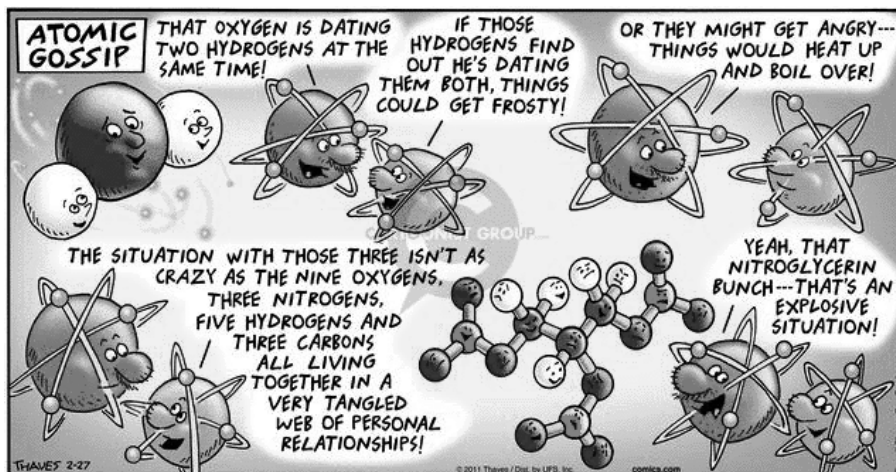# Objectives: Climates Past and Future – Day 1

Big Question: How do past climates help us predict future climates?

Before each Essential Learning is taught, give yourself a "pre" score of 0-4 (0= I've never heard of this; 4= I can teach this.) After each learning set, give yourself a "post" score.

MAIN LEARNING TARGET	OBJECTIVE	Lessons Involved	Pre	Post
Essential Learning #1: **I can explain how energy flow affects the Earth's temperature.**	1a. Use concepts of energy, conservation of energy, heat transfer, and electromagnetic radiation to describe what controls the Earth's temperature.	*Heat packs* *Rainbow glasses* *IR camera* *EM spectrum* *Lecture: Energy & EM Radiation*		
	1b. Compare and contrast the blackbody nature of the sun and the Earth.	*Lecture: Energy & EM Radiation*		
	1c. Draw a diagram showing solar energy being absorbed, transmitted, reflected, and emitted by the Earth.	*Lecture: Energy & EM Radiation*		
	1d. Calculate the radiating power of objects given their temperature.	*Lecture: Energy & EM Radiation* *People Power*		
	1e. Define and give examples of energy, power, transmission, emission, reflection, absorption, emission, heat, and temperature.	*Heat packs* *Rainbow glasses* *IR camera* *EM spectrum* *Lecture: Energy & EM Radiation*		
Essential Learning #2: **I can explain how energy flows in a climate system.**	2a. Model the vibrational energy of various gasses in the atmosphere.	*Greenhouse molecules dancing*		
	2b. Explain using physics why the atmosphere influences Earth's temperature. Include concepts of absorption, emission, molecular motion of greenhouse gasses, and the Earth's energy balance.	*Greenhouse molecules dancing* *Glass Plates Atmosphere model* *Lecture: Earth's Energy Budget* *Rally Coach* *Q Tic-tac-toe*		
	2c. Draw a diagram that shows how the atmosphere emits radiation to warm the surface of Earth.	*Glass Plates Atmosphere model* *Lecture: Earth's Energy Budget*		
	2d. Calculate Earth's radiation temperature.	*Lecture: Earth's Energy Budget*		

MAIN LEARNING TARGET	OBJECTIVE	Lessons Involved	Pre	Post
Essential Learning #3 **I can describe climates of the deep past and the properties and processes that have influenced climate through geologic time.**	3a. Using plate tectonics, explain where the carbon dioxide in volcanic emissions comes from.	*Video: Plate tectonics*		
	3b. Describe how weathering and erosion contribute to a cooling climate.	*Sparkling Water and the Climate Cycle*		
	3c. Explain how plate tectonics acts as a long-term thermostat that regulates Earth's temperature.	*Lecture: Climate Changes of the Deep Past*		
	3d. Plot Earth's major climate changes on a geologic timeline, and explain the most likely reasons for each change.	*Lecture: Climate Changes of the Deep Past Guided Notes*		
	3e. Compare and contrast catastrophic climate changes to gradual climate changes in Earth's past.	*Lecture: Climate Changes of the Deep Past*		
	3f. Draw a diagram of ocean circulation and explain how oceans influence climate.	*Lecture: Climate Changes of the Deep Past*		
Essential Learning #4 **I can differentiate between processes that cause climate change over thousands of years vs. millions of years.**	4a. Model a climate reconstruction using tree ring data.	*UCAR: Dendrochronology interactive*		
	4b. Describe the life cycle of a glacier or ice sheet, and what evidence scientists use to identify where glaciers and ice sheets have existed in the past.	*Viceo: Ice Cores* *Lecture: Ice Age Climates*		
	4c. Demonstrate how the tilt of Earth's axis and orbit influence climate.	*Spin a Top* *Lecture: Ice Age Climates*		
	4d. Use graphs to identify patterns in Earth's eccentricity, tilt (obliquity), and precession and correlate those patterns to patterns in Earth's ice ages.	*Lecture: Ice Age Climates*		
	4e. Explain why it takes longer to cool down the planet than it does to heat it up.	*Lecture: Ice Age Climates*		
	4f. Evaluate a Quaternary CO_2 graph, and make inferences about properties and processes that were happening at various times on the graph.	*Graphing Quaternary Climate*		
	4g. Explain why there have been ice age cycles over the past couple of million years, but not over most of geologic time.	*Lecture: Ice Age Climates*		

Objectives: Climates Past and Future – Day 2

Big Question: How do past climates help us predict future climates?

Before each Essential Learning is taught, give yourself a "pre" score of 0-4 (0= I've never heard of this; 4= I can teach this.) After each learning set, give yourself a "post" score.

MAIN LEARNING TARGET	OBJECTIVE	Lessons Involved	Pre	Post
Essential Learning #5: **I can use climate forcing and feedback information to determine Earth's climate sensitivity.** **(Simple)**	5a. Create a timeline of discoveries about global warming throughout history.	*Global Warming Card Sort*		
	5b. Identify sources of climate forcing.	*Lecture: Climate Forcing*		
	5c. Describe how both positive and negative feedback systems work to impact climate.	*Lecture: Climate Forcing Kagan Corners*		
	5d. Identify sources of positive and negative feedbacks to a climate system.	*Lecture: Climate Forcing Kagan Corners*		
	5e. Calculate how many degrees of warming happen with each W/m^2 of heating.	*Lecture: Climate Forcing*		
	5f. Explain where estimates of Earth's climate sensitivity derive from, and identify the most likely increase in temperature for a doubling of CO_2 based on current data.	*Lecture: Climate Forcing Kagan Corners Observations of Climate Change*		
Essential Learning #6: **I can explain the effects of changing the carbon cycle on Earth's climate.** **(Serious)**	6a. Calculate my personal carbon footprint and determine strategies for reducing my personal carbon emissions.	*Carbon Calculators*		
	6b. Identify sources and sinks of carbon in the biogeochemical carbon cycle.	*Jigsaw: Carbon Cycle*		
	6c. Explain the relationship between CO_2 emissions, concentrations and climate.	*Jigsaw: Carbon Cycle*		
	6d. Predict and justify how long extra CO_2 will last in the atmosphere.	*Jigsaw: Carbon Cycle*		
	6e. Demonstrate how fossil fuel emissions are driven by economic growth.	*Jigsaw: Carbon Cycle*		

MAIN LEARNING TARGET	OBJECTIVE	Lessons Involved	Pre	Post
Essential Learning #7 **I can evaluate climate models.** *(Serious / Solvable)*	7a. Explain inputs to a climate model that allow scientists to predict future climates.	*Climate Model Board Game* *Computer Carbon Calculator*		
	7b. List what climate models can predict.	*Climate Model Board Game* *Computer Carbon Calculator* *Lecture: Future Climate*		
	7c. Describe how scientists generate climate models, and list possible sources of error in developing climate models that accurately predict climates of the past and future.	*Video: Ostrich- Warming* *Lecture: Future Climate* *Emissions Calculator*		
Essential Learning #8 **I can describe Earth's current climate change as "simple, serious, and solvable."** *(Solvable)*	8a. Identify and evaluate 15 changes humans can make to significantly reduce carbon emissions.	*Video: Birthing a Solar Age* *Climate Wedges Game* *Lecture: Solving the Climate Problem*		
	8b. Compare the costs & benefits of a variety of CO_2 emission reduction strategies.	*Climate Wedges Game* *Lecture: Solving the Climate Problem*		
	8c. Describe some policy options for mitigating climate change.	*Climate Wedges Game* *Lecture: Solving the Climate Problem*		
	8d. Explain strategies individuals can implement in their lives and communities that will reduce CO_2 emissions on a global and local scale.	*Climate Wedges Game* *Inside/Outside Circle*		