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Addressing Climate Change Using the Virginia 2018 *Science Standards of Learning*

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The K-12 *Virginia Science Standards of Learning* indicate the science concepts and practices to be taught in Virginia classrooms. The intent of these standards is to provide students with a foundational understanding of science concepts and scientific and engineering practices needed to make informed decisions on societal issues throughout their lifetimes.

One of the societal issues that the world is currently facing is that of the science of climate change. Although evidence indicates that climate change is occurring and is impacting all of Earth’s systems, the cause of this change as well as the steps needed to slow down or reverse climate change are highly debated in different facets of society. By providing students with the skills needed to interpret and analyze evidence and the science conceptual understanding to understand the interactions within and between Earth systems, students can make informed decisions about their own actions and participate in making change in their community in the future.

The term climate change is initially introduced in the 2018 *Science Standards of Learning* in sixth grade. The intention of introducing climate change into the sixth-grade curriculum is twofold. First, students need a foundational knowledge of weather, climate, matter and energy, geochemical cycles, Earth systems, and ecosystems prior to introducing the more complex concept of climate change. The foundation knowledge gained in elementary school provides the 6th-grade students with the knowledge essential to develop an initial understanding of climate change data and the skills to begin analyzing it. Students build on these foundational concepts in middle school and apply these concepts as they construct a more robust understanding of climate change in Earth Science. Decisions on when to include climate change is based on the K-12 Framework for Science Education (NSF, 2012), the Next Generation Science Standards (NGSS), and other state standards.

The inclusion of climate change in sixth grade also led to the development of the sixth-grade theme in the 2018 science standards, Our World, Our Responsibility. The intent is to have students realize that their actions, the actions of others in their community, and the actions of countries have a significant impact on our planet and on future generations. Telling students that their actions have an impact may not inform their actions. Allowing them to be able to use data to "discover" the impact of human activities and build an understanding of climate change has a much greater and long-lasting impact on students and their actions. This level of critical thinking, data analysis, and modeling may not be appropriate for students younger than sixth grade or Earth Science.

An additional goal in creating the standards and supporting curriculum framework was to provide equitable science opportunities for all through place-based science instruction. Some environmental issues are widespread, such as climate change, but others may be a particular focus within certain localities. For instance, in the Virginia Tidewater Region, sea level rise is a problem and continues to be a focus of these communities (USGS, 2021). Other areas in the state are dealing with energy transport pipeline concerns, and yet others are concerned with windmill farms off the coast. Teachers are encouraged to use these local environmental issues to engage students with science concepts appropriate for their grade level. Overall environmental education and environmental concerns are addressed and teachers to use local issues to encourage students to conduct stewardship in their community.

The 2018 *Virginia Standards of Learning* pertaining to climate change, student performance expectations from the *Virginia Standards of Learning Curriculum Framework*, and excerpts from the Content Guidelines are provided below.

**Sixth Grade**

6.9      The student will investigate and understand that humans impact the environment and individuals can influence public policy decisions related to energy and the environment. Key ideas include

a)     natural resources are important to protect and maintain;

b)     renewable and nonrenewable resources can be managed;

c)     major health and safety issues are associated with air and water quality;

d)     major health and safety issues are related to different forms of energy;

e)     preventive measures can protect land-use and reduce environmental

hazards; and

f)      there are cost/benefit tradeoffs in conservation policies.

*Student performance expectation*: construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources affect Earth’s systems (e.g., climate, oceans, rainforest) (6.9 a)

**Life Science**

LS.8   The student will investigate and understand that ecosystems, communities, populations, and organisms are dynamic and change over time. Key ideas include

a)      organisms respond to daily, seasonal, and long-term changes;

b)     changes in the environment may increase or decrease population size; and

c)      large-scale changes such as eutrophication, climate changes, and catastrophic disturbances affect ecosystems.

*Student performance expectation*: argue, citing evidence, that changes to physical or biological components of an ecosystem affect populations (LS.8 b)

*Student performance expectation*: predict the effect of large-scale changes on ecosystems and communities (LS.8 c)

*Student performance expectation*: predict the environmental effects of large-scale changes, such as climate change, ocean acidification, and sea-level rise (LS.8 c).

*Essential Understanding:* Changes in environmental factors such as habitat loss, increased pollution, climate change, and invasive species can challenge the survival of members of a population. Organisms that survive pass their traits on to offspring (LS.11 c).

**Biology**

BIO.8 The student will investigate and understand that there are dynamic equilibria within populations, communities, and ecosystems. Key ideas include

a)    interactions within and among populations include carrying

capacities, limiting factors, and growth curves;

b)    nutrients cycle with energy flow through ecosystems;

c)    ecosystems have succession patterns; and

d)    natural events and human activities influence local and global ecosystems and may affect the flora and fauna of Virginia.

*Student performance expectation*: provide examples to illustrate and explain how habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change can disrupt an ecosystem and threaten the survival of species (BIO.8 d)

*Student performance expectation*: design, evaluate, and refine a solution for reducing the negative effects of human activity on a Virginia watershed or ecosystem (BIO.8 d).

**Earth Science**

ES.10 The student will investigate and understand that oceans are complex, dynamic systems and are subject to long- and short-term variations. Key ideas include

a)   chemical, biological, and physical changes impact the

oceans;

b)   environmental and geologic occurrences affect ocean dynamics;

c)   unevenly distributed heat in the oceans drives much of Earth’s weather;

d)   features of the sea floor reflect tectonic and other geological processes; and

e)   human actions, including economic and public policy issues, impact oceans and the coastal zone including the Chesapeake Bay.

*Student performance expectation*: explain short- and long-term global occurrences and assess proposed explanations as related to mass extinctions (short-term occurrences include asteroid/comet impacts, volcanism, earthquakes; long-term occurrences include continental collisions, climate collapse, global glaciation) (ES.9 a)

*Essential Understanding*: Climate change maintained deviation in at least two climatic variables. This natural process has been accelerated by human activities. Evidence for climate change includes global temperature rise, warming oceans, shrinking ice sheets, glacial retreat, decreased snow cover, sea level rise, declining Arctic sea ice, extreme weather events, and ocean acidification (ES.11 c).

*Essential Understanding*: Legislation can promote change in human actions and reverse or stall the negative effects of their actions on the atmosphere. An example is evidenced by the policy that banned the use of chlorofluorocarbons (CFC) resulting in the reduction of ozone-layer depletion (ES.11 d).

ES.11 The student will investigate and understand that the atmosphere is a complex, dynamic system and is subject to long-and short-term variations. Key ideas include

a)  the composition of the atmosphere is critical to most forms of life;

b)  biologic and geologic interactions over long and short time spans change atmospheric composition;

c)  natural events and human actions may stress atmospheric regulation mechanisms; and

d)  human actions, including economic and policy decisions, impact the atmosphere.

*Student performance expectation*: explain how biologic activity, including human activities, may influence global temperature and climate (ES.11 c)

*Student performance expectation*: describe human and natural factors that have led to the rise in global temperature over the past century (ES.12 e)

*Student performance expectation*: analyze geoscience data and the results of global climate models to make an evidence-based forecast of the current rate of global and regional climate change and associated future effects on Earth systems (ES.12 e).

*Student performance expectation*: Earth’s climate is an example of how complex interactions among systems can result in relatively sudden and significant changes (ES.12 d).

**Environmental Science Content Guidelines (to become standards in 2025)**

The content guidelines were developed to support educators in teaching laboratory science courses that currently do not have Standards of Learning. The goal is to have these content guidelines inform the development of state standards during the next science revision.

ENV.11 The student will investigate and understand that global climate change is occurring. Key content includes

* scientific evidence such as changes in average global temperature, greenhouse gases, quantities of artic and land ice, ocean temperature, ocean acidification, and sea level rise are indicators of climate change;
* there exists a relationship between global climate change and the frequency or magnitude of extreme weather events;
* sea level rise is currently affecting coastal areas of Virginia and will lead to the destruction of current habitats; and
* consequences of climate change will affect the biosphere on many levels including species migration and extinction, disease spread, and ecosystem health (e.g. bleaching corals and dying forests).

ENV.12 The student will investigate and understand that their actions as an environmentally literate citizen will play a role in environmental policies. Key content includes

* consumer choices in Virginia impact jobs, resources, pollution, and waste here and around the world;
* environmental justice is the study of the impact of environmental policy including resource allocation, pollution regulations, and waste disposal across all communities;
* political, legal, social, and economic decisions may affect global and local ecosystems;
* the media impacts public opinion and public policy;
* individuals and interest groups influence public policy;
* environmental decisions should include a cost-benefit analysis and may lead to trade-offs in conservation policy; and
* different methods are used by local, state, national, and international governments and organizations with varying results to protect the environment.

Resources:

National Research Council. 2012. A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. Washington, DC: The National Academies Press. https://doi.org/10.17226/13165.

USGS. 2021. *Science Summary Sea-Level Rise and Chesapeake Bay*. U.S. Department of Interior. Retrieved from https://www.usgs.gov/centers/cba/science/sea-level-rise-and-chesapeake-bay?qt-science\_center\_objects=0#qt-science\_center\_objects.