Broken Rulers: Teaching Notes

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GRADE RANGE: 1–3

MATHEMATICAL TOPICS: Measuring length, representing length as a collection of sublengths

MATERIALS (for each group of students): A section of a broken ruler with 4 cm to 9 cm units of length remaining (possibly cut out from the Activity Sheet), 30 cm of string, an unbroken ruler, one rectangular piece of cardboard approximately 5 cm by 7 cm, one of the quadrilateral shapes (labeled A, B, C, or D) from Shape Cutouts

Discussion of the Mathematics

This activity emphasizes the essential unit structure embedded in rulers. As students grapple with the problem of using a broken ruler, with the first 2 or 3 cm and the last few centimeters of the ruler broken away, students must make sense of the marks and number labels. They will gradually focus on the spaces between the hash marks (or between the number labels) rather than simply reporting the number label next to the end of an object. Eventually children describe length as the total number of unit segments needed to match the length of an object.

The rectangle on the Activity Sheet has a perimeter of 30 cm, with length 9 cm and width 6 cm. The quadrilaterals on Shape Cutouts have perimeters as follows: A is 15 cm, B is 12 cm, C is 27 cm, D is 24 cm.

Implementation

Begin by asking the students to predict whether they can measure the perimeter of a shape using only a section of a broken ruler. Next, give each group of students a cardboard rectangle (measuring approximately 5 cm by 7 cm) and a broken ruler section. Ask them to find the lengths of the sides and the perimeter. Have them make a drawing of the cardboard shape and label the length, width, and perimeter. Look for different ways of measuring and ask students to explain how they are finding the length of each side.

Then distribute the Activity Sheet to each group of students. Ask students to measure the length of string needed to wrap exactly around the shape and then to use the broken ruler to find the length of each side and calculate the sum of these lengths to find the perimeter. Have each group report whether the sum of the four sides is the same as the string perimeter. Finally, give each group a quadrilateral shape from Shape Cutouts and ask students to measure its perimeter using the broken ruler section. Each student should make a drawing of the quadrilateral and label its sides and the perimeter.

If students are struggling to measure accurately with the broken ruler, ask them to use the unbroken (standard) ruler instead. Ask students to explain how they

are measuring each side; for example, counting centimeter segments along the ruler. Ask students if they can explain how the unbroken ruler can be used so they don't have to count; for example, report the number at the end of the last segment. Help them see that the ruler is like a rigid collection of 1-cm pieces that are lined up in a row for easy counting.

Questions to Ask Students

- What do the numbers on a ruler mean? Show me the centimeters along a ruler. Can I simply count the hash marks?

- Discuss the idea of repeating a 1-cm piece to measure along an object. Would it be efficient? Would it work as well as using a section of a broken ruler, or a standard ruler?

- How does a ruler help us to compare objects for their length? Are you comparing the object you are measuring to something else?

Students' Typical Responses

Some students will merely guess at a length or perimeter. Others will read the number label nearest the end of the object being measured, even though the broken ruler does not start at zero. Some students will count the number labels, beginning with the location corresponding to zero; but they will count it as the first unit, so they overstate the length by 1 unit. Some students in grade 1 may (correctly) count the spaces between the hash marks or the number labels and report the length accurately; even more students in grades 2 and 3 will do this.

Although students may succeed in reporting the length of a segmented object by counting spaces, they may struggle when asked to measure an unsegmented object given only a short unit object like a paper clip. By prompting students to attend to the spaces along a ruler as unit parts of a whole length, the broken-ruler activity can help students associate the iteration of a unit along an object to their use of rulers.
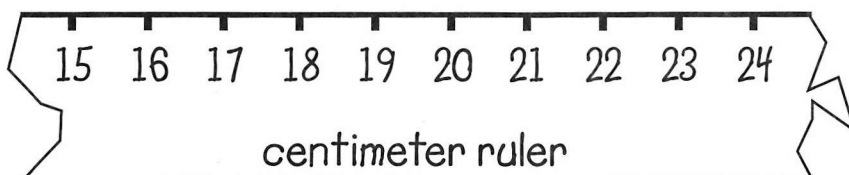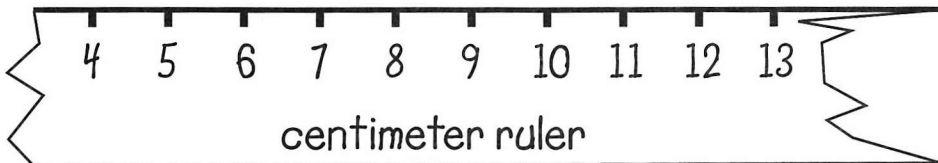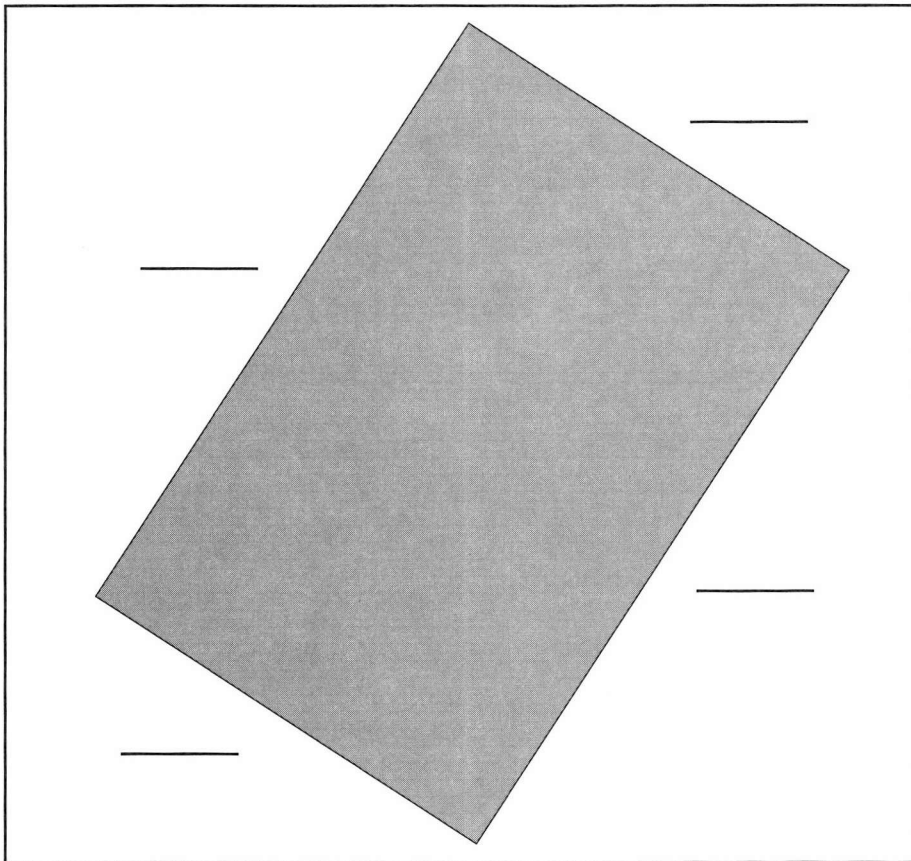
CREDIT

Note: This activity accompanies "Understanding Children's Developing Strategies and Concepts for Length," by Jeffrey E. Barrett, Graham Jones, Carol Thornton, and Sandra Dickson, published in the 2003 NCTM Yearbook, *Learning and Teaching Measurement*. Please refer to this article for more background on children's understanding of length.

Name _____ Date _____

Broken Rulers: Activity Sheet

Use a broken ruler, or cut out one of the ruler pieces below, to measure around the rectangle. Write down the length of each side.

How far is it around the whole shape? _____

4 5 6 7 8 9 10 11 12 13
centimeter ruler

15 16 17 18 19 20 21 22 23 24
centimeter ruler

Broken Rulers: Shape Cutouts