to believe things to create a worldview and social dynamics that are internally consistent. *Most everyone holds as true things that are clearly and demonstrably false;* because we are wrong about these things, we cannot see that we are wrong. These aspects of human nature drive us to believe certain things that are demonstrably false falls under the umbrella of **identity-protective cognition.** Familiarity with some of the kinds of common biases is helpful when considering and teaching about controversial issues.

The common phenomenon, discussed above, of additional evidence alone being insufficient to change understandings and associated beliefs, can be a precondition to the backfire effect.[6] The **backfire effect** causes beliefs to become stronger when they are challenged with conflicting evidence.[7] The backfire effect is in part a response to identity protective cognition**,** the status quo bias, and allegiance to community norms, each of which are powerful forces that resist change. The **status quo bias** is an emotional bias and a preference for the current state of affairs. The current baseline (or status quo) is taken as a reference point, and any change from that baseline is perceived as a threat or loss.

Myside bias or **confirmation bias** is the tendency to seek out information that agrees with one's existing prior opinions, and to ignore established evidence that might conflict with those opinions. A common occurrence of this bias is reading only media likely to align with one's existing views. More subtle subconscious confirmation biases can occur, however, even in research in selective choice

[6] Scientists often prefer to use the term "accept climate change" rather than "believe in climate change," as a way to distinguish evidence-based conclusions (accepting evidence) as opposed to faith-based conclusions (belief). In this article and this book, we often follow this convention, but do use the terms "believe" and "beliefs" when we feel the intended meaning is not likely to be misinterpreted.

[7] People may be more likely to consider another position when they do not feel challenged or threatened. See Horowitz, Eric. "Want to Win a Political Debate? Try Making a Weaker Argument." Pacific Standard, August 23, 2013. https://psmag.com/want-to-win-a-political-debate-try-making-a-weaker-argument-446f21de17a1.

of data to analyze and literature to reference. One function of the peer-review process in scientific publication is to insure that researchers have taken into account all available credible evidence for and against their hypotheses.

The sunk-cost fallacy, spending good money (or time, or other resources) after bad, is the tendency to pour resources into a system in part to justify the resources already used. Such reasoning makes it difficult to abandon existing infrastructure or long held practices. If, however, putting resources into new solutions is more likely to lead to better outcomes than maintaining an existing system, the amount already invested in the existing system logically should not factor into decision-making.

Solution aversion refers to the idea that claims (such as the influence of climate change) might be rejected because the implication of accepting those claims would be accepting solutions that require sweeping (and therefore challenging) changes to the systems and cultures in which one lives and works.

The **availability heuristic** pushes us to rely on immediate examples rather than information grounded in extensive data or research. The understanding of cause and effect within complex systems over long-intervals is thus challenging in part due to delays in feedback. Examples include attributing individual weather observations to support for climate change (an extreme weather event) or against it (a cold and snowy day), even though climate change by definition refers to long-term averages.

Objections to climate change are also commonly in the form of narratives of good and evil. This is addressed in Chapter 11, Perspective.

4. How Do People Change Their Minds?

Changing a closely held worldview is not about changing understandings of isolated concepts, but rather remaking that worldview. What goes into such a large change? Changing one's mind about deeply held beliefs requires reaching a tipping point. Ultimately, to release an idea people have clutched tightly, they divorce themselves from it. The word "divorce" is not chosen lightly. For some individuals and communities, separating from such ideas may mean divorcing from other individuals and communities that are central to identity. That separation may be as painful as divorce from a marriage, or a conversion of faith.

Some ideas are hard to swallow because they imply that we or our sociocultural group have been contributing to something harmful. We may strongly identify as a "good" person who makes decisions based on what we think is best for our families, communities, and country, and other good people around us may think the same way. Thus if an idea is at conflict with those of our social groups, it is natural to assume there must be something wrong with the arguments of the other side. We select the evidence that maintains the most internal consistency within our worldview. There is an advantage to this in certain contexts – it helps us to maintain important social connections and to protect our identity. It may push us to believe things that are demonstrably false, but some new beliefs are accompanied by a cascade of other implications – beliefs we would need to let go of, and people in our social group with whom we'd be at odds. Thus,

while maintaining belief in something that appears to be false based on a preponderance of available evidence may, out of context, seem illogical, in the broader scope maintaining our belief may create the least tension, and in that sense may be perceived as a logical choice.

5. How Can We Envision New Systems?

In responding to challenges of climate change, there is a drive to make existing energy-using systems more efficient at what they do. While this makes good intuitive sense, it is focusing on "the right way to do the wrong thing."[8] It focuses upon teaching what we know how to do rather than upon doing what needs to be done. We focus on making specific *existing* processes, strategies, and technologies better. We should do that, of course, but often it is more important to make fundamentally (revolutionarily) *new* processes, strategies, and technologies (*Figure 10.1*). For example, part of the strategy to reduce carbon emissions is making better cars and trucks. There may, however, be a limit to improved efficiency from vehicles that look too much like cars. Ultimately, we may need to make a transportation system that is *better* than cars and trucks.

By analogy, on the route to improving educational outcomes, we need to make better schools, but there's a ceiling effect if we're locked into the systems of traditional schools. Eventually it is likely more important to make an educational system that is better than schooling. This, of course, is a heavy lift. We hope that the approaches and ideas discussed here serve both the existing educational system and whatever educational systems might lie in the future.

For adoption to occur of new system innovations—transportation, energy, education, or otherwise—the new things need to look enough like the old things to be understandable. Successful (broadly adopted) innovations are likely to be "optimally distinct," that is, different enough from current practice to make a difference in outcomes, but not so different as to be outside of cultural or professional norms or too weird to be understood.[9] In a study of journal articles with the highest impact, for example, it was found that found that combining conventional science in unconventional ways is twice as likely to yield higher impact studies than either novelty or conventional science alone.[10] For reforms of systems that make a difference to mitigating climate change, we need to consider how to combine conventional ideas in unconventional and productive ways.

[8] To lift a lyric from singer-songwriter, Cheryl Wheeler. See: http://www.cherylwheeler.com/songs/rway.html.

[9] Berger (2016) Berger, Jonah. "The Goldilocks Theory of Product Success." Harvard Business Review, July 7, 2016. https://hbr.org/2016/07/the-goldilocks-theory-of-product-success.

[10] Uzzi et al (2013) Uzzi, Brian, Satyam Mukherjee, Michael Stringer, and Ben Jones. "Atypical Combinations and Scientific Impact." Science 342, no. 6157 (2013): 468–472. http://www.kellogg.northwestern.edu/faculty/uzzi/htm/papers/Science-2013-Uzzi-468-72.pdf.

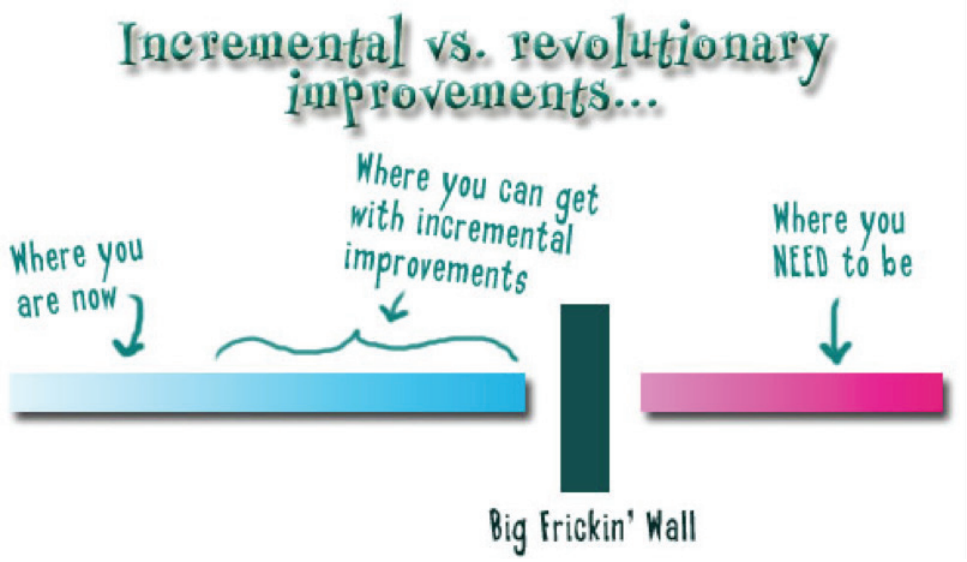

Figure 10.1: Often a barrier ("Big Frickin' Wall") to improvement of a system requires revolutionary improvement, rethinking the system, rather than incremental improvements within the existing system.

Resources

Online Resources

The website "You Are Not So Smart," by David McRaney, the author of the book of the same name, includes an excellent series of podcasts on logical fallacies. https://youarenotsosmart.com/. McRaney is, as of April 2017, finishing a new book about how people change their minds on important issues.

See the website http://yourlogicalfallacyis.com, which is titled at the top "Thou Shalt Not Commit Logical Fallacy." The site compiles in table form information about many of the best known logical fallacies, and offers this as a poster that can either be downloaded as a pdf or ordered from the site.

The Cultural Cognition Project at Yale Law School offers a large selection of articles written for both academic and popular publications and blog posts on cultural and psychological issues that complicate science communication. Access here: http://www.culturalcognition.net/.

The website for the Yale Program on Climate Change Communication, http://climatecommunication.yale.edu/, includes the various "Six Americas" reports that cluster Americans into six groups based on their attitudes, beliefs, behaviors, policy preferences and risk perceptions related to global warming. The six groups are: Alarmed, Concerned, Cautious, Disengaged, Doubtful, and, Dismissive, and the website includes resources and strategies for effective communication with these different groups. The sister site, Yale Climate Connections (http://www.yaleclimateconnections.org/), "is an online news service providing daily radio broadcasts and original online reporting, commentary, and analysis on the issue of climate change," with readings and 90 second daily podcasts that are readily usable in the classroom.