NSTA Position Statement

The Teaching of Climate Science

Introduction

The National Science Teachers Association (NSTA) acknowledges that decades of research and overwhelming scientific consensus indicate with increasing certainty that Earth's climate is changing, largely due to human-induced increases in the concentrations of heat-absorbing gases (IPCC 2014; Melillo, Richmond, and Yohe 2014). The scientific consensus on the occurrence, causes, and consequences of climate change is both broad and deep (Melillo, Richmond, and Yohe 2014). The nation's leading scientific organizations support the core findings related to climate change, as do a broad range of government agencies, university and government research centers, educational organizations, and numerous international groups (NCSE 2017; U.S. Global Change Research Program 2017). According to the National Academy of Sciences, "it is now more certain than ever, based on many lines of evidence, that humans are changing Earth's climate" (NAS 2014). Scientific evidence advances our understanding of the challenges that climate change presents and of the need for people to prepare for and respond to its far-reaching implications (Melillo, Richmond, and Yohe 2014; Watts 2017).

The science of climate change is firmly rooted in decades of peer-reviewed scientific literature and is as sound and advanced as other established geosciences that have provided deep understandings in fields such as plate tectonics and planetary astronomy. As such, *A Framework for K–12 Science Education* (*Framework*) recommends that foundational climate change science concepts be included as part of a high-quality K–12 science education (NRC 2012). Given the solid scientific foundation on which climate change science rests, any controversies regarding climate change and human-caused contributions to climate change that are based on social, economic, or political arguments—rather than scientific arguments—should not be part of a science curriculum.

NSTA recognizes that because of confusion and misinformation, many Americans do not think that the scientific basis for climate change is established and well-grounded (Leiserowitz 2005; van der Linden et al. 2015). This belief, coupled with political efforts to actively promote the inclusion of non-scientific ideas in science classrooms (Plutzer et al. 2016), is negatively affecting science instruction in some schools. Active opposition to and the anticipation of opposition to climate change science from students, parents, other subject-area teachers, and/or school leadership is having a documented negative impact on science teachers in some states and local school districts (Plutzer et al. 2016).

Teachers are facing pressure to not only eliminate or de-emphasize climate change science, but also to introduce non-scientific ideas in science classrooms (NESTA 2011; Branch 2013; Branch, Rosenau, and Berbeco 2016). This pressure sometimes takes the form of rhetorical tactics, such as "teach the controversy," that are not based on science. Scientific explanations must be consistent with existing empirical evidence or stand up to empirical testing. Ideas based on political ideologies or pseudoscience that fail these empirical tests do not constitute science and should not be allowed to compromise the teaching of climate science. These tactics promote the teaching of non-scientific ideas that deliberately misinform students and increase confusion about climate science.

In conclusion, our knowledge of all the sciences, including climate science, grows and changes through the continual process of scientific exploration, investigation, and dialogue. While the details of scientific understandings about the Earth's climate will undoubtedly evolve in the future, a large body of foundational knowledge exists regarding climate science that is agreed upon by the scientific community and should be included in science education at all levels. These understandings include the increase in global temperatures and the significant impact of human activities on these increases (U.S. Global Change Research Program 2009), as well as mitigation and resilience strategies that human societies may choose to adopt. Students in today's classrooms will be the ones accelerating these decisions well underway in communities across the world.

NSTA confirms the solid scientific foundation on which climate change science rests and advocates for quality, evidence-based science to be taught in science classrooms in grades K–12 and higher education.

Declarations

To ensure a high-quality K–12 science education constructed upon evidence-based science, including the science of climate change, NSTA recommends that teachers of science

- recognize the cumulative weight of scientific evidence that indicates Earth's climate is changing, largely due to human-induced increases in the concentration of heat-absorbing gases (IPCC 2014; Melillo, Richmond, and Yohe 2014);
- emphasize to students that no scientific controversy exists regarding the basic facts of climate change and that any controversies are based on social, economic, or political arguments and are not science;
- deliver instruction using evidence-based science, including climate change, human impacts on natural systems, human sustainability, and engineering design, as recommended by the *Framework for K–12 Science Education* (*Framework*);
- expand the instruction of climate change science across the K–12 span, consistent with learning progressions offered in the *Framework*;
- advocate for integrating climate and climate change science across the K–12 curriculum beyond STEM (science, technology, engineering, and mathematics) classes;
- teach climate change as any other established field of science and reject pressures to eliminate or de-emphasize climate-based science concepts in science instruction;
- recognize that scientific argumentation is not the same as arguing beliefs and opinions. It requires the use of evidence-based scientific explanations to defend arguments and critically evaluate the claims of others;
- plan instruction on the premise that debates and false-equivalence arguments are not demonstrably effective science teaching strategies;
- help students learn how to use scientific evidence to evaluate claims made by others, including those from media sources that may be politically or socially biased;
- provide students with the historical basis in science that recognizes the relationship between heat-absorbing greenhouse gases—especially those that are human-induced—and the amount of energy in the atmosphere;
- highlight for students the datasets from which scientific consensus models are built and describe how they have been tested and refined;
- recognize that attempts to use large-scale climate intervention to halt or reverse rapid climate change are well beyond simple solutions and will likely result in both intended and unintended consequences in the Earth system (NRC 2015; USGCRP 2017);
- analyze different climate change mitigation strategies with students, including those that reduce carbon emissions as well as those aimed at building resilience to the effects of global climate change;
- seek out resources and professional learning opportunities to better understand climate science and explore effective strategies for teaching climate science accurately while acknowledging social or political controversy; and
- analyze future climate change scenarios and their relationships to societal decisions regarding energy-source and land-use choices.

Necessary Support Structures

To support the work of teachers of science, NSTA recommends that school administrators, school boards, and school and district leaders

- ensure the use of evidence-based scientific information when addressing climate change and climate science in all parts of the school curriculum, such as social studies, mathematics, and reading;
- provide teachers of science with ongoing professional learning opportunities to strengthen their content knowledge, enhance their teaching of scientific practices, and help them develop confidence to address socially controversial topics in the classroom;
- support teachers as they review, adopt, and implement evidence-based science curricula and curricular materials that accurately represent the occurrence of, evidence for, and responses to climate change;
- ensure teachers have adequate time, guidance, and resources to learn about climate science and have continued access to these resources;

- resist pressures to promote non-scientific views that seek to deemphasize or eliminate the scientific study of climate change, or to misrepresent the scientific evidence for climate change; and
- provide full support to teachers in the event of community-based conflict.

To support the teaching of climate change in K–12 school science, NSTA recommends that state and district policy makers

- ensure that licensure and preparation standards for all teachers of science include science practices and climate change science content;
- ensure that instructional materials considered for adoption are based on both recognized practices and contemporary, scientifically accurate data;
- preserve the quality of science education by rejecting censorship, pseudoscience, logical fallacies, faulty scholarship, narrow political agendas, or unconstitutional mandates; and
- understand that demand is increasing for a workforce that is knowledgeable about and capable of addressing climate change mitigation and building resilience to the effects of global climate change.

To support the teaching of climate change in K–12 school science, NSTA recommends that parents and other members of the community and media

- seek the expertise of science educators on science topics, including climate change science;
- augment the work of science teachers by supporting student learning of science at home, including the science of climate change;
- help students understand the contributions that STEM professionals, policy makers, and educators can make to mitigate the effects of climate change and how they can make decisions that contribute to desired outcomes; and
- clarify that societal controversies surrounding climate change are not scientific in nature, but are social, political, and economic.

To support the teaching of climate change in K–12 school science, NSTA recommends that higher education professors and administrators

- design curricula that incorporate climate change science into science and general education coursework, and that these materials meet social, economic, mathematical, and literary general education goals;
- provide teacher-education students with science content and pedagogy that meets the *Framework's* expectations for the grade band(s) they will teach; and
- recognize that a solid foundation in Earth system science should be a consideration in student admissions decisions.

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NSTA offers the following background information on the teaching of climate science, with additional resources found at www.nsta.org/climate:

The Nature of Science (NOS) and Scientific Decision Making

One of the central components of the Science and Engineering Practices (SEPs) in the Framework is the expectation that students should argue from evidence. Specifically, it states "Argumentation is the process by which explanations and solutions are reached." This requires that a person be able to distinguish between opinions and evidence, and between scientific debate and unscientific denial. Good science teaching includes instructing students how to distinguish between opinion and peer-reviewed scientific evidence, helping students recognize common weaknesses in arguments, and explicitly attend to cognitive biases held by others through respectfully providing and receiving critiques about evidence and reasoning.

Controversy and Personal Beliefs

Efforts to properly teach the science of climate change are regularly challenged by those seeking to frame it as being different from other scientific fields, often with claims that it is either "uncertain" or "controversial." Debate as a form of dialogue can occur in any area of science, but a great amount of scientific consensus has been reached about fundamental understandings in science, and the same holds true for climate science. Any apparent controversies about the fundamental observations related to climate change science come from social, economic, or political domains, not from the scientific community. Teachers should know how to acknowledge student and parental beliefs while clarifying the difference between beliefs and evidence-based understandings. They also need tools for dealing with socially or politically motivated controversies.

The Nature of Deep-Seated Beliefs

A significant barrier to teaching climate change science derives from the cognitive biases we all carry with us. Belief systems do not necessarily arise from logic and evidence, which are the basis of scientific understanding. Belief systems develop from one's faith, family, and personal emotional experiences. An individual's desire to be a part of a specific community or group will inform his or her beliefs and affect his or her ability to change their beliefs based on the pressures applied by the community or group they belong to or wish to join. Beliefs are more likely to change when analogies, stories, and emotional messaging are used to explain evidence.

The Time Needed for Learning

An interdisciplinary approach is necessary to understand the complexity of most modern science research and how that science is contextualized in social and psychological issues. Given the human relevancy and transdisciplinary nature of climate science, which spans topics in life, physical, and Earth and space science, climate change science is an excellent source of phenomenon-based storylines through which students can learn all three dimensions of the Framework. Teaching about any form of human impact on Earth systems is most effective when encouraging students to approach the topic from the perspective of designing and revising mitigation strategies and solutions to problems, not just focusing on the problems themselves. Teachers require sufficient time to adequately plan instruction that supports student engagement with the complexity of climate change science, as well as adequate time for student understanding to progress from basic concepts to complex interactions.

Responses to Climate Change

The relative stability of the climate over the last 12,000 years has allowed agriculture and civilization to rise and flourish. Carbon-dense fossil fuels led to the Industrial Revolution and ultimately made our modern way of life possible. The continued extensive use of these same fuels now jeopardizes that very way of life. Human activity has affected the composition of the atmosphere in ways that are altering atmospheric dynamics and changing global and regional climates. The teaching of climate change science should enable learners to strategize solutions to human energy needs, examining multiple costs and benefits. Social and individual decision making will drive the development of new technologies that will in turn reduce the costs, allowing human societies to modernize. Students in today's classrooms will be the ones making these future decisions.

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