Unit Summary

Exploring the New and Old Arctic

Course/Subject Area	Earth Science
Grade Level	Middle/High School
Unit time requirements	2 Weeks, Flexible Formatting
Big Idea(s)	• The process/nature of science is one of adventure, unexpected challenges, and new questions that adds to or refines a body of knowledge • Changes in one part of Earth's climate system can cause unexpected changes in another
NGSS Connections:	• Nature of Science in the NGSS
Disciplinary Core Ideas	• ESS2.A: Earth Materials and Systems • ESS2.D: Weather and Climate • PS4.B: Electromagnetic Radiation
Science and Engineering Practices	• Developing and Using Models • Analyzing and Interpreting Data • Constructing Explanations • Using Mathematics and Computational Thinking • Obtaining, Evaluating, and Communicating Information
Crosscutting Concepts	• Systems and System Models • Energy and Matter • Cause and Effect • Stability and Change • Patterns

Unit Overview

“Exploring the Old and New Arctic " is a middle school/high school nature of science unit in which students compare and contrast past (Fram) and present (MOSAiC) Arctic expeditions. The unit is developed around the driving question, “How have scientific questions, methods, technologies, and our knowledge of the Arctic changed over time?”, and consists of five unique lessons, each tied to **nature of science understandings**. At the end of each lesson, students complete an exit ticket and update a whole class **summary table** in order to keep track of similarities and differences as they relate to the motivation, navigation/technologies, and investigations of the Fram and MOSAiC expeditions. Students will reference their exit tickets and the final summary table when completing the **final assessment**, a visual representation comparing and contrasting the Fram and MOSAiC expeditions.

Unit Driving Question

How have scientific questions, methods, technologies, and our knowledge of the Arctic changed over time?

Description of Unit Driving Question

The Arctic climate system is changing rapidly, warming twice as fast as the rest of the world. Increasing Arctic temperatures have contributed to a dramatic decline in sea ice and as a result made the Arctic more accessible to humans. By understanding the Arctic climate of the past and present, we will be able to more accurately project the Arctic climate in the future and as a result plan for future Arctic natural resource extractions, Arctic shipping routes, Arctic tourism.

Summary Table:

The goal of a summary table is to keep track of what was learned from each lesson and how it applies to the unit driving question. It is used after each lesson and provides an important public record at the end of the unit when students complete their final assessment, a visual representation comparing and contrasting past (Fram) and present (MOSAiC) Arctic expeditions.

The statements written on the summary table are consensus statements developed in a whole class discussion. Prior to the class discussion, students should complete and discuss their exit tickets. Then, the teacher facilitates a discussion and writes the consensus statements on the table.

- See summary table examples **here**.

Final Assessment:

For the final assessment, students are asked to create a visual to explain/address the unit driving question, “How have scientific questions, methods, technologies, and our knowledge of the Arctic changed over time?” Students should reflect on their learning, referencing classwork and the whole class summary table when constructing their visual.

- See final visual examples **here**.

Instructional Calendar

- Full Instructional Calendar **here**

Monday	Tuesday	Wednesday	Thursday	Friday
Lesson 1: Introduction to the Arctic In this lesson, students will… • Define and describe the Arctic • Identify major players in Arctic politics • Be introduced to the unit driving question	Lesson 2: Fram Motivation In this lesson, students will… • Discover the motivation for the Fram expedition • Identify human qualities that helped the Fram expedition successfully navigate the Arctic	Lesson 3: MOSAiC Motivation In this lesson, students will… • Discover the motivation for the MOSAiC expedition • Identify factors contributing to changes in Arctic sea ice extent	Lesson 4: Ice Floe Identification - Day 1 In this lesson, students will… • Analyze Arctic sea ice data to find a suitable ice floe for an Arctic research expedition.	Lesson 4: Ice Floe Identification - Day 2 In this lesson, students will… • Analyze Arctic sea ice data to find a suitable ice floe for an Arctic research expedition.
Lesson 5: Measuring Albedo In this lesson, students will… • Measure the reflectance (albedo) of different surfaces to describe the relationship between the color of a surface and it’s albedo	Optional Extension Activities: • MOSAiC Distributed Network VR Google Expedition • Lesson: Ice-Albedo Feedback • Lesson: Arctic Preparation	Final Assessment In this lesson, students will… • Develop a visual to answer the unit driving question.	Final Assessment In this lesson, students will… • Develop a visual to answer the unit driving question.	

Flexible Formatting

This 2-week curriculum has many different components. Pick the parts that fit your classroom -- facilitate individual lessons, implement in parts (e.g., 1 lesson/week), or complete all at once! Most materials are editable in Google Docs which can be used as-is or customized for the way you want to use them.

Lesson Descriptions:

Lesson 1: Introduction to the Arctic

Summary: In this lesson, students will define and describe the geography of the Arctic and identify the major players in Arctic politics.

Driving Question(s):

- Why should we care about the Arctic?

Learning Goal(s):

- Define and describe the geography of the Arctic
- Identify Arctic stakeholders

Standards:

- **Science Addresses Questions About the Natural and Material World:** Science knowledge can describe consequences of actions but is not responsible for society's decisions

Lesson 2: Fram Motivation

Summary: In this lesson, students experience the Fram expedition through a VR Google Expedition and learn why science truly is a "human endeavor".

Driving Question(s):

- What was the motivation for the Fram expedition?
- What human qualities did crewmembers display during the Fram expedition?

Learning Goal(s):

- Identify and describe human qualities that helped the Fram expedition successfully navigate the Arctic

Standards:

- **Science is a Human Endeavor:** Scientists and engineers rely on human qualities such as persistence, precision, reasoning, logic, imagination and creativity

Lesson 3: MOSAiC Motivation

Summary: In this lesson students discover what is motivating hundreds of scientists from around the world to spend a year, frozen in ice as a part of the MOSAiC expedition.

Driving Question(s):

- What is the motivation for the MOSAiC expedition?

Learning Goal(s):

- Identify factors contributing to changes in sea ice extent (growth and melt)
- Describe and compare sea ice extent observations to model projections

Standards:

- **Scientific Knowledge is Open to Revision in Light of New Evidence:** Scientific explanations are subject to revision and improvement in light of new evidence

Lesson 4 - Ice Floe Identification

Summary: In this 2-day lesson, students will analyze and interpret data about Arctic sea ice to find a location with ice floes suitable for attaching an icebreaker to.

Driving Question(s):

- What do various data tell you about Arctic sea ice conditions, and how can you use this data to identify an ice floe with desired characteristics?

Learning Goal(s):

- Scientific investigations use a variety of methods, and scientists use existing data and evidence to inform and achieve scientific research goals
- Sea ice in the Arctic is dynamic and not uniform everywhere. It changes seasonally and over longer periods of time due to natural and human-induced forcings.
- We can get information about sea ice using a variety of instruments and methods (optical satellite, radar satellite, ice cores, drifting buoys, etc.)

Standards:

- **Scientific Investigations Use a Variety of Methods:** Science investigations use a variety of methods and tools to make measurements and observations.

Lesson 5 - Measuring Albedo

Summary: In this lesson, students measure the reflectance (albedo) of different surfaces and create a rule to describe the relationship between the color of a surface and its albedo.
Driving Question(s):

- What is the relationship between the color of a surface and its albedo?
- What happens to energy that is not reflected by a surface?
- How could a decline in sea ice affect the Arctic's albedo and temperature?

Learning Goal(s):

- Describe the relationship between the color and albedo
- Describe the relationship between albedo and temperature

Standards:

- **Scientific Knowledge is based on Empirical Evidence:** Science knowledge is based upon logical and conceptual connections between evidence and explanations.

Final Assessment

Summary: Students develop a visual representation to address the unit driving question by comparing and contrasting past (Fram) and present (MOSAiC) expeditions.
Driving Question(s):

- How have scientific questions, methods, technologies, and our knowledge of the Arctic changed over time?

Learning Goal(s):

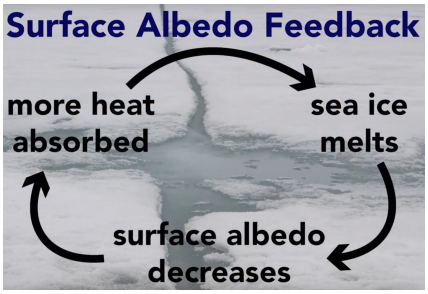
- Compare and contrast past (Fram) and present (MOSAiC) Arctic expeditions.

Standards:

- **Science Addresses Questions About the Natural and Material World:** Science knowledge can describe consequences of actions but is not responsible for society's decisions
- **Science is a Human Endeavor:** Scientists and engineers rely on human qualities such as persistence, precision, reasoning, logic, imagination and creativity
- **Scientific Knowledge is Open to Revision in Light of New Evidence:** Scientific explanations are subject to revision and improvement in light of new evidence
- **Scientific Investigations Use a Variety of Methods:** Science investigations use a variety of methods and tools to make measurements and observations.
- **Scientific Knowledge is based on Empirical Evidence:** Science knowledge is based upon logical and conceptual connections between evidence and explanations.

Optional Lessons:

Ice-Albedo Feedback



Summary: In this lesson, students analyze maps to calculate and compare changes in albedo.

Driving Question(s):

- What is a feedback loop?
- Why does a decline in Arctic sea ice lead to further melting of sea ice?

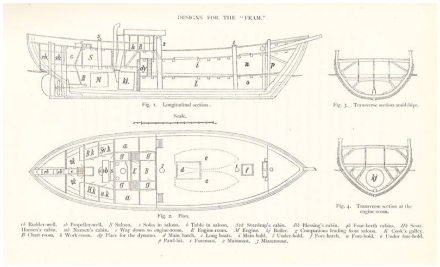
Learning Goal(s):

- Describe the ice-albedo feedback loop.

Standards:

- **Scientific Knowledge is based on Empirical Evidence:** Science knowledge is based upon logical and conceptual connections between evidence and explanations.

Arctic Preparation



Summary: In this lesson students compare and contrast Arctic vessels of the past (*Fram*) and present (*Polarstern*).

Driving Question(s):

- How are past and present Arctic ship designs similar? Different?

Learning Goal(s):

- Identify and describe structures and functions characteristic of Arctic vessels, Fram and Polarstern

Standards:

- **Science is a Human Endeavor:** Advances in technology influence the progress of science and science has influenced advances in technology