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Chapter 15
Fostering Educator Resilience: Engaging the Educational Community to Address the Natural Hazards of Climate Change

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Abstract Climate change and the natural hazards associated with it are some of the greatest environmental, economic, and political challenges of our time. Given how important students are to the future of addressing these issues, it is surprising that those who are tasked with educating them, teachers, have been so greatly overlooked. This chapter will address the challenges and opportunities for creating a resilient, supported, and informed educational community that can work with students to plan for the future.

Keywords: natural hazards, climate change, climate education, climate literacy, Next Generation Science Standards, Common Core State Standards, National Climate Assessment, science denial

15.1 Introduction

Climate change and the natural hazards associated with it are some of the greatest environmental, economic, and political challenges of our time. Complex, often nonlinear in their causes and effects, both are often overlooked and at times deliberately avoided because of their overwhelming implications. Both have non-intuitive aspects that may baffle those unfamiliar with the science and mathematics behind them. A 500-year flood could in theory occur two years in a row, and even as global average temperatures continue to rise, record-breaking cold temperatures still are being set. When students are not afforded the opportunity to learn about these vital topics in their formal education, their alternative or naïve concepts may well continue into adulthood.

As the world prepares for future disruptions associated with a changing climate, many political, scientific, and social groups are working to understand the potential impacts and associated costs. There is still confusion, however, within the public sphere about the legitimacy of the science that indicates human activity is responsible for climate change as well as the economic and political implications. Though in the recent past less than half of Americans believed climate change was human-caused, and a third believed there was a lot of disagreement

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within the scientific community as to whether or not it was happening (Leiserowitz et al. 2010), recent research suggests more general acceptance of human causation but a shallow understanding (Leiserowitz et al. 2013).

In an attempt to enlist the public in a more comprehensive discussion of the natural hazards associated with climate change, many researchers have been working on the best way to engage with the public: how to discuss the topic and how to get the public interested (Hamilton et al. 2012; Hassol 2008; Leiserowitz et al. 2010). Attempts have also been made to track, analyze, and improve media coverage of this topic (MT Boykoff and Boykoff 2007; Huertas and Kriegsman 2014), including a recent focus on utilizing weathercasters in particular as spokespeople for discussing these issues. When the third National Climate Assessment was released in the spring of 2014, President Obama invited weather forecasters to the White House to discuss the implications and encourage them to address these issues with their viewers (Davenport 2014).

As future citizens and policymakers themselves, students are another group that has been heavily researched (Hamilton College 2007; Leiserowitz et al. 2011). Attempts have been made to discover how to best reach this audience without unduly alarming them about the consequences of natural hazards or discouraging them from thinking about mitigation and adaptation (Hicks and Bord 2001; Ojala 2012). Indeed, students are in some respects a perfect group with which to work. They are already immersed in an environment conducive both to learning and to action, and though many admit to know little about climate change, they report they are interested in learning more (Leiserowitz et al. 2011).

In light of how important students are to the future of addressing the challenges of climate change and its associated natural hazards, it is perplexing that teachers, who are tasked with educating them, have been largely overlooked. Research has been limited on understanding how educators address these topics with students, the best practices for climate change education, or even the opinions and concerns of the educators themselves. Moreover, though science educators are typically trained in the sciences and pedagogical practices, there is a risk, with a topic such as climate change that is politically contentious, that educators will be too concerned about political implications to address the topic forthrightly. As a reliable and trusted source for accurate scientific information, science educators are depended on as the first and often the last time many students engage with scientific concepts. Ensuring that science teachers have a clear and accurate understanding of the science is central to a scientifically literate citizenry.

In this article, the value of educators in addressing both climate change and its implications related to natural hazards will be addressed. Through a thorough discussion of the challenges and opportunities for engagement, including an emphasis on informed responses, we can create a more resilient educational community ready to confront the challenges ahead.

15.2 Unique Challenges for Educators

There are many challenges to addressing climate change and its associated natural hazards. These include science denial and politicization related directly to climate change (Rosenau 2012), student misconceptions of both the causes and impacts of climate change and the associated natural hazards (Boyes et al. 1993; Harrington 2008; McCaffrey and Buhr 2008), as well as psychosocial issues attendant on bringing potentially upsetting topics into the

classroom (Hicks and Bord 2001; Ojala 2012). These challenges have been expounded upon in the past, particularly as they relate to student understanding of these concepts (Berbeco and McCaffrey 2014). Here, though, the particular challenges that educators face will be addressed. Also discussed here will be how educators' misconceptions and personal beliefs trickle down into substandard teaching practices and how the scientific community can better support educators in teaching the core science in an accurate and confident manner.

There is much that can be garnered from the social science research that attempts to understand the challenges educators face when teaching a socially contentious topic. Prior to climate change being integrated into the classroom, evolution was perhaps the most socially controversial topic to arise in science courses in the United States. A 2007 national survey of public high school biology teachers (Berkman et al. 2008) found that few educators steered away altogether from teaching general evolutionary processes, and less than 20% avoided the discussion of human evolution. However, a quarter of the educators reported that they devoted at least an hour to creationism or intelligent design in addition to evolution and, of those, nearly half felt that creationism was "a valid scientific alternative to Darwinian explanations for the origin of species" (p. 922). Of at least equal concern, however, was what the researchers subsequently dubbed "the cautious 60%" of science teachers who, while not preaching creationism, nevertheless fail to be "strong advocates for evolutionary biology" (Berkman and Plutzer 2011, p. 404). It would be easy to blame these educators for shirking academic and professional responsibilities as their creationist colleagues do. This, however, would be a simplification of the challenges such teachers face and dismissive of the realities of teaching topics that can be emotionally challenging both to the students and to the teachers themselves.

In a separate study by Griffith and Brem (2004), researchers surveyed biology teachers about the sorts of pressures they face when addressing evolution. They found three categories of teachers: *scientists, selective*, and *conflicted* (p. 791). The *scientist* teachers felt there was no place for controversial social issues in their classroom. This is not to say they avoided teaching evolution or did not acknowledge that evolution was perceived by many in the public sphere to be controversial, but rather that they felt no internal conflict about teaching the topic in a straightforward manner and insisting on its scientific value. They felt a deep love of the science and a desire to share that with students, reporting few classroom stresses and not worrying about incidents or conflicts arising in the classroom. The *selective* teachers were concerned with harmony in the classroom, specifically selecting topics that would be less controversial to avoid conflict. Moreover, they altered their teaching structure from more open to more closed when they addressed evolution (e.g., fewer opportunities for questions and more of a lecture style). The last group, *conflicted* teachers, experienced stressors internally as well as through interactions with their students. They had grave concerns regarding the consequences for teaching evolution, and their concerns were mostly religious in nature, causing them much personal stress. This group felt the least comfortable with the content as well and was more likely to present the content as controversial. Griffith and Brem's (2004) categories correlate, roughly, with the three groups identified by Berkman et al. (2008): the 28% who present evolution as a unifying theme of biology, the cautious 60%, and the 13% who present creationism as scientifically credible.

These findings are not unique to educators who teach evolution, but can be extrapolated to include those who address any scientific topic that has a social or political controversy associated with it, such as climate change. Rather than religious in nature as with evolution, the challenges to climate change are of a more political nature (Rosenau 2012). Still, with climate

change, one would expect a similar breakdown of the educational community, with some teachers (such as those in the *scientist* group) choosing to present the scientific consensus forthrightly, others (the *selective* group) focusing on those areas with the least bit of controversy, and a third group choosing to misrepresent the science as controversial rather than to present the scientific consensus.

Regarding climate change, far more educators may fall into this last group than with evolution. Rather than reflecting their ideological preferences, though, it may be a misguided pedagogical choice on their part. In a study of science teachers in Colorado, Wise (2010) found that a large percentage (85%) of earth science teachers who taught about climate change felt that they should be teaching *both sides* of the public controversy (p. 297). Their reasoning varied, however; 25% reported that they thought their *both sides* perspective actually represented the science well, 50% reported they used it as a critical thinking activity, and 25% reported they taught *both sides* but emphasized the scientific consensus. Few of the teachers reported having encountered pressure not to teach about climate change, so their concerns about conflict presumably arose internally or through anticipation of possible controversy.

Though pedagogical approaches focusing on scientific controversy have been touted over the years (Metz 2013; Osborne 2010), there are many pitfalls that educators have not been trained to avoid (Berbeco et al. 2014). First and foremost, there is the question of teacher content preparation. In the aforementioned Colorado study, few teachers reported learning about climate change from college or graduate-level courses, professional development, or school in-service opportunities. Rather, the majority reported that they learned about the issue from climate-change-specific websites (68%) or magazines (58%). This is not unique, as others have found both students and educators utilize the internet in preference to many other conventional sources such as textbooks to learn about climate change (Berbeco et al. 2013; Leiserowitz et al. 2011). This is also troubling due to the variety of internet sources with many different agendas—a website maintained by a federal scientific agency such as NASA or NOAA, for example, may give a different account of the science than a source with a more political agenda.

The consequence of the lack of teacher content preparation is clear. It has been noted in several texts that without proper training or sources of information, many current and pre-service educators suffer from the same misconceptions as their students. These include holding misconceptions regarding the causes of climate change, often confusing other environmental hazards such as acid rain and ozone depletion with climate change (Groves and Pugh 1999; Papadimitriou 2014; Ratinen et al. 2012; Summers et al. 2001). Interestingly, in some cases pre-service educators are more knowledgeable about these topics than educators who have been teaching longer either because it is fresher in their minds or because these topics are more frequently covered in science courses now than in the past (Summers et al. 2001). Whatever the causes of these misconceptions, the reality is that educators cannot possibly address these issues accurately without a better understanding themselves (Groves and Pugh 1999).

Though researchers have looked into the psychosocial impacts of addressing with students climate change and natural hazards and many have focused specifically on the potential to depress or discourage students (Ojala 2012), few researchers have looked into the effect on educators. If there is a class of educators who are concerned about the impact such discussions will have on their students (i.e., in the terms of the Griffith and Brem 2004 evolution study, the conflicted group), then perhaps a way to support them would be to help eliminate some of their internal conflict and associated concern. In a study of both pre- and in-service teachers, Lombardi and Sinatra (2013) looked at how teachers' emotions affected the perceived

truthfulness of new information related to climate change. They found that the teachers' emotions were a significant predictor of their perceptions of the information. Moreover the more eager educators were to reach a conclusion, the less likely they were to perceive climate change as plausible. This indicated that the individuals, in their desperation to come to a quick resolution, ended up relying too much on their own experiences or background knowledge than on new sources of information. Interestingly, educators who did not teach about climate change demonstrated greater anger and urgency to come to a decision than pre-service teachers or in-service teachers who do teach about climate change—suggesting that the former group had a greater amount of anxiety related to the issue, which perhaps related to their willingness to address climate change in their classroom.

Based on this research, it would be easy to argue that it is simply the emotional position of educators that limits their ability to teach about climate change and natural hazards. But this argument would be far too simplistic, neglecting the evidence for a number of further sources of limitation. These findings are important to recognize when trying to engage educators. As with students, so with educators: there is not just a single problem such as lack of knowledge. Not only the lack of core knowledge but also the lack of educational opportunities and resources, as well as their own cognitive and emotional states coming to the topic, all tie together to make climate change and the related natural hazards a challenging topic for educators to address. This suggests that when educators use *teaching both sides* as a pedagogical approach to addressing climate change, it may be a way to circumvent some of these challenges of unfamiliarity with the science and discomfort with its implications. Teachers, being human, are not immune to their own feelings about and concerns with these difficult topics, and it may be easier from their perspective to credit the possibility that perhaps the science is still uncertain rather than face the harsh possibilities of an uncertain future.

15.3 New Leverage Points for Engagement with Educators

Rather than castigate educators for actions, behaviors, misunderstandings, and positions that are shared by the larger population, it is important for the larger educational and scientific communities to consider how best to support them in their activities. Though educators may be alone in the classroom, a stronger support network for all of these issues (from the scientific to the political to the emotional) would help to strengthen educators' confidence to present the scientific consensus, rather than throwing up their arms in a questionable pedagogical approach. There are many opportunities and leveraging points for both the professional development and scientific community to work with these educators in the coming years, a few of which will be discussed below.

National Climate Assessment The National Climate Assessment (NCA) is an interagency report representing contemporary research on the current and predicted impacts of climate change on the United States. First published in 2000, the third report came out in 2014, was written by over 300 authors and is went through a rigorous public and expert review process. The report is split into different sector and regional sections, including topics such as energy and agriculture (US Global Change Research Program 2014).

As a comprehensive review of the scientific literature, the NCA has the unique benefit of being a scientific document written for the lay audience, making it available to science teachers

of all levels. It also addresses climate change on a regional, rather than global, scale, highlighting the natural hazards associated with each part of the country. This allows educators to use local information to discuss the associated impacts with students. The NCA, though, is the beginning of the conversation, not the end, for teaching students only about the impacts of climate change, specifically natural hazards, could be considered cruel, leaving them dismayed and disturbed by the prospect of such a challenging future ahead. The purpose of using such a document in the science classroom is not to terrify, but to engage—and engaging students in general with a serious dilemma and asking them then to devise solutions is an ideal learning opportunity. The Third NCA is available online: http://nca2014.globalchange.gov/, and Learning Pathways developed to help unpack the regional chapters are available at http://climate.gov/teaching/2014-national-climate-assessment-resources-educators, NOAA's Climate.gov website.

State Science & Language Arts Standards There are many opportunities within the curriculum for educators to engage students in discussions both of climate change and natural hazards, and, with the adoption of new science, language arts, and mathematics standards across the country, the alignment with classroom activities will become even easier. Both the Next Generation Science Standards (NGSS 2013, available at http://www.nextgenscience.org/) and the Common Core Language Arts and Math Standards (http://www.corestandards.org/) provide opportunities for student inquiry of climate change and related topics.

While Common Core standards have been adopted by most states, the newer Next Generation Science Standards, released in 2013, are in the process of being adopted. While this process may take several years, this set of K–12 science standards covers a wide range of topics relating to natural hazards, climate, energy, and risk assessment and reduction. The standards were developed through a state-led collaboration of 26 states and sponsored by the National Research Council, the National Science Teachers Association, the American Association for the Advancement of Science, and Achieve. Natural hazards and climate change fit directly or indirectly in multiple places within the standards (NGSS Lead States 2013). These standards are clear in their expectations of the inclusion of climate change, and specifically how human activities have led to recent climate conditions.

For example, NGSS requires students to look at the evidence of warming, utilize models to simulate energy flows, and analyze authentic data related to global climate change. Furthermore, under the headings of *Human Impacts* and *Human Sustainability*, students are asked to analyze authentic data related to natural hazards to inform technology development for potential mitigation. Examples of natural hazards, of course, would include more obvious hazards such as volcanic eruptions and earthquakes, but severe weather events such as flooding and extreme precipitation events, which are expected to increase in frequency and severity due to climate change, would be covered, too. In high school, these themes are further developed to make a connection among natural hazards, climate change, and natural resources. Examples of these connections include how climate change will drive migration from changes in sea level rise, influence temperature and precipitation, and affect agriculture.

Importantly, rather than using this opportunity to alarm students about hazards and impacts, the standards ask for students to use scientific and engineering principles to monitor and minimize the problems, emphasizing responses and solutions rather than focusing only on the problem, which can be overwhelming. This allows educators to talk about management, technology, and policy options for addressing natural hazards related to climate change—not to

encourage students to be blasé about the consequences, but encourage students to recognize the associated opportunities associated.

By engaging students in a discussion of the technical and/or policy opportunities and responses (without being dogmatic in approach), educators also have an opportunity to address the more thought-provoking question, What should we do? This allows educators to discuss a very challenging and potentially distressing topic with their students in an engaging manner—starting with the core science based on the scientific consensus and then enriching the experience by asking students to come up with potential mitigation or adaptation strategies for dealing with the consequences.

Perhaps surprisingly, the Common Core State Standards, K–12 English language arts and mathematics standards, also provide an opportunity to incorporate climate change content and problem-solving skills into the curriculum. As with the NGSS, the development of Common Core was initiated by education chiefs and governors and their representative organizations from 48 states, with teachers, administrators, and others providing input. Though their focus is math and English language arts, Common Core contains a set of standards devoted entirely to building science literacy, which can be leveraged to engage students in learning how to develop arguments that utilize the science to bring it out of the lab and into the public sphere.

In the early year Common Core standards, students are asked to evaluate sources and distinguish among facts, judgments, and speculation. With a topic as political and rife with misinformation as climate change and its associated natural hazards, this is an ideal place for educators to help students wade through misinformation with a knowledgeable guide. In later years, students are asked to evaluate information from many sources to problem solve. This is a great opportunity to answer some of the more troubling issues related to natural hazards with a problem-solving rather than despairing focus (National Governors Association Center for Best Practices & Council of Chief State School Officers 2010).

Both NGSS and Common Core standards allow for a transition from a discussion of the scientific ideas to a more inclusive discussion of natural hazards and climate change, as students are asked to take the data and sources from their science classroom and integrate them into a cohesive discussion of potential resolutions. Through integrating subjects (like English language arts and the sciences), educators have a unique opportunity to deepen students' understanding of the science as well as to develop their scientific problem-solving skills to address larger public issues. Moreover, with new standards being implemented across the country, educators will be seeking out professional development opportunities to learn about these topics. Through leveraging these standards, scientists and other interested parties can encourage educators to use this opportunity to engage their students in a thoughtful and hopeful approach to the materials. Academically and emotionally, this would benefit not only the students but also the educators themselves.

Two important and authoritative resources for teachers that provide an overview of high quality, vetted online resources relating to climate change and natural hazards are: 1) CLEAN (http://cleanet.org), the Climate Literacy and Energy Awareness Network, funded through the National Science Foundation with support from NOAA, and 2) Climate.gov: (http://climate.gov/teaching). Both include pedagogical guidance and annotations to hundreds of free, high-quality online resources, including videos, visualizations, and lesson plans, many of which are solutions-oriented.

15.3 Conclusions: Fostering a Resilient Educational Community

There are many challenges to creating a resilient and confident educational community capable of addressing natural hazards and climate change in a scientifically accurate and pedagogically appropriate manner. This community would benefit from greater support, both academic and emotional, on how best to address these issues through professional development and other training opportunities. In addition, since natural hazards and climate change are a part of the NGSS, educators will be seeking training on this topic, making it a natural place to give them more professional support. Similarly, with the release of the 2014 National Climate Assessment, educators have a unique opportunity to engage in a very user-friendly scientific document that is sector- and region-specific. This allows them to connect the concepts of climate change and natural hazards more closely to their curriculum, as well as to bring regionally specific issues to their students, making the science and potential solutions more relevant.

It is clear, though, that professional development and additional resources will not be enough to assist educators in bringing these ideas into their classroom. In order to get teachers to engage with these topics in a thoughtful and effective manner, their own feelings and concerns cannot be overlooked. Both their own potential discouragement and classroom conflicts are real challenges that need to be addressed for a teacher to feel confident in teaching a depressing and politically challenging topic in what otherwise would be a fairly straightforward and apolitical science course. The challenges to a resilient and capable educational community are not limited to mere knowledge, but require a thorough investigation of all of the conflicts, internal and external, that can arise by addressing a scientific issue with complex political and social implications. Appropriate and meaningful responses to natural hazard and climate change risks based on a firm understanding of the science is key to engaging learners and countering feelings of being overwhelmed. A resilient community not only knows the science and how to use it, but also understands how to manage the personal, political, and social challenges when the topic intersects a public debate.

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