The Science and Policy of Global Climate Change Curriculum Unit

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Global climate change …

- **is unequivocal,**
- **almost certainly is caused mostly by us,**
- **already is causing significant harm**
- **is growing rapidly, and**
- **requires global action and local solutions.**

In order to understand and accept this, this curriculum leads students through a progression of understanding. It begins with students thinking about climate and weather, and the local impact of sea level rise due to climate change in Lesson 1. This is to hook the students to the unit, getting them to think about their own connection to climate change. In order to understand how excess carbon dioxide is rapidly changing the climate, students first learn about the Earth's energy budget (Lesson 2) and then focus on greenhouse gases (Lesson 3). Carbon dioxide and its ability to absorb and re-radiate heat is key in understanding climate change. Lesson 3 ends with students looking at sources and sinks of carbon dioxide, allowing them to understand that climate change is almost certainly caused mostly by humans. The changes in the climate are already causing significant harm to both physical and biological systems. Students examine ice core data as well as other physical datasets to understand the implications of climate change on the physical and biological worlds (Lesson 4). Students think about the adaptations that humans need to make to adjust to survive the changing climate. Student may still have doubts about the reality of climate change and the process of scientific consensus that makes us know that climate change is unequivocal and that there is overwhelming evidence that human activities are the main cause. Lesson 5 provides an opportunity for students to step back from the data and think about the process of science and how we use language. Climate change requires global action and local solutions. The final unit on climate change mitigation provides students an opportunity to examine and choose mitigation strategies to reduce carbon dioxide emissions.

I. Introduction to the Curriculum

Global climate change and its impacts on people and resources pose serious societal challenges. The actions we take today will influence future greenhouse gas emissions and the magnitude of warming; they will also affect our ability to respond and adapt to changes, and to reduce the vulnerability of people and places to harm. Educating future generations about the causes and effects of global climate change is imperative since implementing solutions depends on an informed public, for both societal and individual level actions.

This curriculum integrates concepts from the earth, life, and physical sciences as well as the most current data on climate systems to help students understand the phenomena of climate change, the justification for these phenomena, and why these phenomena are both scientifically and

socially important. Specially, the student goals that frame the unit and are woven throughout the lesson plans are as follows:

1.Students will be able to (SWBAT) explain the elements of climate and analyze the earth's energy balance that affects climate change. (What is climate change?)

2.SWBAT identify the proximate and ultimate causes of climate and climate change as well as the evidence for these causes. (What is responsible for climate change and how do we know?)

3.SWBAT analyze the impact of climate change on physical and biological systems. (Why does climate change matter?)

4.SWBAT compare and contrast climate change mitigation strategies (macro and micro) and adaptation strategies in light of environmental, economic, political, and ethical impact. (What can we do?)

5.Students will use data and evidence to justify claims relating to climate, climate change, and mitigation.

To achieve these goals, the curriculum has been divided into seven multi-day lesson plans for a total of 17 days of instruction. The lesson plans include a variety of both teacher-centered and student-centered activities ranging from lectures based on provided slideshows, teacher-led demonstrations, student-led investigations, and group analysis of data. Underlying these activities is a philosophy of learning by inquiry as well as justifying claims with evidence.

To measure the achievement of the above goals, formative assessments are embedded throughout the unit as well as sets of questions applicable to particular topics. For example, students begin a concept map in the first lesson plan that is continually developed with more terms and more interactions over the course of the following lessons. Two summative assessments are also included. Measuring student achievement in a variety of ways provides a more valid picture of student understanding. The first summative assessment, a traditional test, includes 10 multiple-choice items on the major concepts of the unit. It also includes 3 open-ended questions that push students to interpret data and apply their knowledge of the climate system to new, but related situations. The second summative assessment – perhaps the keystone of the entire unit – combines group and individual work that forces students to use their understanding of climate science and mitigation options to make decisions about how society should cut carbon emissions.

One final, but important note. The curriculum is *comprehensive* in that it includes the activities, assessments, and materials to carry out an entire unit on climate change. However, the curriculum is not intended to be *prescriptive* as teachers should feel free to exercise their professional judgment about modifying activities and lesson plans to suit their needs.

II. The Organization of the Curricular Materials

The climate change curriculum is captured in an Excel-style template that includes a unit cover page – an overview of the entire unit as a whole – followed by daily lesson plans. Each lesson plan begins with a Bell work (BW) exercise that students can do as the teacher executes the necessary administrative tasks at the start of the period. A set of activities and their brief description are in the left column while a list of materials and resources are indicated in the right column. Many days end with a suggested Homework (HW) activity. The authors of this curriculum expect teachers to integrate assignments into the already established classroom culture and expectations.

The materials and resources that relate to each lesson plan can be found immediately following each lesson plan's template. The materials are labeled systematically with three sets of numbers separated by decimal points. For example:

Concept Maps

Concept maps serve a rich purpose in helping students articulate their understandings of how concepts are related and help tell a coherent story about climate systems and climate change. In lesson 1 students are asked to begin their individual concept map and continue adding words through lesson 4. While it may seem intuitive for the teacher to model a concept map for students at the front of the room, we suggest that you model a map not directly related to climate change. The concept map can be used as an important learning tool for students as well as a formative assessment measure for teachers only if students are forced to create the relationships between the concepts themselves. It may be useful, however, to create a 'word wall' for the entire class in which new or difficult terms are defined for students to reference. We also suggest development of a class list of connector phrases.

Students should be encouraged to add terms that may not appear in the lesson plans and to use these concept maps on activities throughout the unit. It might be helpful to provide students with a legal sized piece of paper (8.5 x 14) or bigger (11 x 17) so that students will have enough room for all of the concepts and connections.

III. Language goals and demands

Access to curriculum and instruction relies greatly on the language demands of the tasks and interactions. The role of language demands in the science classroom has recently been of great importance as evidenced by the release of the English and Language Arts Standards for use in Science Classrooms. This curriculum was created with language goals for students that can be found on the lesson plan templates. The activities and resources were also created in a way that

recognizes the language demands and provides access, with proper scaffolding and assistance from the teacher, for all students.

IV. Materials

The materials for all of the activities in the unit are provided with the curriculum. There are enough materials for 24 students and for 6 groups when group work is required. In order to execute the curriculum as written, teachers will also need:

- ☐ An Internet Accessible Laptop
- ☐ A Projector
- ☐ Microsoft PowerPoint
- ☐ External Speakers (Video Sound)

V. We are Scientists and We are Climatologists

This unit, as well as other units in your science classroom are to help students understand what science is and what scientists do. The scientists mantra was implemented in the first classroom that used this curriculum, written by Salina Gray. It was written on a large sheet of paper for all to see. Students proudly stood at the beginning of class and together read the following. It was used as a reference throughout the unit.

> **Who We Are:**
> **We think like scientists:** We make thoughtful, intelligent choices. We take responsibility for our learning. We discipline ourselves so no one else has to.
> **We speak like scientists:** We use our words to build up others, not tear them down. We use clear, powerful language to express ourselves.
> **We investigate like scientists:** We challenge ourselves and are not afraid to ask questions. We constantly seek understanding and knowledge.

A sixth grade teacher used the scientists mantra all year long. So when it was time for this unit, Sarah Arnosky wrote and used this mantra with her students.

> **We Are Climatologists!**
> The climate is changing all over the Earth,
> It makes us question what it's all worth.
> The hot gets hotter and the wet gets wetter,
> The sea is rising and we don't breathe better.
> Greenhouse gases are trapping the heat,
> We need to do something, we can't sit on our seat.
> Public transportation is the way to go.
> It's one of the ways to keep emissions low.
> Energy from the sun, wind, & plants won't run out,
> They can power our world without any doubt.