Lesson Title: Predicting Climate Change

Grade Band: 10-12 Science Research

Length: 4- 42 minute lessons

Materials: Access to internet

NYSSLS Standards:

DCI:
ESS3.D: Global Climate Change
Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. (HS-ESS3-5)

Cross Cutting Concepts:
Patterns: Students observe patterns in systems at different scales and cite patterns as empirical evidence for causality in supporting their explanations of phenomena. They recognize classifications or explanations used at one scale may not be useful or need revision using a different scale; thus requiring improved investigations and experiments. They use mathematical representations to identify certain patterns and analyze patterns of performance in order to reengineer and improve a designed system.

Stability and change:
Students understand much of science deals with constructing explanations of how things change and how they remain stable. They quantify and model changes in systems over very short or very long periods of time. They see some changes are irreversible, and negative feedback can stabilize a system, while positive feedback can destabilize it. They recognize systems can be designed for greater or lesser stability.

SEP:
Analyzing and Interpreting Data:
• Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.

Asking Questions:
Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.
Ask questions:
○ that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.

Engaging in Argument from Evidence:
• Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence, challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining additional information required to resolve contradictions.

• Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.

• Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.

Using Mathematics and Computational Thinking:

Using algebraic thinking and analysis for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

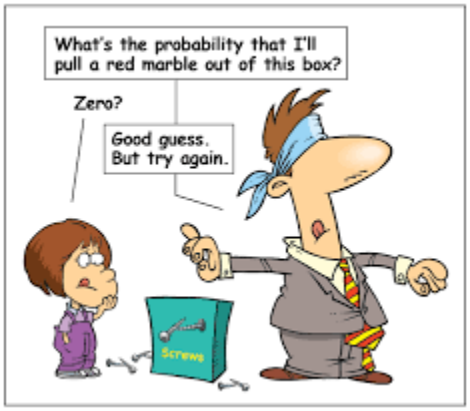
Math: Investigate chance processes and develop, use, and evaluate probability models.

CCSS.MATH.CONTENT.HSS.IC.B.5
Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.
CCSS.MATH.CONTENT.HSS.ID.A.4
Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.

Student Experience:

Engage:

Students will look at cartoon and discuss what “probability” means with a partner. Students will do a record their thoughts on post-its and put on front board. Student volunteers will help to sort similar responses.



Explore:

Students will visit the following site to individually read for understanding. They will record definitions that they develop (Likelihood, uncertainty, probability, confidence interval) in their notebook.

Link to Global and Regional Climate Change Lesson 9-Introduction

Explain:

Students will come together as a class and teacher will check for student understanding by posing scenarios highlighting each term and asking students to raise fingers for their answers. Definitions for all terms will be projected for students to check their responses and modify as needed.

Teacher will introduce a 160 year dataset from Lake Mendota in Madison Wisconsin reflecting seasonal ice cover. Students will create a scientific question that the data set can be analyzed to answer.

Students will revisit the same site to answer the class question--something like: “Is ice off date on Lake Mendota in recent decades statistically different (earlier) than the first two decades of observed ice cover?”

Students will work through the activity online, first analyzing the data qualitatively, then quantitatively. Students will use reference scales/statistics (t-test, probability of occurrence and IPCC likelihood scale) to answer the class question.

Link to Global and Regional Climate Change Lesson 9-Online Activity
Student Worksheet

Students will then report their findings on their lab station white board in the form of a CER chart. Students will then do a gallery walk to see classmate’s claims and the evidence they selected to support their claim. They can then modify/add to their original answers.

Elaborate:

Students will repeat the process using data from My NASA Data:

My NASA Data Earth System Explorer Link

Students will work in pairs to explore the data that is available in My NASA Data.

Students will choose a “Featured Phenomenon” dataset within My NASA Data. They will explore the data and develop a scientific question that can be answered using the selected data set.

Once they’ve selected a question, they will check with teacher and explain their data selection choice and their reasoning of how they think they will analyze the data to answer their question. Teacher will scaffold, as needed after this formative assessment, to ensure each student group has a question that the selected data can answer using the statistical tools used during the Explore phase.

After teacher approval:

- Students will describe the data that they will download as a CSV file
- Students will download data to construct a graph using the downloaded data from My NASA Data Earth System Explorer
- Students will make a prediction based on the graph that they’ve created as to whether or not their prediction will be statistically significant.
- Students will then run a t-test using an online stats tool and accept or reject their prediction

Online Statistical Tool: Vassar Stats

Evaluate:

Partners will make a “mini-poster” to represent their findings. They will do a CER chart that will be posted around the room based on their research question. Students will evaluate the usefulness of their data representation as a tool to predict current and future global climate change as a result of human activities.

When complete, students will circulate, giving color coded feedback on each CER based on the rubric, below. Students will return to their work and evaluate if they need to make any changes prior to teacher review. The science reasoning rubric will be used by both students and teacher for formative (student feedback) and formative (teacher feedback) assessment.

Science Reasoning Rubric

		2 pts	1 pt	0 pt
Statement	**Claim** An assertion that something is true	Makes a claim that is sufficient to answer the question and is coherent.	Makes a claim that is sufficient to answer the question or is coherent.	Does not make a claim or makes an incoherent claim.
	or			
	Explanation Describes how and why a phenomenon occurs	Provides an explanation that addresses how and why a phenomenon occurs	Provides an explanation that addresses how or why a phenomenon occurs	Does not provide an explanation.
Argument	**Reasoning** Provides reasons the reader should accept your claim or explanation.	Includes all of the following: ❑ Cites sufficient and relevant evidence to support the claim/explanation. ❑ Describes how the cited evidence defends the claim/explanation. ❑ Reader feels compelled to accept your argument.	Includes two of the following: ❑ Cites sufficient and relevant evidence to support the claim/explanation. ❑ Describes how the cited evidence defends the claim/explanation. ❑ Reader feels compelled to accept your argument.	Includes one or none of the following: ❑ Cites sufficient and relevant evidence to support the claim/explanation. ❑ Describes how the cited evidence defends the claim/explanation. ❑ Reader feels compelled to accept your argument.

Citations:

Global and Regional Climate Change. Global and regional climate change. (n.d.). Retrieved October 22, 2021, from http://cimss.ssec.wisc.edu/climatechange/globalCC/lesson9/concepts.html.

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Lowry, R. (1998). *Vassar Stats: Statistical computation web site*. VassarStats. Retrieved October 22, 2021, from http://vassarstats.net/.

NASA. (n.d.). *Earth System Data Explorer (ESDE)*. NASA. Retrieved October 22, 2021, from https://mynasadata.larc.nasa.gov/EarthSystemLAS/UI.vm.

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