How Low Can You Go?

Summary

Students will learn about measuring temperatures.

Materials

For each group:

- 6 ice cubes
- Set of three 9-oz. clear plastic cups (labeled A, B, and C)
- Celsius thermometer
- 100-ml beaker
- 15 ml of table salt
- Basin for flood control (optional)
- Colored pencils
- Stirring stick (small straw)

For the class:

- 2 liters of ice water
- 2 liters of hot water (40-50 C)
- 4 liters of room temperature water
- Bucket or access to a dump sink
- *Cold Water Graph*

Additional Resources

Books

- *FOSS Measurement*, by Lawrence Hall of Science, UCB, (available at http://www.deltaeducation.com/fossgallery.aspx?subID=&menuID=2); Item #WX542-2005, ISBN 0-87504-766-1
- *Measure Up! Experiments, Puzzles, And Games Exploring Measurement*, by Sandra Markle; ISBN 0-689-31904-5
- *Temperature*, by Rebecca Olien; ISBN 0-7368-2619-X
- *Thermometers*, by Adele Richardson; ISBN 0-7368-2519-3

Background for Teachers

The tool that measures temperature is the thermometer. The scale used by most scientists is the Celsius scale, named after Anders Celsius. He developed the scale where zero degrees is the point at which water turns to ice, and one hundred degrees is the point at which water boils. This unit of temperature is known as *degrees Celsius* (C). The thermometer you will use is glass with a narrow tube of red-colored alcohol. The liquid alcohol *expands* as it gets hot and *contracts* as heat is lost. Alcohol is a suitable liquid for student thermometers because it will not freeze until it is well below the freezing point of water. To use a thermometer, place the bulb of the thermometer in the liquid to be measured. If you are measuring the temperature of the air, hold the thermometer so that the bulb is not touching any surface. After a few seconds (for liquids) or minutes (for the air), read the temperature by looking to see to which marked line the top of the column of red alcohol has reached.

Intended Learning Outcomes

4. Communicate mathematically.

5. Make mathematical connections.
6. Represent mathematical situations.

Instructional Procedures

Invitation to Learn

Just prior to the activity, put out a set of three labeled cups (A, B, and C) for each group. Pour 100 ml of room-temperature water into all of the A and C cups. Pour 100 ml of ice-cold water into the B cups. You may want to place each set of cups in a basin for flood control.

Ask students to share what they think when you say the word *hot* or the word *cold*. Where in the world is it generally hot? Where is it generally cold? How can you tell if something is hot or cold?

Point out the cups of water you have prepared. The students' task is to use their fingers to determine any differences in temperatures between the three cups. Tell them that each group will work together to put the cups in order from warmest to coldest.

Each person will have one turn only and will use only one finger. The finger will be put into each cup in order, first into cup A, into cup B, and then into cup C.

When everyone is finished, they are to collaborate, arrange the cups in order from warmest to coldest, and be ready to report out loud the three letters in the order they have decided.

Not all groups may agree on the order. Whether or not they do, have the groups repeat the procedure with a new finger. They should return the cups to the original order A, B, C. This time have students test in reverse order, placing their finger first into cup C, into cup B, and then into cup A.

Discuss the results, highlighting any discrepancies between the results of the first and second tests.

Ask students how they might determine the temperature of the water in each cup with greater accuracy than their fingers.

Instructional Procedures

Part I

Introduce the thermometer as a way of measuring temperature. Explain that the standard unit for measuring temperature in the metric system is the degree Celsius (C). Hold up a thermometer and explain how it works and how they are to use it (see Background Information).

Distribute the thermometers and have the students carefully measure the temperature of the water in each of the three labeled cups from the Invitation to Learn. Have students record the three temperatures in their journal. They may be surprised to discover that the temperatures of cups A and C are the same. Discuss why they seemed to be different temperatures when they tested using their fingers.

Have students dispose of the water in cups A and C, but retain the cold water in cup B. Place 100 ml of hot water in cup A. Have students measure the temperatures of the water in each of the two cups. Have them record the temperatures in their journal, identifying cup A as "hot water" and cup B as "cold water." Invite students to estimate what the temperature of the water will be if they mix equal amounts of the hot and cold water. Have them write their estimate in their journal, identifying cup C as "mixture of hot and cold water." Have them then mix the two cups into cup C. Instruct them to gently stir the water with the thermometer and then measure the temperature of the mixed water. Students record the actual temperature in their journals next to their estimate. Invite students to explain why the temperature of the mixture was between the hot and cold temperatures.

Students create a vertical number line in their journals that shows 0 C at the bottom and 50 C at the top, then plot their recorded temperatures on to the number line labeling each as "hot water," "cold water," and "mixed hot and cold water." Next, measure the temperature of the air and have them record that temperature on their number line.

Optional: Invite one student in each group to measure their body temperature by placing the bulb of the thermometer under his/her tongue and holding it there, mouth closed, for one minute. Have a partner read the thermometer while it is still in place. Students record “body temperature” on their number line (approximately 37 C). After students have placed thermometers in their mouths, wash the thermometers in a mild bleach solution and then rinse with clear water.

Part II

Provide each group with a 9-oz. clear plastic cup, a thermometer, a stir stick (short straw), and a 100-ml beaker. You may want to place these items in a basin for flood control. Conduct an investigation to find out how cold room-temperature water will become in ten minutes with two ice cubes.

Students measure 100 ml of room temperature water into the clear cup, then create a two-column data table in their journal, one labeled “minutes” and the other labeled “temperature.” Each column should have eleven rows. Number the minutes column zero through ten.

Students measure the starting temperature of the water and record it in the temperature column in the zero-minutes row of the data table in their journal.

Deliver two ice cubes to the empty beaker of each group.

Tell the students when the teacher says “go,” they should carefully add the ice cubes to the cup of water and slowly stir the water with the straw. Have them measure and record the temperature each time a minute is called out. Continue for ten minutes.

After the ten-minute investigation is concluded, distribute a copy of the *Cold Water Graph* to each student.

Guide students to complete the graph. Instruct students to select a colored pencil for marking the graph.

Make sure they plot each point where the temperature and minute lines intersect, creating a line graph.

During a second session, have students repeat the procedure. However, during the second investigation students will not stir the ice in the water.

Students create a second data table in their journals.

When they plot the line graph on the *Cold Water Graph*, have them select a different colored pencil so that the second line will be different from the first line.

During a third session, have students repeat the procedure, this time stirring the ice in the water.

Before beginning, have students add 15 ml of salt to the water.

They should stir the salt into the water until it dissolves, then begin timing.

When they plot the third line graph on the *Cold Water Graph*, have them select a *different* colored pencil so that the third line will be different from the first two graphed lines.

Discuss the varied results of the three investigations. Help students connect variables in the procedure to the results achieved.

Extensions

Students research the origins of the Fahrenheit and Celsius systems. Compare the freezing and boiling points of both systems.

Use the Internet to monitor the daily temperature of two different locations for five consecutive days. Students develop a strategy to compute the average temperature at each location and compare the two.

Practice taking temperatures. Make a list of locations and/or materials. Estimate what the temperatures at these locations or of these materials might be, then use a thermometer to measure the actual temperatures.

Family Connections

Students use the newspaper or television weather report to record the highs and lows where they live for a week. Create a line graph showing the changes during the week. Draw two lines on the same graph, one for the high temperatures and one for the low temperatures.
Students use a thermometer to record temperatures in various locations in their home. Record findings on a data table.
Students place a thermometer in their refrigerator for approximately ten minutes. With a timer that tracks minutes, and a paper to record temperatures, remove the thermometer from the refrigerator and begin recording the temperature every ten seconds for one and a half minutes. Create a line graph showing the change in temperature over time.

Assessment Plan

Provide a list of locations and objects such as in a refrigerator or the temperature of freshly prepared hot chocolate. Next to each, identify two significantly different temperatures in degrees Celsius. Have students select the more reasonable temperature and explain why they made their selection.
Provide a data table of collected temperature changes over time. Have students correctly plot a line graph on a provided graph form.
Move about the class with two cups of water of different temperatures. Invite individual students to estimate the temperatures of each cup, then correctly use a thermometer to accurately measure the temperatures.

Bibliography

Research Basis

Moscovici, H. (1999). *Shifting from Activitymania to Inquiry Science—What Do We Need to Do?* This paper concentrates on what science educators can do to support the shift toward inquiry science in the elementary classroom. Inquiry is discussed as a central part of the methods courses.

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