Scaffolding Task: Meters of Beads

STANDARDS FOR MATHEMATICAL CONTENT

MCC4.NF.5 Express a fraction with denominator 10 as an equivalent fraction with denominator 100, and use this technique to add two fractions with respective denominators 10 and 100. *For example, express 3/10 as 30/100, and add 3/10 + 4/100 = 34/100*[1].

MCC4.NF.6 Use decimal notation for fractions with denominators 10 or 100. *For example, rewrite 0.62 as 62/100; describe a length as 0.62 meters; locate 0.62 on a number line diagram.*

MCC4.NF.7 Compare two decimals to hundredths by reasoning about their size. Recognize that comparisons are valid only when the two decimals refer to the same whole. Record the results of the comparisons with the symbols >, =, or <, and justify the conclusions, e.g. by using a visual model.

STANDARDS FOR MATHEMATICAL PRACTICE

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make sure of structure.
8. Look for and express regularity in repeated reasoning.

BACKGROUND KNOWLEDGE

The meter stick is a length model of decimals that is a familiar context for the use of decimals. This lesson provides students a visual model for seeing the centimeters within a meter as decimals of a whole meter, as well as seeing each decimeter as a tenth of the meter stick.

ESSENTIAL QUESTIONS

- What models can be used to represent decimals?
- What are the benefits and drawbacks of each of these models?

MATERIALS

- 100 beads of 2 different colors per partner pair (or 100 paper cm squares of different colors to be taped together)
- Approximately 1.5 meters of yarn per partner pair
- Meter sticks

- Adding tape or a strip of paper approximately a meter long

GROUPING

Individual or partner

TASK DESCRIPTION, DEVELOPMENT AND DISCUSSION

Comments

Prepare a sandwich bag of 100 beads for each group, 50 of two different colors. Try to find beads that are slightly less than 1 cm in diameter so that 100 beads fit well along the edge of a meter stick. If beads are larger than 1 cm, students will have to offset each bead slightly to fit 100 pieces along the meter. As this may cause confusion, it is best to find beads that are an appropriate size. (If beads are not available, unit squares copied on different colored pieces of papers could be used and taped together rather than strung together.)

Also prepare for each group a paper strip cut slightly longer than 100 cm. Provide one mark on the paper strip 2–3 cm from one end for students to label as 0. Adding machine tape works well for the strips.

Task:

Show students a meter stick and review the number of centimeters in a meter stick. Discuss how each centimeter can be expressed as a decimal of the whole meter stick. (1 cm = 0.01 m)

Organize students into groups of 2 or 3. Don't tell them how many beads are in each bag. Let them estimate and discuss individual estimates.

Next, have groups place their 100 beads randomly along a meter stick, one bead per hundredth. Ask, "Can you easily tell what decimal of the beads are red? green? Why or why not? What would help you to determine the decimals?"

Guide students to understand that grouping the bead pieces by color along the meter stick does not change the decimal of each bead color, but it does provide a clearer visual representation of the decimal of each color.

For the moment, ask students to return their beads to the sandwich bag; the beads will be used again later in the lesson.

Part 1: Linear Model- The Meter

Have each group make a linear representation of their collection of 100 beads. First, they should label 0 on their strip, at the mark you made previously. Then, have students lay their paper along a meter stick, lining up the 0 on the paper strip with the 0 cm mark on the stick. Ideally, they should place a pencil mark at each centimeter from 0–100. However, the paper

meters become too messy if every centimeter is labeled with a numeral. Introduce *decimeter* as you have students count and label by 10s from 0–100 cm. (Discussion about a centimeter representing 1/100 of a meter and a decimeter representing 1/10 of a meter would happen at this time!)

Next, ask students to make piles of their bead pieces by color. Ask students:

- How easily can you estimate the decimal that represents each color if the whole is the meter? [Not very; large groups need actual counting.]
- How can the meter stick help you? [It shows hundredths.]

Reinforce the connection between hundredths (written as fractions and decimals) and percentages. Have students count and record their bead data (colors/numbers) on the A Meter of Beads activity sheet.

Finally, have students place the beads by color along their paper meter strip and color the paper according to the colors of their beads. Students can complete Questions 1–3 on the activity sheet.

Have students share their colored paper meters. Post the meters around the classroom. Emphasize that the meter is a linear model showing decimals. You can verify understanding by having students do a round robin between paper meters and share the decimal values of colors verbally using the terms *hundredth*. Have one member of each group remain by his/her paper strip while other students visit and ask questions. Rotate the students from each group so everyone has a chance to present to classmates (and you can listen in).

Part 2: The Area Model- Grid Paper

Suggest to students that decimals can be shown on a grid. Ask students:

- How many squares should be in the grid? [100]
- Is the number of squares important? [yes]
- What shape should the grid be? [It can vary.]
- Does the grid shape matter? [no]
- Will the decimals stay the same? [yes]

Use the Grids activity sheet, which has grids of 10×10, 4×25, and 5×20. All the grids use the same unit size. You may want to enlarge the activity sheet so students have room to place their beads on the grids prior to coloring. The members of the small groups can do the same grids or different ones. Depending on students' understanding, have them lay out their beads prior to coloring or just color according to their data sheet.

Have students think about and discuss the best ways to group the colors. Let them discuss and decide choices. Students should then color the grids according to the decimals of their bead colors. Once the grids are posted, students can discuss similarities and differences. If a student

randomly colors individual squares, it will be apparent that counting is required to determine the decimals of color. After the grid work, students can complete Questions 4–6 of the Meters of Beads sheet.

Review with students the grids they created, and compare the linear and area representations. Spend time discussing the different rectangular shapes of the area models.

Part 3: The Region Model- Decimal Circles and Hundredths Disks.

Have students brainstorm other figures that could show decimals. Lead the discussion towards the idea of a decimal circle, which is a circular model that can show decimals.

To begin creating their decimal circles, have students connect the ends of their linear meter to form a circle. Students match the 0 cm mark with the 100 cm mark and tape the circle closed. Have students lay their meter strip around the circumference of their poster-board circle. They should mark where each color begins and ends. Then, have students connect these marks to the center of the circle to create each piece of the circle. The pieces become area representations of the decimal of each color of bead. Students should color and then label each sector of the circle with decimals and fractions.

Show students the Hundredths Disk and compare these to their Decimal Circles. Have them discuss which would be more precise to show the decimals of the bead colors. (The hundredths disks because it would show exact values.) Have students create a Hundredths Disk that matches their decimal circles. Students should color and then label each sections of the circle with decimals and fractions.

Part 4: Putting It all Together

To help students contemplate all three models (linear, area, and region), direct them to individually write one true mathematical statement about each model. This can be done in journals or on cardstock (for posting later). Have them review their statements with peers for clarification. Then, as a class, share their statements aloud. This is a great time to highlight statements that are similar even though they are about different types of models because this shows the interconnectedness of the representations. You can also challenge students to count how many unique statements are made throughout the sharing.

Have students write a series of statements comparing the decimals of each color within their bag of beads. This can be done in journals or on cardstock (for posting later). Have them review their statements with peers for clarification. Then, as a class, share their statements aloud. Compare the decimals of each color in different bags and have the students make statements comparing the decimals of each color around the room. For instance, students could compare the decimal of red beads in each bag. Who had the greatest decimal of reds? How can we be sure? Which model shows this clearly?

FORMATIVE ASSESSMENT QUESTIONS

Part 1:

- What strategies did you use to count your beads?
- How did your strategy help you determine the decimals representation of each color of beads?
- How did you know you had accounted for all of the beads?
- What were the benefits of each model you used?
- What were the drawbacks of each model?
- Which model did you prefer and why?
- Which model might be easiest to use when comparing decimals?
- Which would be easier for combining decimals (like adding together 2 colors)?
- Which model showed the link between tenths and hundredths best? Why do you think that?

Part 2:

- What strategies did you use to complete your grids?
- How did you decide the color in your grids? Why did you choose this?
- How did you count the colors of the squares? What strategies did you use?
- What strategy did you use to determine the decimal representation of each color on this grid model?
- Was this model or the linear model easier for you to see the decimals on?

Part 3:

- How did the linear model help you create a decimal circle?
- How can you be sure your model accounts for all the beads?
- How were your decimal circles and hundredths disks the same? Different?
- Which of the two circle representations were easier to "see" the decimals on? Why was that one easier?

Part 4:

- What were the benefits of each model you used?
- What were the drawbacks of each model?
- Which model did you prefer and why?
- Which model might be easiest to use when comparing decimals?
- Which would be easier for combining decimals (like adding together 2 colors)?
- Which model showed the link between tenths and hundredths best? Why do you think that?

DIFFERENTIATION

Extension

- Give students another bag of beads with different numbers of beads in it and have them create another set of the three models using the new number. Have them compare their models with another student and write about the differences shown in their bags on the three types of models.

Intervention

- Allow students to lay the beads on the meter stick, on the grid, and around in a circle as they create each model.

Name _____ Date _____

Meters of Beads

Create a chart or table below to organize the data from your bag of beads.

Part 1: Linear Model – The Meter
Did you have a strategy for placing your beads along the meter? Did you go by color? by number? Explain how you and your partner(s) created your meter strip.

_____

_____

_____

_____

_____

How easy is it to determine the decimal of each color when looking at the meter strip? Explain.

_____

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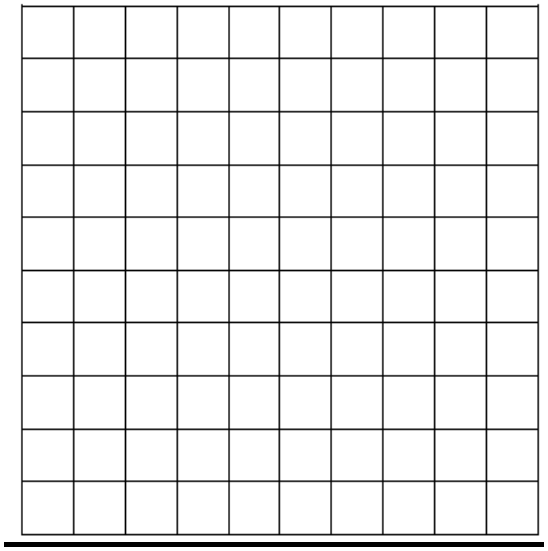
_____

_____

Area Model – The Grid

How could you color a 10×10 grid to calculate the decimals? Explain.

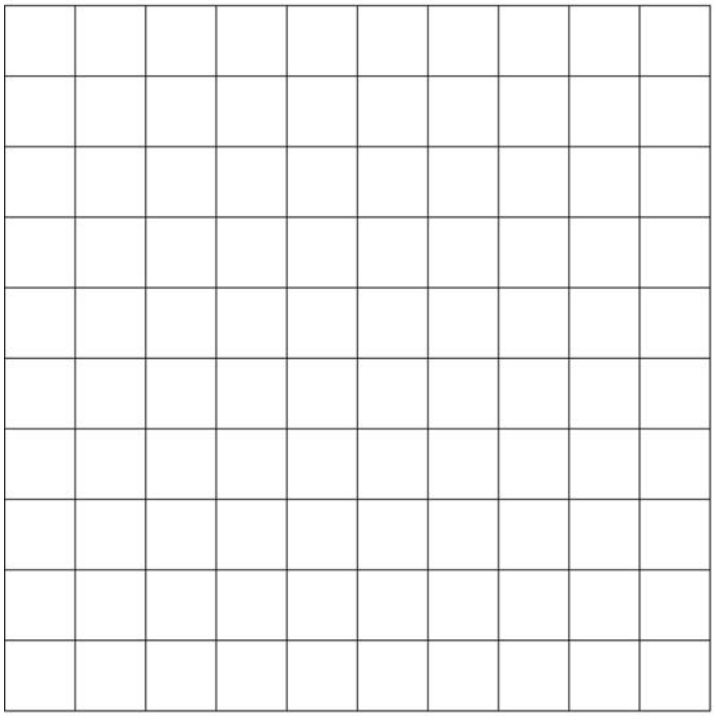
Color the grid according to your bead colors.

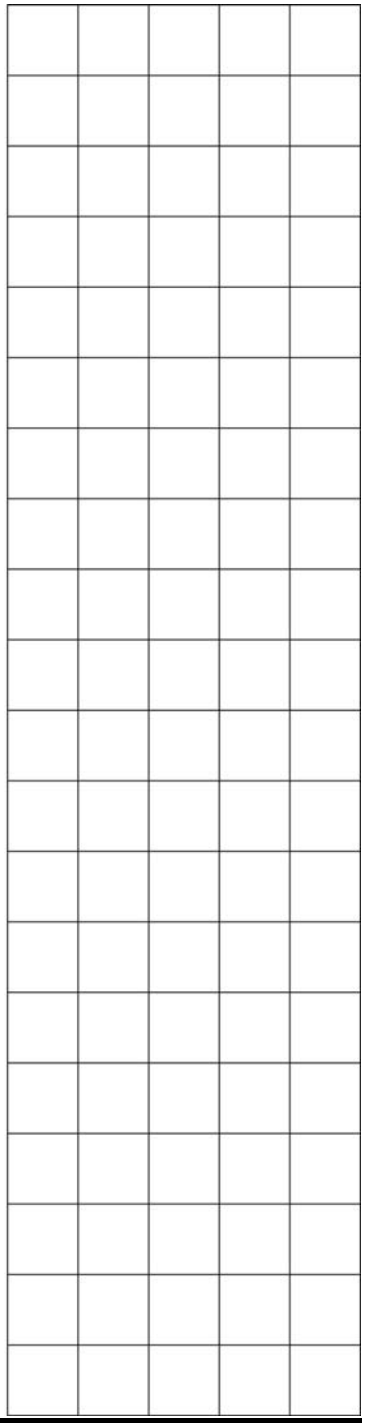


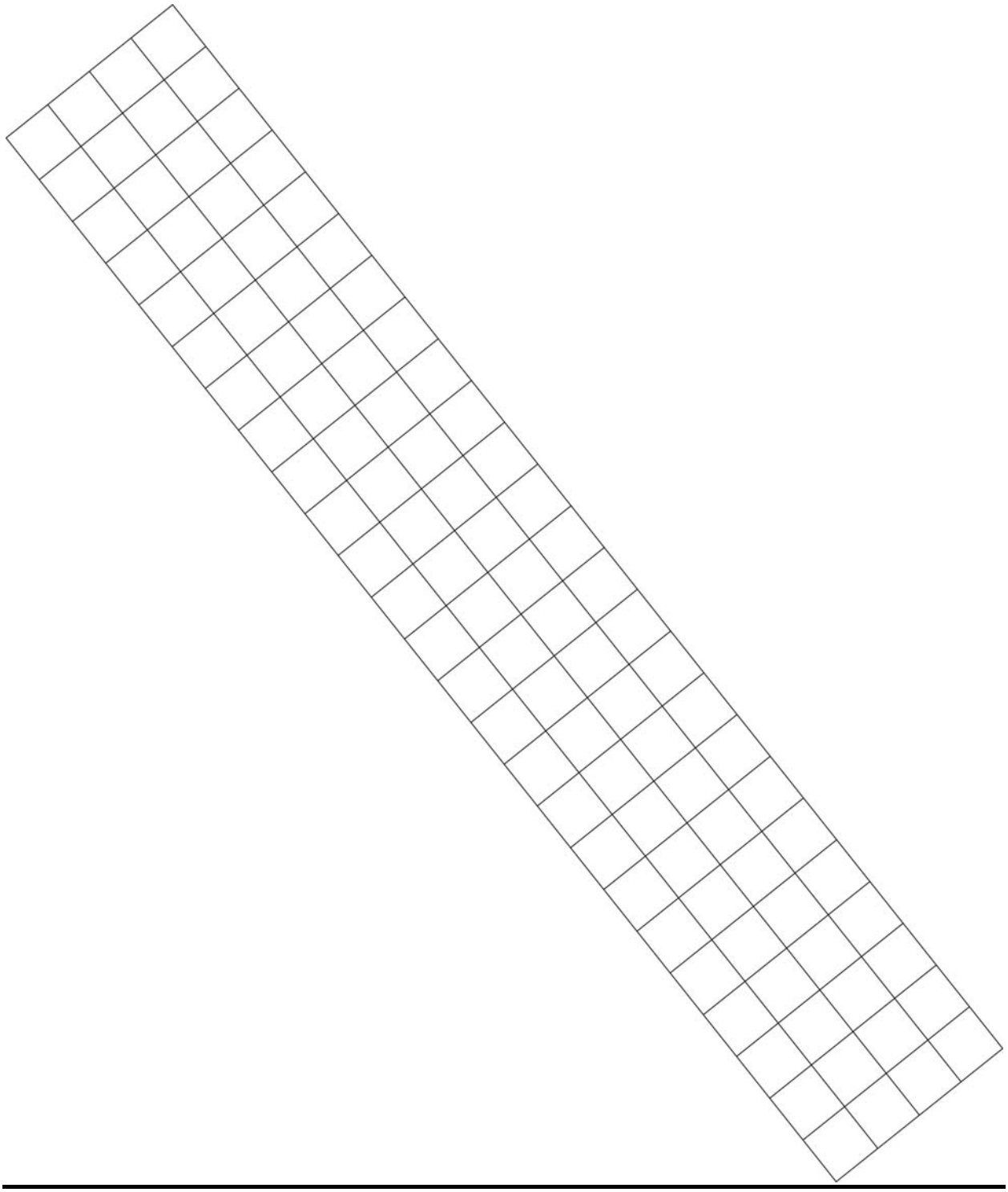
Create a table below to show each color, decimal fraciton, and decimal below.

Name _____ Date _____

Grids Sheet

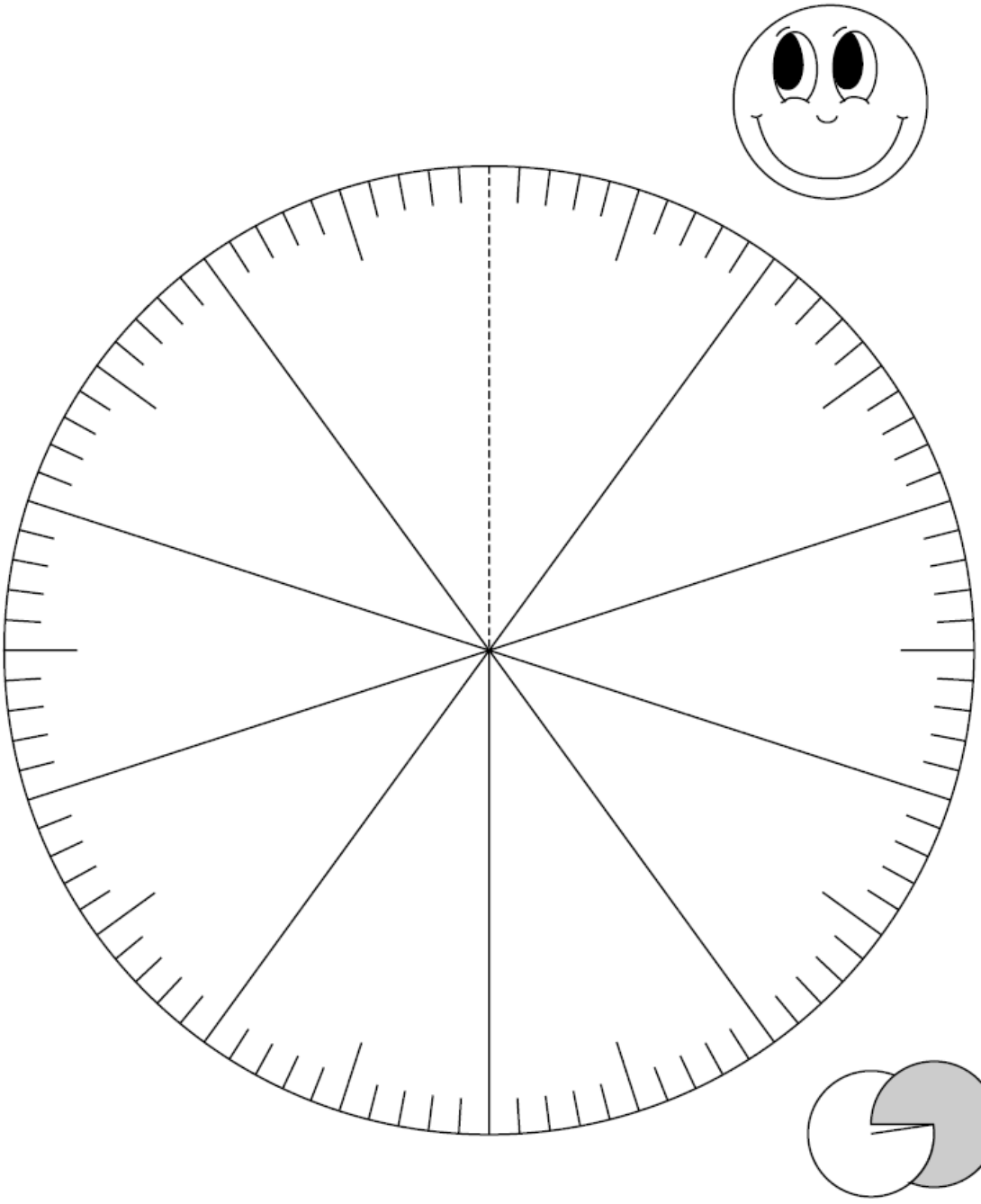






Name _____ Date _____

Hundredths Disk



(from Teaching Student Centered Mathematics, by John Van de Walle and LouAnn Lovin, 2006)