Lesson title: Northwest Passage

NSF GK12 Fellow: Mike Gartrell (Boulder, CO)

Grade level: 8th grade Earth Science

Type of lesson: STEM. Note that this lesson will require at least two class periods for completion.

Science objectives addressed:

- ESS2: Accurately uses appropriate tools and technology and metric measurement units to gather, organize, and analyze data and to report results.
- ESS11a: Explains why the poles receive less sun than the equator.
- ESS12: Predicts weather and climate patterns by observing, measuring, and recording weather patterns over time.
- ESGS 6: Describe and interprets Earth's surface features and explains changes in the Earth's surface due to geologic processes.
- ESGS13: Explains how the Earth's global ocean, powered by the Sun, affects weather and climate through a complex series of atmospheric interactions.

Background information:

- The teacher and students should be aware of the basics of global warming. To get proper context, students should view the short video at http://www.youtube.com/watch?v=oJAbATJCugs, entitled "Global Warming 101", prior to beginning the Northwest Passage activity. The teacher should allow 5-10 minutes for questions from students.
- For background on the Northwest Passage, see information provided under the "Engage" section below.

References:

- This lesson plan was based in part on material from the Northwest Passage exercise available at http://serc.carleton.edu/sp/library/google_earth/examples/northwest_passage.html.
- Summative grading rubric obtained from http://rubistar.4teachers.org/index.php?screen=ShowRubric&rubric_id=1525075&

Materials required:

- This lesson requires access to a computer lab. Each computer should have the Google Earth application installed, and there should be enough computers so that no more than one or two students are seated at each computer.

Preparation:

- Google Earth may need to be installed on each computer in the computer lab that will be used for this lesson. The time to download and install Google Earth on each computer is

expected to be 5-10 minutes, depending on CPU, memory, and speed of network connectivity on each computer.

Engage

Wikipedia provides the following description of the Northwest Passage:

"The Northwest Passage is a sea route through the Arctic Ocean, along the northern coast of North America via waterways amidst the Canadian Arctic Archipelago, connecting the Atlantic and Pacific Oceans. The various islands of the archipelago are separated from one another and the Canadian mainland by a series of Arctic waterways collectively known as the Northwest Passages or Northwestern Passages.

Sought by explorers for centuries as a possible trade route, it was first navigated by Roald Amundsen in 1903–1906. Until 2009, the Arctic pack ice prevented regular marine shipping throughout most of the year, but climate change has reduced the pack ice, and this Arctic shrinkage made the waterways more navigable. However, the contested sovereignty claims over the waters may complicate future shipping through the region: The Canadian government considers the Northwestern Passages part of Canadian Internal Waters, but the United States and various European countries maintain they are an international strait or transit passage, allowing free and unencumbered passage."

Using information found on the above Wikipedia page, students will learn about some of the early explorations of the Northwest Passage. Some of the trips were harrowing and are sure to pique student interest. Of particular importance to the context of the earth science curriculum, the Northwest Passage was considered for use to transport oil in the late 1960s. Ultimately, however, this route was deemed to be too costly and the Alaska Pipeline was constructed instead.

Explore

Students will use Google Earth to orient themselves to the location and routes through the Northwest Passage. Students should be encouraged to explore on their own during this stage of the lesson with the teacher only providing guidance as necessary. Students should record responses in their science notebooks.

1. Start Google Earth and choose the Google Earth *Ruler* tool. Select the *Path* tab.
   a) How long is the shortest route by ship, in kilometers, between Germany and Japan that does not go through the Arctic Ocean? Hint: this route passes through the Suez Canal.

   b) How long is the shortest route by ship, in kilometers, between northern Alaska and New York City that does not go through the Arctic Ocean? Hint: this route passes through the Panama Canal.

2. Examine the Arctic Sea Ice News and Analysis page of the National Snow and Ice Data Center (NSDIC).

a) What seasonal and long-term trends in Arctic sea ice extent are note in this report?

b) In what month is Arctic sea ice extent typically at its minimum? Explain why this occurs in terms of seasonal cycles.

c) What was the average Arctic sea ice extent (in millions of square kilometers) in mid-September from 1979 to 2000?

d) What was the Arctic sea ice extent (in millions of square kilometers) in the middle of this past September?

3. Go to View NSIDC Data on Virtual Globes: Google Earth. Under *Sea Ice: Minimum and Maximum Extents*, open the *Sea ice extents file for Google Earth* that is found near the bottom of the page.

   a) Choose the *September* radio button in the *Places* pane for the interval of years that is indicated. Gradually drag the time slide at the top of the 3D Viewer from left to right. The display may flicker as each image loads, go give this time to occur. What is the trend in sea ice extent for September? For what year do you notice the greatest change in ice extent from the previous year?

4. Read the following news article: Arctic becomes an island as ice melts.

   a) What historic event in the Arctic has been revealed by satellite images?

   b) Taking this event into account, how long is the shortest route by ship, in kilometers, between Germany and Japan?

   c) Taking the same event into account again, how long is the shortest route by ship, in kilometers, between northern Alaska and New York City?

5. Read the following article: A Chilling Possibility.
    a) How could melting of Arctic ice lead to climate change in eastern North America and Western Europe?

6. Read the following article: Why Is Arctic Sea Ice Melting Faster Than Predicted? NOAA Probing Arctic Pollution.
    a) What factors may be causing the Arctic sea ice to melt so quickly?

7. What are some positive effects of the changes in Arctic sea ice?

8. What are some negative effects of the changes in Arctic sea ice?

Explain

The teacher will lead a class discussion of the findings of the students during the exploration component of the lesson. The teacher will lead a class discussion of the findings of the students during the exploration component of the lesson. The following guiding questions may be used to prompt discussion and should be used as a formative assessment at the end of the class period:

1. How could you use a globe and a lamp to model the seasonal changes in the extent of the sea ice?
2. Based on the investigation today, do you think that global climate change is occurring? Do you think climate change should be a major concern? Why?
3. Should scientific funding be contributed to further study of global warming and the condition of the Polar Ice Caps? Why?
4. Explain in detail how this melting might affect the Earth's ecological/systems balance? What might happen to our weather, climate, sea levels, or coastal ecosystems. Make predictions about what you think the greatest changes will be, if any. (Teacher may want to lead students in developing a concept map of the ideas that students have in order to help students understand the interconnectedness of earth systems).

Note: The teacher may want to use animated global models such as those found at http://www.noaa.gov to remind students of concepts such as global ocean currents.

Extend

Students will begin work on this extension activity in class and will be complete it as a homework assignment.

You are an engineer working for a company that currently extracts oil from the North Slope Oil Fields in Alaska. Your company is realizing that with the changing conditions of the sea ice in the Northwest Passage that it may be economical to transport oil via ship rather than to continue using the Alaska Pipeline, which is expensive to maintain as it ages (http://www.scientificamerican.com/article.cfm?id=alaska-pipeline-closed-oil-prices-r).

Your assignment is to determine whether it is viable to use the Northwest Passage as a transport route. For full credit you will include your findings in the following areas:

1. Based on data from your investigation, what months will it be possible to use the passage?
2. Describe in detail (with diagrams) what would be necessary to explore possible routes in terms of people and equipment.
3. Describe how your company would mitigate the potential environmental threat of an oil spill like the one that occurred in the Gulf of Mexico in 2010 or with the Exxon Valdez in Prince William Sound, Alaska in 1989.
4. Summarize the shortest and most economical routes for your company. Also, outline alternative routes for your shipping in the event that your shortest route is blocked by ice.
5. What do you predict will be the long-term outlook for using the passage as a practical (ice-free) passage to transport oil for your company?

Prepare a short (three paragraph) summary of your findings that explains to the company leadership whether you recommend using the Northwest Passage as a transport route. Back your findings with scientific evidence found during your investigations in this lesson.

Report your findings in a PowerPoint presentation to be shared at a stakeholders meeting. The teacher will briefly explain how to use PowerPoint in class and assist the students with questions on PowerPoint usage. Each student will present in class.

Evaluate

Formative:

1. Formative feedback will be provided in the following ways:
2. The teacher will circulate the room and evaluate students understanding based on conversations and interactions.
3. Students will receive written feedback on their questions following the “explore” portion of the lesson to help guide their understanding and help the teacher assess the level of understanding of individual students and the class as a whole.
4. At the end of the “explain” portion of the lesson, students will answer one of the prompts in a well-developed paragraph. This will give the teacher the opportunity to evaluate student understanding as well as to promote writing across the content areas. The following rubric will be used to evaluate student responses:

Grading Rubric	
Grade	**Description**
4	✓ Answers the "question/problem" of the lab ✓ Clear statement of what you learned ✓ The statement is supported with several pieces of evidence from the lab ✓ Well-developed paragraph with organized thoughts
3	✓ Answers the "question/problem" of the lab ✓ Statement of what you learned ✓ The statement is supported with some evidence from the lab ✓ Writing mistakes but still well organized thoughts
2	✓ Answers the "question/problem" of the lab ✓ NO statement of what you learned ✓ NO supporting evidence is provided from the lab ✓ Hard to follow with several writing mistakes
1	✓ It is not clear what you learned

Summative:

The following rubric will be used to evaluate PowerPoint presentations and will be provided to students prior to the start of the project.

Category	**4**	**3**	**2**	**1**
Use of Class Time	Used time well during each class period. Focused on getting the project done. Never distracted others.	Used time well during each class period. Usually focused on getting the project done and never distracted others.	Used some of the time well during each class period. There was some focus on getting the project done but occasionally distracted others.	Did not use class time to focus on the project OR often distracted others.
Content Accuracy	Information is thorough and covers all relevant facts relating to the topic.	Information is accurate and facts are displayed on the poster. Most relevant facts are covered with few areas left unresearched.	Information is generally accurate with some questionable facts. Gaps are left in several areas related to the topic.	Facts are questionable about accuracy. Gaps are left in many areas related to the topic.
Knowledge Gained	Student can accurately answer all questions related to facts in the presentation and processes used to create the poster.	Student can accurately answer most questions related to facts in the presentation and processes used	Student can accurately answer about 75% of questions related to facts in the presentation and	Student appears to have insufficient knowledge about the facts or processes used in the presentation.

	He/She has made strong connections and included numerous thoughtful explanations.	to create the presentation. He/She has made some connections and included several thoughtful explanations.	processes used to create the presentation. He/She has made connections and/or included some explanations.	He/She did not make sufficient connections or include needed explanations.
Mechanics	Capitalization and punctuation are correct throughout the presentation.	There are only a few errors in capitalization or punctuation.	There are several errors in capitalization or punctuation.	Errors in capitalization or punctuation are numerous.
Grammar	There are no grammatical mistakes in the presentation.	Grammatical mistakes in the presentation are minimal.	There are several grammatical mistakes in the presentation.	There are numerous grammatical mistakes in the presentation.
Graphics - Originality	Several of the graphics used in the presentation reflect a exceptional degree of student creativity in their creation and/or display.	One or two of the graphics used in the presentation reflect student creativity in their creation and/or display.	The graphics are made by the student, but are based on the designs or ideas of others.	No graphics made by the student are included.
Graphics - Clarity	Graphics are all in focus and the content easily viewed and identified from 8 ft. away.	Most graphics are in focus and the content easily viewed and identified from 8 ft. away.	Most graphics are in focus and the content is easily viewed from close proximity.	Many graphics are not clear or are too small.
Graphics - Relevance	All graphics are related to the topic and make it easier to understand. All borrowed graphics have a source citation.	All graphics are related to the topic and most make it easier to understand. All borrowed graphics have a source citation.	All graphics relate to the topic. Most borrowed graphics have a source citation.	Graphics do not relate to the topic OR several borrowed graphics do not have a source citation.