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Understanding and Maintaining the Classroom Weather Station

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PREFACE

I have participated in the Yale Teacher's Institute for the past five years. Each year my objective in developing each unit has been two-fold. First, my principal concern was to place as many "hands-on" scientific investigations as possible in the units. Secondly, I wanted to make each unit as self-explanatory as possible for the teachers using it.

This year I plan to create activity cards which the teachers can duplicate for their students to record their data and perform their activities. I feel that if this third dimension is added to our units, more teachers will use them. After all, we pay anywhere from five dollars to fifteen dollars at most teacher book-stores to find appropriate activities to demonstrate our lessons.

This year I participated in the seminar, "Meteorology and Oceanography," and have decided to develop a unit about classroom weather stations. The concept- weather—is a part of our fifth grade science curriculum. By teaching at a science magnet school, I feel that making and using a weather station in the classroom is a great addendum to our science curriculum at Troup Magnet Academy of Sciences. Since the students will get a chance to make most of the instruments used in the weather station, they will receive a thorough understanding of the function of each of the instruments. They will also gain insight on how the data they receive from the instruments help meteorologist in forecasting the weather.

I honestly feel that this is an extremely exciting unit for my students, and hopefully for anyone else who chooses to use it.

INTRODUCTION

The curriculum unit, "Understanding and Maintaining the Classroom Weather Station", is designed to be used with fifth grade students. This unit should ignite students' interest and excitement over a natural phenomenon which occurs daily—the weather. Another feature which makes the unit even more exciting for students is that they construct most of the weather instruments mentioned in this unit. They even get to make the weather station which houses the equipment or instruments!

The word weather is used to denote the state of the atmosphere at a particular place for a short period of time. The variables that constitute the type of weather that we have at a given place and time are made up of the following elements: (1) air temperature; (2) humidity; (3) air pressure; (4) the type and amount of precipitation; and (5) the direction and speed of the wind. All of the instruments which meteorologist use to measure each of the previously mentioned variables will be discussed in detail later within this unit.

Upon completion of this unit, and the reinforcement activities included throughout the prose, the student should be able to accomplish the following cognitive objectives:

(A)Maintain a weather station throughout the course of this unit.
(B)Maintain a weather journal including data from their weather station and other weather conditions.
(C)Construct the following weather instruments, and state the importance of each in forecasting weather: (1) wind vane; (2) anemometer; (3) barometer; (4) psychrometer; and (5) rain gauge.

THE CLASSROOM WEATHER STATION

The classroom weather station will be the focal point of the unit. The station which your students will design will not be as sophisticated as the National Weather Service, but a wealth of knowledge and information can be obtained from the one your students design in your classroom. An excellent closure to this unit, or motivational aspect, would be to plan a field trip to a local weather station. Your students will discover that even though the weather station's instruments are much more sophisticated and technologically advanced than their models, both sets of instruments produce or obtain the same weather data. In order to set up the weather station in your classroom, you will have to construct instruments to measure the wind, air pressure, relative humidity, and precipitation. Background information and instructions for designing each of these instruments needed for your weather station can be found in the prose, and Appendices 1 through 6 at the conclusion of this unit.

Some of the instruments, such as the rain gauge anemometer and wind vane, have to be placed outside in the open, free from any objects that can obstruct windflow or precipitation. The barometer, an instrument which measures air pressure, can be housed in the classroom. The thermometer will require a special holding station to protect it from precipitation and direct sunlight. However, air must be able to pass through it. Instructional information can be found in the Appendix at the end of this unit.

It is extremely important that the students record the data from their weather station in their journals each day. They should also write a brief description of the weather conditions each day. The worksheet in Appendix 1 can be used by the students to record their data, or they can design their own individualized data sheets.

INSTRUMENTS USED TO MEASURE WIND

Wind is defined as the movement of air, especially a natural horizontal movement. Meteorologist are interested in measuring four properties of wind: (1) the direction in which the wind is blowing; (2) the speed of the wind; (3) wind gust; and (4) any wind shifts that may occur.

Wind direction refers to the direction in which the wind is blowing. Meteorologist usually record wind direction according to its cardinal direction, or compass points—East, West, Southeast, etc . . . The students can take this exercise one step further by stating the degree at which the wind is blowing. For example, they can record the wind direction as 180 degrees South, or 230 degrees Southwest, etc . . .

Wind speed is recorded according to the rate of motion of the air in relationship to a specific unit of time. Therefore wind speed is recorded in knots (nautical miles per hour). Wind speed can also be measured in miles per hour (mph).

Gusts are rapid fluctuations in wind speed with a variation of 10 knots or more between peaks and lulls. If there is a fluctuation in wind speed between 15 knots and 20 knots, sustained for at least one minute, they are called squalls. If the wind speed fluctuates above 20 knots, they are known as peak gust—the highest wind speed that can be recorded.

Wind shifts are changes in wind direction of 45 degrees or more that occur in less that 15 minutes. Wind shifts of that magnitude are normally an indication that a cold front is passing through. Whenever these types of wind shifts occur meteorologist can confidently forecast that a storm is on its way. Atmospherically, there will be a rapid drop in temperature and dew point, and a rise in air pressures.

The two instruments in which meteorologist depend upon to measure the four properties of wind are: (1) wind vane—an instrument which indicates the direction that the wind is blowing; and (2) Anemometer —an instrument which measures wind speed.

A wind vane is simply a large arrow on a pivotal base that points in the direction which the wind is blowing. The wind vane should be placed in an area free from buildings, trees, or any other objects that don’t allow the wind to blow freely. A set of direction (cardinal) indicators should be placed at some point underneath the arrow, which are directly related to the cardinal compass points. Directions for building a wind vane, along with an illustration, can be found in Appendix 2 at the end of the unit.

An anemometer is an instrument which measures the speed of wind. This instrument must be placed high above the ground and away from anything that can obstruct the flow of air. Even though there are several different types of anemometers, the Robinson Anemometer is the most commonly used because it works well under a great number of conditions. The wind speed is determined by the number of turns of the wheel in a certain length of time.

MEASURING AIR PRESSURE

The gas molecules found in the troposphere constantly move around causing air pressure. Air pressure is the force of air against a unit of area. This movement of air creates a push towards the earth. A great way to explain air pressure to children is by using a balloon as an example. When the air is blown into a balloon it will expand as far as the wall, or as far as the balloon will allow it to go. Air in the troposphere acts exactly like that inside the balloon.

Air pressure is measured with an instrument called a barometer. There are two different types of barometers: a mercury barometer and an aneroid barometer. The mercury barometer consists of a glass tubing closed at one end and filled with mercury at the other end. The open end of the glass tube on the barometer is placed in a container of mercury. At sea level, air pushing down on the mercury in the container supports the column of mercury at a certain height in the tube. As the air pressure decreases, the column of mercury drops.

At sea level and 0 degrees centigrade, air pressure is able to support a column of mercury 760 millimeters high. This value is called standard air pressure and is expressed as an atmosphere. Air pressure can also be measured in millibar. Millibar is most commonly used on weather maps. Standard air pressure, or 760 millimeters of mercury is equal to 1013.20 millibar.

A more common type of barometer is called an aneroid barometer. This is the type of barometer which we will be making for our weather station. An aneroid barometer is made up of an airtight metal box from which most of the air has been removed. A change in air pressure causes the needle to move and indicate the new air pressure. By comparing the daily readings on the calibrated scale, the students will be able to tell if the pressure is rising, falling or remaining steady. It is the changes in air pressure, rather than the level of air pressure, which provide the most meaningful indicator of weather. Pressure changes used in connection with the direction of the wind gives the amateur meteorologist the best key to local weather conditions.

Both the mercury and aneroid barometer are expressed in terms of inches of mercury. I have enclosed directions for making both of the previously mentioned barometers in Appendix 4. Homemade barometers are frowned upon by meteorologist because of the inaccuracy of the equipment. For the purposes of this unit, I suggest using a real barometer (usually expensive) or to listen to the local weather channel to get the barometric readings in your area. Then you can compare both pieces of data with your students.

MEASURING TEMPERATURE

The temperature of the air is measured with a thermometer in units called degrees. These instruments should be housed outdoors in a shelter where it is not exposed to direct sunlight, or precipitation. (See Appendix for directions on how to make the shelter). Thermometers are fairly inexpensive instruments, and I strongly recommend purchasing one for your weather station since you have to make the shelter for the instrument.

Meteorologists use a set of two thermometers to record minimum/maximum readings because it is important for them to obtain the warmest and coldest temperature daily. Realistically, the thermometers are one-way thermometers that have to be reset each day. The minimum thermometer uses alcohol as a liquid, with a small indicator inside the tube. The alcohol retracts and pulls the indicator along with it as the air cools, thus

leaving the indicator at the lowest temperature of the day.

The maximum thermometer uses mercury. Mercury is stored in the “neck down” portion the tube. Mercury is a thicker liquid than alcohol. As the temperature increases, the mercury expands beyond the constriction into the top part of the instrument where it stays in place recording the maximum temperature of the day.

As far as the classroom weather station is concerned, a standard air thermometer can be used. These thermometers break easily and should be handled carefully. Tthey should also be cleaned daily of outside elements such as dust, dirt and moisture so that the most accurate temperatures are recorded. In order to get the minimum and maximum temperature for each day, a student should record the temperature early in the morning and at the end of the school day.

MEASURING RELATIVE HUMIDITY

The amount of moisture in the air is usually stated in terms of relative humidity. This term refers to the percentage of moisture the air holds relative to the amount it can hold at a particular temperature. Relative humidity is measured using a instrument called a psychrometer. A psychrometer is composed of two thermometers—a wet-bulb thermometer and a regular thermometer. The wet-bulb thermometer in actuality is a regular thermometer. However, the bulb of the thermometer is covered with a piece of wet cloth. The other thermometer is called a dry-bulb thermometer. The two thermometers are attached to each other and swung around in the outside air.

When the air blows over the wet-bulb thermometer, the water in the cloth evaporates. Evaporation requires heat energy; therefore, the evaporation of water from the cloth cools the bulb of the thermometer. If the humidity is low, evaporation will occur rapidly and the temperature of the wet-bulb thermometer will fall at a fast pace. If the humidity is high, evaporation will occur at a slower rate causing the wet-bulb thermometer’s temperature to remain high.

In order to determine the relative humidity you must first find the difference between the dry-bulb temperature and the wet-bulb temperature. The differences between the two temperatures are calculated by using a table made by and available from the National Weather Service in Washington, D.C. From this information it is also possible to tell at just what temperature the dew point will be reached under all conditions of relative humidity.

MEASURING RAINFALL

The instrument used for measuring the among of rainfall is called a rain gauge. The rain gauge consists of a cylinder with a funnel placed on top of it. A ruler is attached to the cylinder so that the amount of rain that falls into the rain gauge can be measured.

The rain falls into the funnel at the same rate in which it falls upon the ground. The rain is then measured with a ruler. The amount of rain which was measured in the cylinder is equivalent to the amount of rainfall that fell if the rain would have remained in one place. The amount of rain collected in the rain gauge over a given

period is expressed in millimeters or centimeters. The weather observers in the United States express the amount of rain that has fallen in inches.

Activity Sheets

(figure available in print form)

TEACHER'S BIBLIOGRAPHY

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