ExplorA-Pond: 5th Grade Surface Area

Summary

Students estimate the surface area of a pond using ratios and chance methods of estimation.

Time Frame

1 class periods of 45 minutes each

Group Size

Small Groups

Materials

Hole punch; Blank sheet of paper; Blindfold or paper sack; Graph paper; Markers; Map, aerial photo, or drawing of a pond photocopied onto grid paper. If you are using the virtual pond print out the virtual pond.;

Background for Teachers

In this activity students estimate the surface area of a pond using ratios. Along the way students will gain insight into how well estimations based on chance outcomes match the average of a maximum area estimation and a minimum area estimation.
When the students estimate the surface area using chance methods, the students will 'randomly' drop small paper circles (created by a hole punch) onto the map and then count the number of paper circles that land on pond water. The ratio of pond water hitting circles to the total number of circles dropped is used to estimate the total number of pond water squares on the map.
Next the students calculate an average of a maximum estimation and a minimum estimation. Students count the number of grid squares on the map that contain 'some' pond water. This is their maximum estimate. Then the students count the number of grid squares on the map that contain 'only' pond water. This is their minimum estimate. The average of the two values is then compared with the estimate resulting from the use of chance methods. Chance methods are often referred to as 'Monte Carlo' methods in mathematical discussion groups.

Intended Learning Outcomes

Students will explore the role of chance in estimating the surface area. Students will understand and apply ratios, proportions, and percents in a real world setting.

Instructional Procedures

Divide the students into groups of at least three members. Explain that the groups will estimate the pond's surface area using two different processes and then, at the end, create a graph comparing the two estimates of pond area.
Using the Chance Method of Estimation -
One group member creates ten paper circles out of a blank piece of paper using a hole punch. The circles need not be perfect circles, but they should be about equal in size. A second member of the group is blindfolded and then drops ten paper circles onto a map of the pond. If some circles do not land on the map of the pond, they must be dropped again until ten paper circles fall upon the map of the pond.
Chance Estimation Method Continued -
The group now counts the number of paper circles that landed on grid squares containing pond water (light blue in the map of the virtual pond). Have another member of the group wear the blindfold and

drop the ten squares. Record the number of paper circles that land on grid squares containing pond water (light blue in the map of the virtual pond).

Chance Estimation Method Continued -

The group should now take the number of paper circles, dropped by person 1, that touched the pond water (E.G. 3) and divide by the number of paper circles dropped (E.G. 10). This will yield a ratio (E.G. 3 to 10). Use this ratio to estimate how many squares on the map contain pond water (.3 *200 total squares yields 60 squares). Repeat the process for person 2 (E.G. if 4 out of 10 strike pond water squares then .4 * 200 = 80). Average the two results and record this number as the estimate for the surface area of the pond using the chance method (E.G. 60 squares from person 1 + 80 squares from person 2 divided by 2 yields an average of 70 pond water squares).

Averaging Maximum and Minimum Estimations -

Have the group examine the map carefully and count the number of grid squares containing 'some' pond water (on the virtual pond map there is a row that contains the label 'LEVEL'. On this row there would be three squares that contain 'some' water and only 1 square that contains 'only' pond water. Determining which squares contain 'some' pond water is a difficult task. Expect variations in student results - students should count approximately 110 squares that contain 'some' pond water). Encourage the students to look for pond water squares that form a rectangle. Multiplying the length (in square grids) and the width (in square grids) of the rectangle may be faster than counting the individual grid squares.)

Averaging Maximum and Minimum Estimations Continued -

Have the group look carefully at the map of the pond and count the number of squares that contain ONLY pond water (on the map of the virtual pond there are about 67 such squares).

Averaging Maximum and Minimum Estimates Continued -

Have the group average their two counts (E.G. (110+67)/2 yields 88.5) and use that average as their estimate of the surface area under the second method. The group will need this number for the graphing activity that follows.

Comparing the Two Estimates of Surface Area -

Assign each group to create a bar graph comparing the two estimates of surface area (Chance method vs. Average Maximum & Minimum).

Assign a short report that both compares the two results and discusses the factors which affected the results under each method.

Extensions

At the fifth grade level your students may be ready to turn their estimation of the surface area using grid squares into a measurement using standard units. Check the scale on your map of the pond (if you are using a map of the virtual pond each grid square is approximately 0.5 cm by 0.5cm). Assign the students to calculate the area of the grid square in standard units. Then multiply by the number of 'pond water' grid squares to obtain an estimate of the surface area in standard units. In Fifth grade, some students may be interested in which state is the largest state. Here you could have some fun using a standard map of Alaska vs. Texas. What bias does the usual projection introduce and why would the chance method not be a good means of determing which of the two states is the largest? (Answer: The normal maps do not use the same scale for Texas and Alaska. Alaska is generally inserted into the map at a scale calculated to help it best 'fit' on the page. Using a map that shows the entire North American contintent can also be dangerous if the projection stretches countries near the north pole to make them 'better fit' on the page.

Assessment Plan

Students will successfully complete a compare/contrast graphic organizer to show the two results and the factors which affected the results under each method.

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