

Antropocene - 5E Lesson Plan

Engaging Context Data Integration

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Abstract

This paper represents the culminating engaging context, data integration lesson plan to fulfill the four subject areas, Science, Technology, Engineering and Math being discussed during the NASA Endeavor STEM Methods course in May through July, 2014. This lesson plan incorporates the “5E” model of Science, Technology, Engineering and Math (STEM). The five “E” verbs are Engage, Explore, Explain, Elaborate/Extend and Evaluate. The purpose of this plan is to provide a teacher guided investigation to engage students by gathering evidence to answer the question, “Is there a correlation between the irreversible melting of the Antarctic Ice Sheet, rising sea level trends and the devastating water damage incurred in the aftermath of these devastating storms?” Additionally, this investigation is being conducted as a viable basis for a lesson plan that adheres to The Next Generation Science Standards (NGSS), and the tenets of the Nature of Science (NOS) and the Nature of Math (NOM).

Anthropocene: The current geological age, when human activity has been the dominant influence on climate and the environment.

Grade Level: Ninth through Twelfth

Justification Statement

I selected this lesson because I wanted to follow through on the topic that I examined for our first assignment to seek out an engaging context topic for further development into a data-driven, 5E model. The May 2014 Gillis and Chang article in the New York Times, “Scientists Warn of Rising Oceans From Polar Melt”, provides a wealth of information to help students understand the Nature of Science and the Nature of Mathematics. Since the Western Antarctic ice sheet is in an irreversible decline, future scientific and mathematical studies must point to measuring the increasing height of oceans and the depletion of coast lines. Students can draw conclusions and follow the progression of scientific and mathematical studies that could indicate a domino effect of not heeding the warnings published from 1978 through the present. The term, “anthropocene” was coined by Andrew Revkin in his 1992 book *Global Warming:*

Understanding the Forecast to address our current geological age, where the consequences of human activity have directly influenced earth’s climate and the environment. (Revkin, 1992)

This “engaging context” lesson plan will propose the following question to students to analyze evidence and draw conclusions: “Is there a correlation between the irreversible melting of the Antarctic Ice Sheet, rising sea level trends and the devastating water damage incurred in the aftermath of Hurricane Katrina in 2005 and Hurricane Sandy in 2012?”

Next Generation Science Standards: HS-ESS3 - 5 - Earth and Human Activity

Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems. (Pratt, 2012)

High School Standards: (National Academy of Sciences, 2013)

Science and Engineering Practices:

Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

Disciplinary Core Ideas: ESS2.D: Weather and Climate

Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere.

Crosscutting Concepts: Stability and Change

Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS3-3),(HS-ESS3-5). Connections to Engineering, Technology, and Applications of Science - Influence of Engineering, Technology and Science on Society and the Natural World - New technologies can have deep impacts on society and the environment, including some that were not anticipated. (HS-ESS3-2).

Common Core State Standards (CCSS) (Next Generation Science Standards, 2013)

The NGSS Connections to the Common Core State Standards for Mathematics (Appendix L) addresses the need to reinforce the math by applying concepts to the study of science. The Connections document states, “Such tools can also be better understood, and more securely mastered, by applying them in a variety of contexts.” This document also posits, “During the middle school and high school years, students develop a number of powerful quantitative tools, from rates and proportional relationships, to basic algebra and functions, to basic statistics and probability “ (NGSS, 2013) It has been my observation, however, that students might be presented with the quantitative tools, but they do not know where to begin to apply them. If it is true that, “Mathematics is the chief language of science” (American Association for the Advancement of Science 2014), as stated by the Science for All Americans website, then improvements must be made to instruct students in realizing where we begin to apply mathematical analysis to science topics. The New York Times article presents a significant amount of data with the resulting graphs and analysis. The student of science and math can benefit from this reporting in two ways. First, this is evidence of how scientists are currently studying real world problems to formulate evidence of natural phenomena. The scientists are leading by example to our budding scientists. The creative and resourceful teacher will use the data provided in the article to guide the students in preparing their own explanations of the evidence. The article presents over three decades of data that provide fertile ground for mathematical studies.

How does the lesson integrate science, technology, engineering and math?

Science. The original NY Times article by Gillis and Chang demonstrates that two groups of scientists reached similar conclusions while using different methods. The first tenet of the Nature of Science that we have been discussing in class states that “Science Investigations Use a Variety of Methods” (Next Generation of Science Standards, 2013). By using this article as a “springboard”, the students will become confident that the data can be used as evidence to draw their conclusions. By using the National Oceanic and Atmospheric Administration’s Observed Water Levels webpages, the students can choose areas of the United States that sustained damage during Hurricane Katrina in 2005 and Hurricane Sandy in 2012. I chose Shell Beach in Louisiana area and Sandy Hook in New Jersey. I will encourage students to select coastline areas based on the National Weather Service and National Hurricane Center websites containing data of storm surges for Katrina and Sandy. Additionally, the terms “sea-level”, “below sea-level” and “local mean sea-level” will be discussed in order to assess prior knowledge.

Technology. One of the assessments will be the coding of a webpage in HTML that will contain:

- investigative questions
- data for analysis in the form of links to reliable sources
- images of student produced charts and graphs

Engineering. The students will utilize the design tool on the Urban-Blue Green Grid website to propose solutions for urban environments in danger of flooding during extreme weather.

Math. I will encourage the students to collect data from the NOAA Tides and Currents website for the following timeframes:

1. Katrina: Readings of historical data for chosen location affected by Hurricane Katrina for the decade preceding the date that the hurricane made landfall in the U.S. (e.g. August 29, 1995, August 29, 1996...August 29, 2005)
2. Katrina and Sandy: Readings of current data for the same station for current week.
3. Katrina and Sandy: Readings of historical data for same week one year preceding hurricane.
4. Create charts and graph results.
5. Draw conclusions as to whether sea levels have risen for time periods recorded and graphed.
6. Discover the “local mean sea-level” calculations by NOAA.

Measurable behavioral objectives - Extended Thinking

- The student will be able to collect and analyze data.
- The students will draw conclusions as to whether or not the sea levels have shown a pattern of rising over the recorded time periods.
- The students will design a proposed urban plan to sustain citizens during significant weather events.

Lesson Procedures

Please refer to the attached 5E Lesson Plan Anthropocene document for additional details regarding these lesson procedures:

Engage. The purpose for the engage stage is to pique student interest and get them personally involved in the less, while pre-assessing prior understanding. It had occurred to me that my students, grades freshman through senior, were in the early grades of grammar school when Hurricane Katrina wrecked havoc in the U.S. coastline states of the Gulf of Mexico. My students entering ninth grade would have been entering first grade. My seniors would have been

entering fourth. My first question in the “engage” stage is to build a frame of reference so that they can place their lives within the context of this lesson. I will inquire, “What grade were you about to enter in September, 2005?” Then, I will bring in the historical fact, “On August 29, 2005, a devastating hurricane named Katrina made landfall in the Gulf of Mexico region of the United States.” Next, I would assess prior knowledge by enquiring, “What areas of the United States sustained major damage from Hurricane Katrina?” (Florida, Louisiana, Mississippi and Alabama). Frequently, students are not able to place states in the correct geographical region). Next, I will pose the question, “Why are certain coastal areas more vulnerable to rising sea levels than others?” I will again assess prior knowledge to determine if they are familiar with the term “below sea-level”. Then, I will introduce the concept of below sea level and give the example of the New Orleans, Louisiana region.

Explore. The purpose of the explore stage is to get students involved in the topic, providing them with a chance to build their own understanding. After having engaged my students on the topics of Hurricane Katrina, the Gulf of Mexico region and the terms “sea-level” and “below sea-level”, I will ask them to open Google Earth on their laptop and locate New Orleans, Louisiana. I will ask them to pay particular attention to the Mississippi river region. I will then project my laptop Google Earth and we will have a discussion of the Gulf Coast states. I will then zoom out and show all of the coastal regions of the U.S.

Explain. The purpose of the explain state is to provide students with an opportunity to communicate what they have learned so far and figure out what it means. I will provide more depth for the terms sea-level, below sea-level, the mathematical word “mean” (statistical average) and “local-mean sea level”. These terms are important in order to read the NOAA

website on sea-level trends. I will ask the students to visit the [NOAA website on sea-level trends](#). Then I will ask them to click on the products button in the upper left of the screen, then choose water levels. The student can select a station in a Gulf Coast state to refine their investigation by viewing that day's current readings of sea level. I will explain that these readings are taken to discover trends in sea-level to determine if coastal communities are adequately protected against flooding. We will review the [Frequently Asked Questions page of NOAA regarding sea level](#). An assessment will be assigned to (DOK Level 1 Recall) **identify** and (DOK Level 2 Skill/Concept) **graph** data for the dates of (rows) 8/22 through 8/20 for (columns) two years - 2005 and 2014. Rubric: Spreadsheet Assignment - attached with this post.

Elaborate/Extend. The purpose for the extend stage is to allow students to use their new knowledge and continue to explore its implications. I will begin by asking the students whether Antarctica is the North or South pole. I will then ask students to open Google Earth on their computers and locate Antarctica. Now, it is time to introduce the New York Times article "[Scientists Warn of Rising Oceans from Polar Melt](#)" I will ask the students to take a moment to read the first four paragraphs of the article out loud - taking volunteer turns. Then, I will play the imbedded video that demonstrates the Ice Flow of the West Antarctic Glacier. The students will then be asked to [review the scientific article documenting](#) the Antarctic Polar Melt paying special attention to the Conclusion paragraph. This is one of the independent studies that reached the same conclusion that the melting of the Antarctic Ice Shelf is irreversible.

Evaluate. The purpose for the evaluation stage is for both students and teachers to determine how much learning and understanding has taken place. The students will have been studying how to create a webpage using the Aptana3 development tool. They will be asked to

create a webpage that documents their investigation, data, graphs and resource links using HTML, Cascading Style Sheets and JavaScript. By producing their webpage, they will demonstrate that they have fulfilled the measurable behavior objectives:

- (DOK Level 1 Recall) **Identify**, (DOK Level 2 Skill/Concept) **graph** and analyze sea-level data. (Rubric: Spreadsheet Assignment)
- (DOK Level 3 Strategic Thinking) **Draw conclusions** as to whether or not the sea levels have shown a pattern of rising over the recorded time periods. (Rubric: Webpage Assignment)
- The students will (DOK Level 4 Extended Thinking) **design** a proposed urban plan to sustain citizens during significant weather events. They will blog about their proposal for proposed solutions. (Rubric: Blog Assignment)

Conclusions and Further Study

I will be utilizing this 5E engaging context lesson plan within my Web Design course in September of 2014. The amount of authentic data that is provided by the scientific community, and especially the National Oceanic and Atmospheric Administration and NASA provides a treasure trove of information for teachers and their students. By providing students with this engaging and authentic data, the true Nature of Science and Nature of Math can be constructed and retained. I will continue to utilize the data provided on these websites to develop the 5E Lesson Plan model that works well in the technology classroom.

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