Measure Wind

Subject Areas

Science, Math

Summary

In order to measure wind speed the students will create anemometers. The students will then collect the necessary data to compare the wind speed in different time and locations.

Duration

We recommend to divide the course in 5 lessons:

Part 1: 20 minutes
Part 2: 20 minutes
Part 3: 45 minutes
Part 4: 120 minutes
Part 5: 45 minutes

Skills

Gathering Information, Organizing Data, Analysing, Interpreting, Applying, Measurements, Conversion, Averaging.

Sailing Skills

Preparation, Wind Awareness, Wind Detection, Wind Direction Clues, Reading Wind on the Water, Wind Velocity, True and Apparent Wind.

Vocabulary

Standard Units, Beaufort Scale, Anemometer, Wind Puff, Miles Per Hour, Wind, True Wind, Apparent Wind.

Objectives

Students will:

- Define wind scientifically using speed and direction.
- Construct an anemometer and use it to take accurate measurements of wind speed.
- Convert revolutions per minute to miles per hour and collect wind speed data.
- Be introduced to the Beaufort Wind Scale.
- Compare their data to the Beaufort Wind Scale and explain why we have standards in measurement.
- Identify wind using visual clues.

Materials

- US - Learn Sailing Right! Beginner Chapter I Preparing Yourself for Sailing
- Pencil with new eraser - One per person
- Paper Dixie cups-Four per person
- Two paper drinking straws per person (non bending)
- Masking Tape
- Straight pin (used for sewing)
- Black permanent marker
- Clipboard
- Stopwatch/timer
- Whiteboard
- Weather report from daily paper
- Electric fan
- Smart phones
- Weather apps
- Radar

Sailing Centers

Sailing Centers should complete Parts I. II. and III followed by 2 hours of sailing time applying boat handling and wind awareness skills. The goal of this lesson is to help students identify wind and understand the complexity of wind, it's direction, and changes in velocity. By improving wind awareness and detection students will be able to predict shifts and identify wind patterns becoming more knowledgeable sailors.

Formal Classroom Settings

Classroom Teachers should complete Parts I, and III in a single class period followed by Parts II and IV in period 2. and Pan V in period 3. The extension actively can be implemented in period 4. On day 5 invite your local meteorologist to the classroom to present on local weather patterns in your area and the causes of typical wind patterns in your area.

Career Connection

There are many careers in weather: meteorologist, hurricane hunter, weather reporter, weather writer, wind turbine engineers. Contact your local weather station to connect students with a meteorologist.

Procedure

Part I: What Do We Know About Wind?

Classroom - 10 minutes

1. Access Prior Knowledge (APK) Place the word “wind" on the board. Ask students, "What do we know about wind?" Brainstorm in pairs. Ask, "Why is wind important to us? What are the different uses of wind in our world today." Have groups share out their answers with the class.

2. Ask students when they have witnessed the effects of wind. List concrete examples on the board; For example - wind blowing leaves. Looking at these examples. Does it take the same strength of wind to move leaves in a tree as it does to demolish a house? Ask students, "Is it important for you to be aware of the wind's strength in your everyday life? Why? Where would you locate the strength of the wind for the day?" (newspaper, internet, or TV).

3. Now that you have listed examples of wind and we understand why it is important to know the wind's strength for the day, let's define wind. Ask students to define wind `and list answers on the board. Guide students by asking, "Who talks about wind and what do they say?" After a few minutes of questioning lead students to the definition that wind is the horizontal movement of air, it is a current of air that moves along or parallel to the ground, moving from an area of high pressure to an area of low pressure. Surface wind is measured by anemometers or its effect on objects, such as trees. Take this opportunity to discuss careers within wind and weather such as meteorologists, and climatologists.

4. Leaving the word "wind" on the board with the definition, now ask students how you can measure something you cannot see? Collect responses on the board. Ask students, "How do we measure wind?". Lead students to explain how wind is reported on their local news or in the newspaper. Wind is measured by speed and direction.

5. Show students the weather report from the daily paper or the National Weather Service via the internet. Sailors should always check the weather before spending a day on the water. A good rule of thumb for new sailors is to stay on the docks if the wind is 20mph or over.

6. Take the daily weather report of X mph at X direction and write it on the board.

7. Ask students what the unit of measure is in wind speed. They should identify mph as miles per hour. In the United States we use mph as our standard in wind speed.

Part II: Identify Wind Clues

Outdoor Classroom -10 minutes

1. Take students to the docks or beach area to look at boats and sailing location. Ask students to identify the source of power on the safety boat. Ask students to identify the source of power on a sailboat (wind). Take a look at boats on a mooring. Are they all facing the same direction? Why?

2. While standing on the dock or the beach ask students to look for clues about wind. We can't see wind, but we can see the results of wind. Have students identify clues about wind. Can they feel it on their faces? Is it strong or weak? Lead students to identify wind on the water, the blowing of leaves, the movement of trees, flags, halyards, or the result of wind on other boats on the water. Show students the body of water they will be sailing on and discuss the typical wind patterns during their sailing time.

3. Tell students, "Since we can't see wind, we need to use clues about wind to help power our boats." Take 5 minutes and ask students to make observations about the wind silently, then share them with the group. If students are struggling lead them by asking students if the wind is always moving at the same speed, or if it changes.

4. Have students make predictions about the current wind speed and direction and how it will or would affect sailing today. (High winds will make the boats go fast.) 5. Return to classroom to review: Wind is the horizontal movement of air; it is measured in speed and direction. The standard unit of measurement is miles per hour. Now, how can we make an instrument to measure wind speed? Have students design their own instrument on paper.

Part III: Making A Wind Anemometer

Outdoor Classroom -45 minutes

1. Mark one of the cups with a black permanent marker; this will be the marker when counting spins (revolutions per minute).

2. Arrange 4 paper dixie cups and two drinking straws to form a cross.

Note: Educators have two options. The first option is a quick option, show students a preassembled anemometer. The second option Is to provide students with the materials and ask them to build and test their own. It time allows, option 2 has a lasting result and involves engineering, design, and problem solving.

3. Tape the strews to the top of Dixie cups. The top, end of all cups should face the same direction. Let the students test the cups at different angles if time permits.

4. Push a straight pin through the center of the straws into en eraser on the end of a pencil to provide an axel. This instrument is called an anemometer, it is used to measure wind speed. The more spins pm minute, the greater the wind velocity (speed). Once the students 'lave completed construction of the anemometer they should test it with a fan.

5. While holding the anemometer in from of an electric fan on low, count how many times the marker cop (with the black line) goes by. This is the number of spins or revolutions per minute (10 revolutions per minute is approximately 1 mile per hour). Note: Average = (Trial 1 + Trial 2 + Trial 3 + Trial 4)/4.

Trial #	Number of rpm (spin per minute)
1	
2	
3	
4	
Average	

Have students compare their data collected on average spins (revolutions) per minute from the fan on low with each other. They can record their data on the student data collection sheet. Students can then find the class average (sum divided by amount of values, median (middle number), and mode (most often used number).

Student Name	Average rpm with fan on low
Student 1	
Student 2	

Part IV: Measuring Wind in Multiple Locations

Outdoor Classroom - 60 - 120 minutes

Note: This activity can be done on the water while sailing or on land. For seasoned sailors, have them place the boat in safety position before taking a reading. For first time sailors, have the coach place the boat in safety position. For students on land or on the safety boat have students go to various locations. As a challenge, have students take readings during puffs and lulls in different locations on and off the water so they begin to know the winds at their sailing location better.

1. Divide class into groups of three. Each group will have a timer, record keeper, and a holder. The timer will run the stop watch for I minute and say "Go" to start the counting and "Stop" to end the counting. The counter will count how many revolutions (spins) by counting the number of times the black marker cup passes by. The holder will hold the anemometer so the wind is unobstructed.

2. Identify four locations to collect wind speed. They can be on or off the water. Students should take three readings at each location. Make sure groups go to different locations, you can show them on a map or chart, suggest protected vs. unprotected areas. Have students identify the locations through a discussion. 3. Before students head out to collect wind speed data, have them make predictions about the locations that will have higher wind speeds compared to those with lower wind speeds. Have them explain why (their reasoning) they made such predictions. Students should average the three readings at each location and record the groups average wind speed at each location on the class data sheet.

4. Once all the groups have compiled and calculated the average wind speed at each location gather the students to draw conclusions about their data. Ask students if their predictions were correct. Have them explore why wind speeds vary between the locations and what may have caused a difference in the readings. Students can analyse the class data on the Class Data Sheet.

Part V: Beaufort Wind Scale

Classroom - 45 minutes

1. Introduce students to the Beaufort Wind Scale. Have students read Student Sheet 3 on the Beaufort Wind Scale silently, or read it to them aloud. Explain that this is the find standard on wind speed. Explain that it was developed by sailors.

2. Ask students to name a few standards of measurement - inches, miles, feet, meters, pounds. Ask students why we have standards. Discuss how standards are used to create a common understanding in measurement. Lead students to make the connection the Beaufort Wind Scale was the first standard in measuring wind.

3. Review the description of each force and have student visualize the effects of wind.

4. Have each group of students act as meteorologists and create a weather report for a particular location using the terms from the Beaufort Wind Scale. Once they are finished they can give their weather report to the class. This can be completed by accessing buoy data from NOAA's nbdb.org or they can look up weather reports from different cities. They can select a buoy, and record current wind speed data all over the world. Students can collect data using Student Sheet.

Wind Speed Data Collection

Student Name: _____ Date: _____

Student Anemometer Reading with Fan on High

Trial #	Number of rpm (spin per minute)
1	
2	
3	
4	
Average	

Local Wind Speed Reading

Location	Reading 1	Reading 2	Reading 3	Average Reading (Reading 1 + Reading 2 + Reading 3)/3
Location 1 _____	_____ RPM	_____ RPM	_____ RPM	_____ RPM
Location 2 _____	_____ RPM	_____ RPM	_____ RPM	_____ RPM
Location 3 _____	_____ RPM	_____ RPM	_____ RPM	_____ RPM
Location 4 _____	_____ RPM	_____ RPM	_____ RPM	_____ RPM

Module 1: Student Sheet 2

Group Wind Speed Data Analysis

Student Name: _____ Date: _____

List each group's average wind speed at each location

Local Wind Speed Readings

Group	Location 1	Location 2	Location 3	Location 4
Average Wind Speed at each location				

1. Which location had the highest wind speed?

2. Which location had the lowest wind speed?

3. List three factors that affect wind speed.

   a.

   b.

   c.

4. List three indicators of wind

   a.

   b.

   c.

Student Wind Report

Student Name: _____ Date: _____

Beaufort Wind Scale

Wind speed is measured by using a scale of 0-12 based on visual clues originally developed in 1806 by Sir Francis Beaufort. He developed a rating system to make accurate recordings of wind speed. This system was developed for sailors, but has since been modified by the National Weather Service for use on land.

History of the Beaufort Wind Scale

According to the National Weather Service, The Beaufort Wind Force Scale was developed by Rear Admiral, Sir Francis Beaufort, who was born in Ireland in 1774. Beaufort is said to have had an illustrious career on the seas and by 1800 had risen to the rank of Commander. In the summer of 1805, Commander Beaufort was appointed to the command of the Woolwich, a 44-gun man-of-war. It was at this time that he devised his wind force scale. By 1838, the Beaufort Wind Force Scale was made mandatory for log entries in all ships of the Royal Navy. Although be describes them in terms that may be vague to a modem sailor, his descriptions would certainly convey the full meaning of the force of the wind to men who shared years of sailing in ships with characteristics similar to the Woolwich.

The effect of the wind on an 18th-century fighting ship is at the heart of Beaufort's scale. Note that Beaufort intends that you look at the ship, not at the wind! The scale was devised for a group of men who shared the same experience — years of unremitting blockade of Europe in sailing ships, which were all quite similar in characteristics. His descriptions are in terms of the ship's characteristics under sail. The descriptions for Beaufort numbers 0 through 4 describe the wind in terms of the speed that it may propel the ship; those for 5 through 9 in terms of her mission and her sail carrying ability; and those for 10 through 12 in terms of her survival.

Directions

According to Beaufort's Wind Scale on Student Sheet 4, give a weather report for your location. Use the back of this worksheet. Make sure to mention wind speed, direction and use the term from the National Weather Service.

Module 1: Student Sheet 4

Beaufort Wind Scale

Student Name: _____ Date: _____

Beaufort Force	Wind Speed (MPH)	Sea Indicators	WMO Classification
0	0-1	Sea surface smooth and mirror-like	Calm
1	1-3	Scaly ripples, no loam crests	Light Air
2	4	Small wavelets, crests glassy, no breaking	Light Breeze
3	8-12	Large wavelets, crests begin to break, scattered whitecaps	Gentle Breeze
4	13-18	Small waves 1-4 ft. becoming longer, numerous whitecaps	Moderate Breeze
5	19-24	Moderate waves 0-8 ft. taking longer torn, many whitecaps, some spray	Fresh Breeze
6	25-31	Larger waves 8-13 ft. whitecaps common, more spray	Strong Breeze
7	32-38	See heaps up, waves 13-19 ft., white foam streaks off breakers	Near Gale
8	30-48	Moderately high (18-25 ft.) waves of greater length, edges of crests begin to break into spindrift, foam blown in streaks	Gale
9	47-54	High waves (23-32 ft.), sea begins to roll, dense streaks of foam, spray may reduce visibility	Strong Gale
10	55-63	Very high waves (29-41 ft.) with overhanging crests, sea white with densely blown foam, heavy rolling, lowered visibility	Storm
11	64-72	Exceptionally high (37-52 ft.) waves, foam patches cover sea, visibility more reduced	Violent Storm
12	73 or more	Air filled with foam, waves over 95 ft., sea completely white with driving spray, visibility greatly reduced	Hurricane

Module 1: Student Sheet 5

Charting Wind Speed and Direction

Student Name: _____ Date: _____

Select a buoy using NOAA's National Buoy Dam Centre at wsvw.ndbc.noaa.gov. Chart the wind speed and air temperature in the table below for the past 5 complete days. Take note time is based on e 24 hour clock. Click on a buoy. Click on history. Click on real time data. Click on real time standard meteorological data.

Buoy Number and Location: _____

Date	Time	Wind Speed	Air Temperature

Date	Time	Wind Speed	Air Temperature

Date	Time	Wind Speed	Air Temperature

Date	Time	Wind Speed	Air Temperature

Date	Time	Wind Speed	Air Temperature

Notes:

Notes: