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A Unit on Predicting Weather

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Introduction

Précis

This unit on weather observation and prediction aids teachers who are unsure how they might blend federal and state-mandated science content with traditional ways of knowing. Developed for Alaska middle school science teachers, it highlights similarities between western-style science and traditional ways of knowing, and incorporates activities commonly found in the mainstream science classroom with traditional methods and skills. This introduction provides a brief background on the use of traditional knowledge in the classroom, and outlines several practical suggestions for blending the two perspectives on "science," while at the same time maintaining cultural sensitivity and providing students with tools to meet science content and cultural standards

Research shows that incorporating Native ways of knowing into the mainstream curriculum promotes the development of well-rounded students (intellectually, emotionally, physically, spiritually, and culturally) (Barnhardt, 1989; Barnhardt & Kawagley, 2010). However, many educators, especially those from outside of Alaska, view content standards and culture standards as two separate and conflicting regulations. As such, educators frequently make the mistake of separating the cultural standards from traditional western-style content standards — an action that negates the importance of both. Culture is not something that sits isolated, in a box separate from academic learning goals; rather, culture is deeply imbedded and plays an integral role in how students learn and perceive the world (Kawagley, 2010). Consequently, "[cultural] programs need to be integrated with the regular curriculum so students can work toward a single goal, such as communicating with people at different levels and showing signs of intelligence and respect" (Barnhardt, 1989).

This introduction provides background on blending "indigenous" and "western" learning styles and outlines suggestions for how to achieve this in the classroom.

A Brief Background on Blending "Indigenous" and "Western" Learning Styles

What people often call "traditional knowledge" represents a holistic way of understanding the world in which one lives. It embodies the relationships and interactions of all living things with Earth's processes. It is a collective knowledge that has been compiled for thousands of years and is passed down from generation to generation. As such, traditional

knowledge cannot be learned simply by watching one lecture or completing one activity. It is a process that people must participate in again and again (Hild, 1994; Barnhardt & Kawagley, 2010).

A "Native way of knowing" approach takes a whole picture perspective for understanding natural phenomena. In the past and still today, this type of holistic understanding of Alaska's landscape was essential to survival. Intimate knowledge of the environment (*ella,* in the Native Yup'ik language) provides careful observers the ability to recognize and understand tiny shifts in meteorology and consequently to determine how long a particular weather condition might last (Kawagley, 1996). A person versed in traditional knowledge learns to read a number of environmental signs, including those in the sky (sun, moon, stars), the atmosphere (clouds, wind, snow), and the land (changes in soils, foliage, animal patterns, etc.). "Ella does not try to surprise people, but usually tells us ahead of time what it is going to do" (Kawagley, 1996, p.53). Today, this intimate knowledge is no less important; in addition to aiding in subsistence activities, traditional practitioners work closely with climate scientists to provide key information about landscape changes that may otherwise go unobserved.

Suggestions for the Classroom

Historically, Native knowledge was passed from generation to generation through storytelling,close observation, and extensive elder-youth interaction (Kawagley, Norris-Tull, and Norris-Tull, 2010). Young children were expected to carefully observe and mimic their elders as a way of learning. The lessons learned through close observation and mimicry were solidified in legends and oral histories. Today, young people in Alaska spend more of their time in school buildings away from family members, which makes this type of learning difficult. Nevertheless, learning from the stories and experiences that elders have to share remains an important cultural value. To encourage traditional learning methods, teachers can, when possible, welcome elders and culture bearers into the classroom. In this way, young people gain exposure to important cultural stories and knowledge in context with academic content. Students begin to develop an understanding of how traditional knowledge and academic content are related and elders and culture bearers continue to influence the next generation, thereby supporting this culturally valuable way of learning (ANKN, 2010; Ongtooguk, 2010).

When making arrangements with local elders and culture bearers to visit the classroom, or for students to make home visits, teacher and student alike must remember to be sensitive to the cultural needs and expectations of their hosts. Teachers, especially those not from Alaska, should avoid being "takers" — as cultural wisdom teaches that reciprocity is a keystone element in any relationship (ANKN, 2000). To avoid being seen as someone who is only interested in taking from people, teachers should make an effort to present themselves to elders and community members in a number of ways *before* asking for help. One way to do this is to make an effort at becoming part of the community outside the context of their job. Teachers can arrive at their village sites early, and participate in late summer subsistence activities and preparations for winter. In so doing, elders and the community can begin to get to know the teacher and his / her motivation(s), and the teacher can learn about the community in which they live.

It is likewise important to remember that traditions are not artifacts of the past, but rather, living elements of the culture. As such, one must be conscious of practicing appropriate cultural behavior at all times. With this in mind, the producers of the documentary video "Passing On" (ANKN, 2000) emphasize the following guidelines:

- Start planning early — several weeks before you plan to have elders be part of the activity.
- Be sure to identify experts in the community; ask local leaders whom might best speak to particular issues.
- When asking elders to participate, ask politely, in a manner that is culturally respectful.
    - Always begin a request by telling a little bit about the class and how participation would be needed.
- Be clear about expectations for participation — how will people participate? What kind of information do they need to bring?
- Before the elder visits, ensure students know what is expected of them, and what their behavior in class should look like.
- Be patient. Allow elders to participate on their terms — give them plenty of time to share their wisdom and knowledge.
- Find a comfortable location, offer opportunity for refreshment and breaks — often going to places on the land can trigger stories.
- Be sure to express thanks (encourage students to send thank you cards).

Unit Overview

Developing unit plans that meet goals like those outlined above and also "utilize the natural environment of the community" (ANKN, 2000), may seem overwhelming to someone who is not versed in local culture; however, the rewards to students, community members, and teachers are awesome!

This unit provides an example of how this can be easily done. Here, students learn about the science of weather from both western and indigenous perspectives. The "western-style" science lessons (Lessons 2, 3, 4, & 5) have been adapted from the Arctic Climate Modeling Program Curriculum (Geophysical Institute, 2008) to include the Next Generation Science Standards and to incorporate traditional methods of learning. These four lessons are bounded by three original lessons that focus on traditional methods. The first lesson provides some background and initial opportunity for students — both from the traditional perspective and through students' own close observations of the world around them. In the series of lessons that follow, students learn about western and indigenous ways of predicting the weather. The final lesson asks students to observe local weather for the period of a month. They are invited to observe using traditional methods, as well as any they have learned throughout the course of the unit. Their observations will help them realize how important it is to combine approaches from "both worlds." Though the lessons could be used individually, they are best used as part of the package, so that students learn how western and indigenous perspectives of "doing science" blend together.

Lesson 1: An Introduction to Native Ways of Knowing Science

Synopsis:
This introductory lesson familiarizes students with the concept of "traditional knowledge," encourages use of a key traditional skill (observation), and motivates students to begin understanding science concepts from a holistic perspective.

Objectives:
The student will:
- demonstrate observational skills as they observe and communicate findings in the natural world.
- analyze similarities and differences between western and indigenous ways of knowing.

Standards:
Next Generation Science Standards: Disciplinary Core Ideas
ESS2.A: Earth's Materials and Systems
All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms.

ESS3.A: Natural Resources
Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes.

ESS3-1: Constructing Explanations and Designing Solutions
Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) 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.

Cultural Standards
A. Culturally-knowledgeable students are well-grounded in the cultural heritage and traditions of their community.
B. Culturally-knowledgeable students are able to build on the knowledge and skills of the local cultural community as a foundation from which to achieve personal and academic success throughout life.
D. Culturally-knowledgeable students are able to engage effectively in learning activities that are based on traditional ways of knowing and learning.
E. Culturally-knowledgeable students demonstrate an awareness and appreciation of the relationships and processes of all interaction of all elements in the world around them.

Time Needed:
Approximately 2 class sessions (1 for the elder visit, 1 for the activity)

Vocabulary:

Term	Definition
traditional knowledge	the holistic, practical, and common knowledge that has been gathered over thousands of years of observation and interaction with the land; it is passed on from generation to generation through practice, oral stories, dance, and art
deduction	to draw a conclusion by reasoning

Yup'ik Language Terms

Term	Definition
ella	weather, outside, sky, earth, universe, environment, or consciousness
qaneryaraat	proverbs or oral teachings
quyana	thank you

Teacher Note: It is crucial to check language terms with a Native speaker before teaching the lesson. Make use of bicultural teachers in your school, or encourage a Native speaker from your area to visit your class and help you teach the language terms.

Materials:

- Notebooks
- Pens / Pencils
- "Common Practices Worksheet" (create from information below)
- "Native Values" poster appropriate for your location (available from Alaska Native Knowledge Network)

Activity Preparation:

1. Obtain a "Native Values" poster appropriate for your location from the Alaska Native Knowledge Network.
2. Preview a location outside at your school that has enough space for students to remain relatively isolated from one another, but that allows you comfortable observation of students.
    a. Determine whether safe vegetation exists for students to observe by taste.
3. Make arrangements for an elder or culture bearer to visit your classroom. Politely ask him / her to talk about traditional methods of observation
4. Make handouts and copies of the handouts for each student.
5. Arrange the classroom desks into a circle, or arrange for a place on the floor where all students can sit comfortably.

Activity Procedure:

Day 1

1. Arrange to have an elder or culture-bearer visit your classroom. Ask the elder or culture-bearer to talk about traditional methods of observation and traditional ways of "doing science."
    a. Before the elder arrives, review the "Native Values" poster with students. Ask students to think about how they might apply these values not only during the elder visit, but in their daily life and throughout their school day.
    b. Students should be prepared to listen attentively, take notes (optional, depending on learner style), and participate in any activity that the elder asks of them.
    c. The goal of this day is for students to learn about traditional methods of observation, to learn how to practice those, and to begin building an understanding that this takes time, effort, and patience.

Day 2

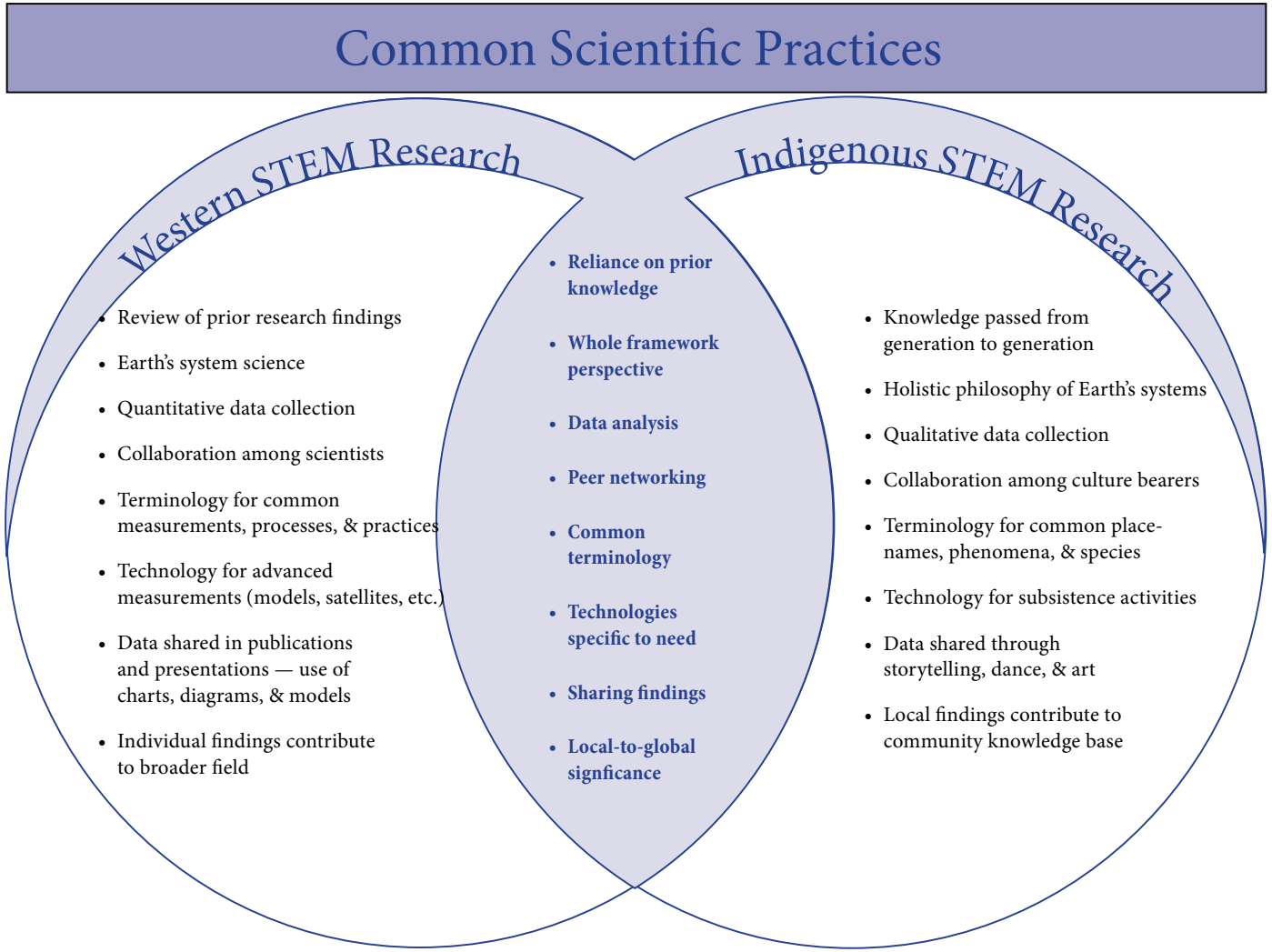
2. Explain to students that the class will be going outside to do some observations. They should take a notebook and something to write with.
    a. While outside, they should sit in a quiet location, they are not to communicate with other students.
    b. During the time (10 minutes), students should make notes of what they observe. They should use four senses (possibly five, if location and safe vegetation exists)—sight, hearing, feeling, smelling, (tasting)
    c. Instruct students to tune-in carefully to their surroundings

Teacher Note: Jot down your own observations, as well.

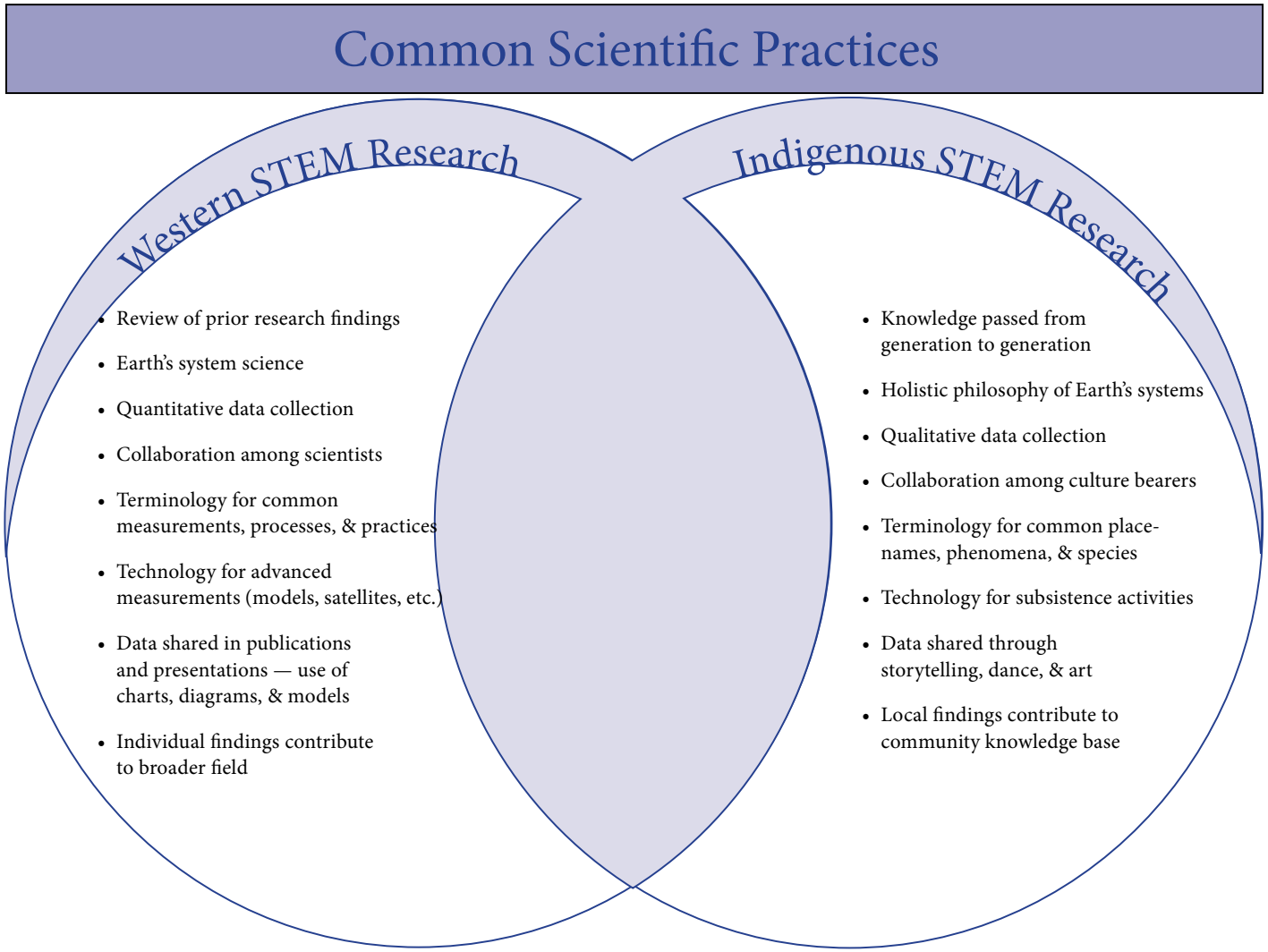
3. Back in the classroom, sit together as a group (either in a circle on the floor, or have the desks grouped into a circle).
    a. Discuss student observations—what did everyone observe?
    b. What kinds of deductions can be made from the sights, sounds, feelings, and smells you observed? (maybe squirrels were gathering materials for a nest (winter coming), maybe leaves are starting to change color (change of season), maybe it is windier than normal (storm coming)).
        i. During the discussion, draw on students' own background knowledge for deductions. Has anyone's parents / grandparents told them a story about a related event? What significance did it have?
4. Ask students to share ideas about how the outdoor observation activity fits with yesterday's elder visit and his / her description of "doing science."
5. Pass out the "Common Practices" worksheet
    b. As a class, discuss each row.
    c. Answer any questions that students have regarding terminology.
    d. Brainstorm how the two different approaches are similar (students write the common practice in the middle column).

Critical Thinking: Students analyze the similarities and differences between western and indigenous practices for understanding Earth system research.

Answers: "Common Practices Worksheet"



STUDENT WORKSHEET: Common Practices



Lesson 2: Analog Forecasting

Objectives: Students will:
- understand the analog method of forecasting; and
- make a weather prediction using the analog method.

Estimated Time: 1 class period + additional time on second day for analyzing results.

Next Generation Science Standards:
Disciplinary Core Ideas — ESS2.D Weather and Climate
ESS2-5: Weather and climate patterns are complex. As such, weather can only be predicted probabilistically.

ESS2-6: Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography. All of which can affect oceanic and atmospheric flow patterns.

The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents.

Science and Engineering Practices — Asking Questions and Defining Problems
ESS3-5: Ask questions to identify and clarify evidence of an argument.

Science and Engineering Practices — Planning and Carrying out Investigations
ESS2-5: Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.

Materials:
- Computer with internet access
- Student Worksheet "Analog" (based on the information below)

Activity Preparation:
1. Obtain a copy of today's weather report, including high and low temperatures, sky conditions, precipitation likelihood, and wind speed, by doing the following:
    a. Navigate to www.nws.noaa.gov, type in your city and state in the upper left hand corner where it says "Local forecast by "City, St." Click go.
2. Make copies of the weather report so that each student will have a copy.

Procedure Details:
1. Explain to students that meteorologists have several ways of forecasting the weather.
2. Explain that this method of forecasting weather is called the analog method. Using this method, one finds a day in history that had the same weather as today and assumes that the weather that followed that day will be the weather for tomorrow.

Assessment:
Student worksheet "Analog" and the daily weather report

Information for Student Worksheet "Analog"

Teacher Note: Use the information below to create the worksheet that students use during the activity. Modify the style as needed for the different learner types in your classroom.

1. Answer the following questions using information from today's weather report.
    a. What is the high temperature for today? _____° F
    b. What is the low temperature for today? _____ ° F
2. Access the National Weather Service Web page at http://www.nws.noaa.gov.
    a. Type in your city and state in the upper left corner where it says "Local Forecast by City, St."
    b. Click "Go."
    c. Click on the link to "Climatology" under Weather Data on the left side of the page.
    d. Click on the "Select a site..." drop-down menu and choose your local community, or a community near you.
    e. Select the current month and the previous year in appropriate drop-down menus.
    f. Click "Go." If no data displays, select a larger community, such as Nome and try again.
    g. Find a day on the Climatology page that has the same maximum and minimum temperature within 5° as today. If you cannot locate a date with close enough temperatures, repeat step 4, but chose a different year.
3. What date has the same high and low temperatures as today? Include the month, day, and year.
4. What are the maximum and minimum temperatures on the National Weather Service Climatology page for the following day?
    a. Maximum Temperature_____ ° F
    b. Minimum Temperature _____ ° F
5. Using the analog method of forecasting, what will the maximum and minimum temperatures be tomorrow?
    a. Maximum Temperature _____ ° F
    b. Minimum Temperature _____ ° F
6. Look at the weather report you used in step 1. What is the forecast for tomorrow?
    a. Maximum Temperature _____ ° F
    b. Minimum Temperature _____ ° F
7. Was your analog forecast the same as the weather report forecast?
8. Why might the two weather forecasts be different?
9. Thinking about the lesson on Traditional Ways of Knowing Science, what method category does this fall under?

Lesson 3: Persistence Forecasting

Objectives: Students will:
- understand the persistence method of forecasting; and
- make a weather prediction using the persistence method

Estimated Time: 2 class periods

Next Generation Science Standards:
Disciplinary Core Ideas — ESS2.D Weather and Climate
ESS2-5: Weather and climate patterns are complex. As such, weather can only be predicted probabilistically.

ESS2-6: Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography. All of which can affect oceanic and atmospheric flow patterns.

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Science and Engineering Practices — Asking Questions and Defining Problems
ESS3-5: Ask questions to identify and clarify evidence of an argument.

Science and Engineering Practices — Planning and Carrying out Investigations
ESS2-5: Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.

Materials:
- Newspaper or website with daily local weather report
- Student worksheet "Persistence" (based on the information below)

Activity Preparation:
- Obtain a copy of today's weather report, which includes high and low temperature, sky conditions, precipitation likelihood, and wind speed.
    - If necessary, access a weather report at the National Weather Service Web page: http://www.nws.noaa.gov.
- Make copies of the weather forecast so that each student will have one.

Procedure Details:
1. Distribute copies of the weather report. Discuss elements of the forecast. Ask students how meteorologists forecast weather.
2. Explain there are 5 main ways forecasters predict weather; the class will learn about one– persistence.
3. Ask students if they know what persistence means. Discuss what persistence forecasting might be. Explain with persistence forecasting the forecaster assumes the weather today

will be the same as yesterday. For example, if it was 10° F and clear today, it will be 10° F and clear tomorrow.

4. Hand out the Student Worksheet: "Persistence" (create this from the information below) Ask students to complete the Day One section of their worksheets.
5. The following day, repeat the activity preparation and allow students to complete their worksheets.

Assessment:

1. Discuss why the persistence method of forecasting may not be the most accurate method.

Information for Student Worksheet, "Persistence":

Teacher Note: Use the information below to create a worksheet (or one for each day) that students use during the activity. Modify the style as needed for the different learner types in your classroom.

Day One:
Using the weather report provided by the teacher, fill in the weather data for today. If there are a range of numbers, use the highest value.

1. High (Max.) Temperature _____ ° F
2. Low (Min.) Temperature _____ ° F
3. Wind Speed _____ mph
4. Wind Direction _____
5. Sky Conditions (Fair, Rain, Cloudy, etc.) _____
6. Using the Persistence method of forecasting, predict what the weather will be tomorrow.
7. High (Max.) Temperature _____ ° F
8. Low (Min.) Temperature _____ ° F
9. Wind Speed _____ mph
10. Wind Direction _____
11. Sky Conditions (Fair, Rain, Cloudy, etc.) _____

Day Two:
Examine the weather report provided by the teacher for today and answer the following questions.

1. Was your forecast accurate? _____
2. Why might the persistence method of forecasting not be the most accurate?
3. Thinking about the Common Methods outlined in the first unit, what techniques from both the western and indigenous perspectives can be applied to your observations?

Lesson 4: Trends Forecasting

Objectives: Students will:
- understand the trends method of forecasting
- make a weather prediction using the trends method; and
- utilize technology to examine weather data

Estimated Time: 1 class period

Next Generation Science Standards:
Disciplinary Core Ideas — ESS2.D Weather and Climate
ESS2-5: Weather and climate patterns are complex. As such, weather can only be predicted probabilistically.

ESS2-6: Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography. All of which can affect oceanic and atmospheric flow patterns.

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Science and Engineering Practices — Asking Questions and Defining Problems
ESS3-5: Ask questions to identify and clarify evidence of an argument.

Science and Engineering Practices — Planning and Carrying out Investigations
ESS2-5: Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.

Hook:
Remind students the persistence and analog methods of forecasting are two ways meteorologists forecast weather. Ask students to explain what these two methods are. Share that today, students will learn a third method, called "Trends."

Materials:
- Map of Alaska (to scale)
- Calculator (1 for every 2 students)
- Computer with Internet access
- Student worksheet: "Trends" (make from information below)

Activity Preparation:
- Create student worksheet based on information below, and make enough copies for each student.

Procedure Details:

1. Another method of weather forecasting is called trends. This method looks at winds and clouds approaching from a distance and estimates when they will arrive at the location in question. For this, one needs to know where the weather is coming from and how fast it is moving.
2. Share the following example with the class:
    a. There is a storm approaching from the east. It is 250 miles away and is moving west at 25 miles per hour. How long will it take the storm to arrive?
    b. 250 miles ÷ 25 miles/hour = 10 hours
3. If there are sufficient computers, ask students to form groups (preferably pairs) and navigate to the following website: http://www.edheads.org/activities/weather.
    a. Direct students to click on the graphic that says "Click here to start"
    b. Then click on "Predict Weather"
    c. Finally, click on "Level 2"
    d. Instruct each group to follow the instructions to complete the game.

Calculators may be used in sections that require math.

4. Distribute the STUDENT WORKSHEET: "Trends."
    a. Explain that students will examine radar maps to determine where the weather in their community is going.
5. Navigate to the "Radar Map" at the above website. Explain the following:
    a. The colors on the map represent cloud cover.
    b. The key on the right shows which colors indicate heavier cloud cover.
    c. Cloud cover is a way of predicting rainfall intensity.
    d. The heavier the cloud cover, the more likelihood of rain.

Assessment:

1. Instruct students to complete their worksheets individually or in small groups. As a class, discuss the answer to question 8 (wind speed and direction can change, storms can dissipate) and 9 (it is more accurate due to the changing nature of our weather).

Information for Student Worksheet: "Trends"

Teacher Note: Use the information below to create a worksheet that students use during the activity. Modify the style as needed for the different learner types in your classroom.

1. Go to the National Weather Service Web site: http://www.nws.noaa.gov
    a. Type in your city and state in the upper left corner where it says "Local Forecast by City, St."
2. Using the forecast retrieved in Step 1, answer the following questions.
    a. What is the wind speed for today? _____ mph
    b. What is the wind direction for today? _____
3. To determine where the weather in your community will be tomorrow, first determine how far the weather will travel in 24 hours.

Multiply the wind speed (Step 2) by 24 hours: _____ mph x 24 hours = _____ miles

4. Use a map of Alaska to find a community located in the direction the wind is traveling (see step 2) and approximately the distance from your community the weather will travel in one day (see step 3). Write the name of the community that you forecast will have your weather tomorrow. Community name: _____
5. Return to the National Weather Service forecast Web page reached in step 1.
    a. Click on the radar picture under the "Radar and Satellite Images" heading.
    b. Next, click on the "Go to: Standard Version" link located at the top of the page.
    c. Colored sections of the radar image represent cloud cover.
    d. The key on the right of the image shows which colors indicate heavier cloud cover.
6. Use the key on the right of the radar image to determine whether the cloud cover in your community is heavy, moderate, light or very light. Write "none" if there is no cloud cover. Cloud cover: _____
    a. Using the trends method of forecasting, predict tomorrow's weather for the community specified in step 4.
7. Go back to the National Weather Service home page at http://www.nws.noaa.gov.
    a. Type in the city and state for the community specified in step 4 where it says "Local Forecast by City, St" in the upper left corner.
    b. What does the National Weather Service predict for tomorrow's weather in the community you specified?
8. Does your trends forecast match the National Weather Service weather prediction for tomorrow?
    a. If not, why do you think this might be the case?
9. Why might a forecaster use a trends forecast instead of a persistence forecast?
10. Thinking about the Common Methods outlined in the first unit, what techniques from both the western and indigenous perspectives can be applied to your observations?

Lesson 5: Climatology Forecasting

Objectives: Students will:
- make a weather prediction using the climatology method

Estimated Time: 1 class period + additional time the following day to analyze results.

Next Generation Science Standards:
Disciplinary Core Ideas — ESS2.D Weather and Climate
ESS2-5: Weather and climate patterns are complex. As such, weather can only be predicted probabilistically.

ESS2-6: Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography. All of which can affect oceanic and atmospheric flow patterns.

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Science and Engineering Practices — Asking Questions and Defining Problems
ESS3-5: Ask questions to identify and clarify evidence of an argument.

Science and Engineering Practices — Planning and Carrying out Investigations
ESS2-5: Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.

Materials:
- Computer with internet access
- Student worksheet (create from information below)

Hook:
1. Remind students meteorologists use several different methods to forecast weather. Three of those methods, which have been addressed in previous lessons, are analog, persistence, and trends.
2. Remind students how analog, persistence, and trends methods are used to forecast weather.

Activity Preparation:
1. Access a copy of today's weather report, which includes high and low temperature, sky conditions, precipitation likelihood, and wind speed, by doing one of the following:
    a. Navigate to http://www.nws.noaa.gov
    b. Type in your city and state in the upper left hand corner where it says "Local forecast by "City, St."
    c. Click go.
    d. Or find a local weather report in the local newspaper.
2. Make copies of the weather report so that each student will have a copy.

3. Make a student handout using the information below

Procedure Details:

1. Explain another way to forecast weather is climatology. Climatology examines daily weather norms. A daily weather norm is the normal weather for a particular day in a specific area. Norms are calculated by averaging weather data for one day every year for many years. For example, to find the high temperature normal for August 3, find the high temperature for August 3 for each of the last 30 years; add all the high temperatures, then divide by 30.
2. When using climatology to forecast weather, meteorologists look at normal weather data for the date in question and assume that will be the weather.
3. Distribute the Student Worksheet: "Climatology" and the weather report. Direct students to complete the worksheet. Discuss the answers to Step 5.

Assessment:
Instruct students to complete their worksheet individually or in pairs. Discuss the answers and any questions students may have. Discuss how this method is similar or different to the methods learned in Lesson 1.

Student Worksheet Instructions / Questions:

Teacher Note: Use the information below to create a worksheet that students use during the activity. Modify the style as needed for the different learner types in your classroom.

1. Using a computer with Internet access, navigate to the Web site: http://climate.gi.alaska.edu/Climate/Normals/index.html. Click on the drop-down menu under "Daily Normals" and choose your community or the community closest to you.

2. The average temperature is the average of all the temperatures recorded in one day. Find the section labeled average temperature. Find the current month and day on the chart.

    a. What is the normal average temperature listed for today? _____ ° F

    b. What is the normal average temperature listed for tomorrow? _____ ° F

3. Using the climatology method of forecasting, what will the average temperature be tomorrow? (Hint: It's the same as the answer to Step 2.) _____ ° F

4. Using the weather report provided by the teacher answer the following questions (Note: Where a range of numbers is provided, use the highest number.):

    a. What will the high temperature be tomorrow? _____ ° F

    b. What will the low temperature be tomorrow? _____ ° F

    c. What will the average temperature be tomorrow? _____ ° F

5. Was your climatology forecast the same as the weather report forecast?

6. Why might they be different?

7. Thinking about the Common Methods outlined in the first unit, what techniques from both the western and indigenous perspectives can be applied to your observations?

Lesson 6: Traditional Weather Forecasting

Objectives:
Students will:
- Interview an elder or culture bearer to determine specific ways of forecasting the weather.
- Use a traditional method to create their own weather forecast.
- Students write a thank-you note to the elder(s) / culture bearer(s) who visited their classroom.

Estimated Time: 1 day for classroom visit / interview + extra time for students to develop their own forecast.

Next Generation Science Standards:
Disciplinary Core Ideas — ESS2.D Weather and Climate
ESS2-5: Weather and climate patterns are complex. As such, weather can only be predicted probabilistically.

ESS2-6: Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography. All of which can affect oceanic and atmospheric flow patterns.

The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents.

Science and Engineering Practices — Asking Questions and Defining Problems
ESS3-5: Ask questions to identify and clarify evidence of an argument.

Science and Engineering Practices — Planning and Carrying out Investigations
ESS2-5: Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.

Cultural Standards:
A. Culturally-knowledgeable students are well-grounded in the cultural heritage and traditions of their community.
B. Culturally-knowledgeable students are able to build on the knowledge and skills of the local cultural community as a foundation from which to achieve personal and academic success throughout life.
D. Culturally-knowledgeable students are able to engage effectively in learning activities that are based on traditional ways of knowing and learning.
E. Culturally-knowledgeable students demonstrate an awareness and appreciation of the relationships and processes of all interaction of all elements in the world around them.

Materials:
- Pens / pencils
- Paper
- Note paper and envelopes

- Active listening ears

Activity Preparation:

1. Invite one or more elders or culture bearers to your classroom to answer student questions about weather forecasting. (Be sure to start planning for this early — allow plenty of time and follow the guidelines set out by Adams, et. al (2006)).

2. Prepare refreshments for your guests.

Hook:

Review the four ways of weather forecasting that have been discussed: persistence, trends, climatology, and analog.

Procedure Outline:

- Elder / Culture Bearer classroom visit / interview
- Students make own predictions using methods outlined by elders / culture bearers.
- Students write a thank-you note.

Procedure Details:

1. Long before modern scientific instruments, indigenous people had developed their own way of forecasting weather. Discuss how traditional methods of forecasting weather are similar to meteorologists' methods. Today, many people trained in traditional ways use both current data and past knowledge to make predictions.
2. Explain that in this activity, students will interview an elder or culture bearer to determine some ways in which they forecast weather. Then, they will make their own weather prediction using those methods.
    a. If agreeable to the elder / culture bearer, and the weather is good, the interview could take place outdoors, on the land.

Assessments:

Students discuss the following (this can be done in writing, to practice writing skills, or can be done as a presentation to the class, to practice public speaking skills):

1. Describe one method of weather forecast mentioned by the guest(s).
2. If possible, use that method to predict tomorrow's weather.
    a. If not possible, explain why not.
3. Thinking about all the methods of forecasting students have learned about (persistence, trends, climatology, analog, and those mentioned by the elder / culture bearer), which method seems to be the most accurate? Why?

Lesson 7: Weather Observation Journal

Objectives:
The student will:
- observe his / her surroundings;
- listen to stories and sayings regarding the weather;
- compare classmates' observations; and
- look for patterns and connections between various weather phenomena.

Estimated Time: 1 month, plus one classroom period to analyze results.

Next Generation Science Standards:
Disciplinary Core Ideas — ESS2.D Weather and Climate
ESS2-5: Weather and climate patterns are complex. As such, weather can only be predicted probabilistically.

ESS2-6: Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography. All of which can affect oceanic and atmospheric flow patterns.

The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents.

Science and Engineering Practices — Asking Questions and Defining Problems
ESS3-5: Ask questions to identify and clarify evidence of an argument.

Science and Engineering Practices — Planning and Carrying out Investigations
ESS2-5: Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.

Cultural Standards:
A. Culturally-knowledgeable students are well-grounded in the cultural heritage and traditions of their community.
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D. Culturally-knowledgeable students are able to engage effectively in learning activities that are based on traditional ways of knowing and learning.
E. Culturally-knowledgeable students demonstrate an awareness and appreciation of the relationships and processes of all interaction of all elements in the world around them.

Materials:
Notebook / journal

Background:
As we have learned, both traditional practitioners and scientists alike depend on weather observation to note patterns in the weather and have a record of stories and information to share with others. This information can be used to predict and prepare for the weather. In this activity, students keep a weather journal for one month. At the end of the month, they examine their entries and note any patterns or connections they find between various weather features.

Hook:
Remind students of the various ways they have learned to predict weather. Share with them that they will be keeping their own weather observation journal for one month. They should track the weather at the same time each day (remind them that it is prudent to check the weather both in the morning and the night).

Activity Preparation:
Prepare a student handout detailing Chester Noongwook's Rules of Weather Observations (from *Watching Ice and Weather Our Way* (2004)).

- First thing, get out early in the morning, and check the wind and the sky conditions, whether the sky is cloudy, and also whether it is cold or warm in terms of your body feeling;
- In the old days, we always used to go down to the sea shore every morning—to check the ice and weather conditions at the water (sea level), how the current is moving, and where is the tide;
- Always talk to other people about weather and ice conditions; listen to other people's minds to see whether it is good to go out hunting;
- Check for any change in wind and weather condition; we are told to watch out for weather all the time, either we are on the ice or on shore—every hour, every minute or listen to other boats what they are saying;
- Keeping watch for any change in water because of currents or clouds or waves—any sign of water change is very important;
- You can never make a good forecast for tomorrow based upon today's weather. Better go out and check it in the evening. Make a guess and check it next day: it is better to see whether it is correct or not.

Procedure Details:

1. Students copy the journal elements they will observe for the following month. Each day, they will create the heading and then write their observations.
    a. Date
    b. Wind
    c. Sky
    d. Ice / Water
    e. Other observations
2. As a class, read the handout out loud.
3. Provide a few minutes for answering of questions. Instruct students to complete their observations each evening and morning. (Remind them each day for the next month).

Assessment:

1. After the last entry, instruct students to analyze their notebooks for any patterns. If necessary, create a worksheet from the questions listed below.

    a. Which weather events happened most frequently?

    b. Which weather events seemed to be connected (cloudy morning skies, foul weather during the day)

    c. Students should share their observations — this can be done in writing, to practice writing skills, or as a classroom presentation to practice verbal skills. Students may also choose to create an iMovie from their observations.

    d. Thinking about the Common Methods outlined in the first unit, what techniques from both the western and indigenous perspectives can be applied to your observations?

    e. *Alternative Activity:* Invite the elder / culture bearer who came earlier in the unit back to the classroom for student presentations. He / she may wish to comment on student observations.

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