

Measurement Activities for CCSS-M

Craig J. Cullen & Jeffrey E. Barrett
Illinois State University

David B. Klanderma
Trinity Christian College

Presentation Goal

Our goal for this session is to help teachers address select topics in the CCSS-M. We plan to accomplish this goal in two ways. First, we will facilitate discussion about how measurement interpretations can be used to improve students' understanding of a variety of mathematical concepts. Second, we want to provide a connection between the presented tasks and relevant CCSS-M standards. Thus, we hope our attendees will gain example tasks designed to address specific standards from the CCSS-M.

The Context of Our Work

Learning Trajectories to Support the Development of Measurement Knowledge, pre-K through Middle School

Principal Investigators

Jeffrey E. Barrett and Craig J. Cullen
Illinois State University

Douglas H. Clements and Julie Sarama
University of Denver

Work on these projects was supported by the National Science Foundation under Grant No. **DRL DRL-1222944**. The opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the funding agencies.



A Pleasure to Measure:
CCSS-M Activities for K-5 Mathematics

Outline of our presentation today

- Linking learning trajectories and CCSS-M
 - An NCTM book project (Kindergarten-Grade 5), based on our research project, involving:
 - Clinical interviews
 - Whole class lessons
 - Resources for classroom teachers

- Book layout and themes (sample from grade 3: see packet-page 3)
 - Formative assessment
 - Measures as comparisons
 - Measurement activities represent various themes: whole number, fractions, operations on both types of numbers, geometry topics, early algebra or scientific measure

- Grade K-5 Assessment: Sample activities
 - Measuring Puppies and Kittens (packet-pages 4-5)
 - Ridiculous Rulers (packet-page 6)
 - Wraps and Sides (packet-pages 7-9)
 - Base ten blocks to model distributive property
 - Sprinklers (angles) and Volume

Grade 3. *Table of Standards, Activity, Task, Standard level, and learning trajectory level*

NCTM and CCSSM Standard by domain	Learning Activity	CCSSM	Learning Trajectory
Multiplying and dividing within 100 3.MD.C.5 Recognize and use area units to cover plane figures 3.OA.A.4 Determine unknown in multiplication or division equations	ACTIVITY 1: Every Square Inch: Designing a Patio Space Key Idea: Connecting area to units and arithmetic	3.MD.C.5, 3.MD.C.5a, 3.MD.C.5b	Complete Coverer and Counter
	ACTIVITY 2: Patio Redesign Task Key Idea: Determining unknown dimensions in area tasks	3.OA.A.4	Physical Coverer and Counter (with all needed tiles) Complete Coverer and Counter (with some tiles)
Understanding fractions, especially unit fractions 3.NF.A.1 Understand all fractions as multiples of a unit fraction 3.NF.A.2 Use number lines to model fractions 3.NF.A.3 Compare fractions	ACTIVITY 3: Wraps and Sides Key Idea: Converting fractions	3.NF.A.3, 3.NF.A.3a, 3.NF.A.3c, 3.NF.A.3d	Conceptual Ruler Measurer
	ACTIVITY 4: Wraps and Sides Continued (Comparing with different units) Key Idea: Converting and comparing fractions	3.NF.A.1, 3.NF.A.2, 3.NF.A.2a, 3.NF.A.2b, 3.NF.A.3b	Integrated Conceptual Path Measurer
	ACTIVITY 5: To the Nearest Quarter Key Idea: Measuring to the nearest quarter inch and converting between measuring unit	4.MD.A.1 3.NF.A.1 3.NF.A.3 3.NF.A.3.b	Integrated Conceptual Path Measurer
	ACTIVITY 6: Ridiculous Rulers Key Idea: Developing an understanding of number lines	2.NBT.B.7	Consistent Length Measurer
Structuring rectangular arrays 3.MD.C.5 Recognize and understand area measurement 3.MD.C.6 Measure areas by counting squares 3.MD.C.7 Relate area to multiplication and addition 3.MD.D.8 Geometric measurement: recognize perimeter	ACTIVITY 7: Partially Erased Arrays and Measuring the Area of Rectangles Key Idea: Developing an understanding of the structure of array	3.MD.C.5, 3.MD.C.5a, 3.MD.C.5b 3.MD.C.6 3.MD.C.7	Initial Composite Structurer
	ACTIVITY 8: Focus on Area and Conserving Area Key Idea: Interpreting area as a count of unit squares	3.MD.C.5 3.MD.C.6 3.MD.D.8	Area Unit Relater and Repeater Level

Activity 6: Measuring Puppies and Kittens



Key ideas: Nonstandard units; comparing lengths

Learning trajectory levels: Length Comparer (Direct, Indirect); End-to-End Length Measurer

Essentials

Gather stuffed animals, rulers and yardsticks (or metric measuring tools), leashes, water bowls, pet toys, and pieces of yarn.

Engage

Read *Measuring Puppies and Kittens* by Patricia J. Murphy (Enslow Elementary 2007). Learn to measure length, height, and width of animals with nonstandard units such as blocks, hands, and paper clips, as well as standard inch units on rulers and yardsticks.

Explore

How much taller is Tuffy the dog than his doghouse door? How much higher does Rocky the kitten jump than Muffin the kitten? Which animal has the widest paw—Jack, Max, or Buddy? Ask students to share their reasoning.

Expect

- The three pictures on pages 6 and 7 of *Measuring Puppies and Kittens* show the same puppy next to a stack of 5 cubes, 11 paper clips, and 3 handspans. Ask students to explain why the same puppy is said to be 5, 11, and 3 units tall. Can they explain why choosing smaller units (the paper clips) requires using more units than choosing larger ones (cubes or handspans) does?
- On pages 8 and 9, Pal is measured with both a blue and a yellow yardstick. If Pal had been measured once more with a red yardstick, how tall would he be?
- The book's illustrations show scaled, rather than actual-size, images of the animals. This allows the reader to see the entire animal on one page. Still, students may wonder why they cannot measure a picture and get the actual measure of the animal (e.g., the puppy is 34 inches tall, as shown on page 8, but the image of the puppy and the ruler really measures about 5 inches). Can students explain why we cannot measure the real puppy by measuring the photograph of the puppy?

- Students may answer the measurement questions with numbers alone, instead of including units. The book stresses labeling measurements with the unit of measure.

Extend

- The measurement situations lend themselves to further comparisons through subtraction. If Muffin's jump is 6 inches high and Rocky's is 9 inches high, it might be obvious that Rocky jumps higher, but can students figure out how many inches higher Rocky jumps than Muffin?
- Have students work in small groups to compare two or three stuffed animals by measuring different parts of the animals with rulers. Encourage the students to measure and record the length and width of each animal's nose, ears, head, paws, arms, hips, feet, and toes.
- Ask students to work with a partner to measure various aspects of their own bodies, such as their forearms, handspans or foot widths, head width, and shoulder breadth. This is a good time to explain to students that long ago, people used their bodies to measure things, as discussed on pages 6 and 7 of the book. They used the width of their hands, finger length, elbow-to-fingertip distance (called a *cubit*), and the distance from fingertip to fingertip across the span of their outstretched arms (called a *fathom*).

Enrich

Select other books in the same series: *Adding Puppies and Kittens*, *Counting Puppies and Kittens*, *Subtracting Puppies and Kittens*, *Telling Time with Puppies and Kittens* by Patricia J. Murphy (Enslow Elementary 2007).



Ridiculous Rulers

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.

From *A Pleasure to Measure: Tasks for Teaching Measurement in the Elementary Grades*.
 Copyright © 2017 by the National Council of Teachers of Mathematics, Inc., www.nctm.org.
 All rights reserved. This material may be used for personal and classroom use only.

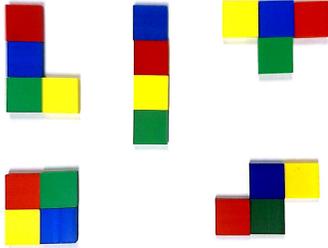
ACTIVITY 3: Wraps and Sides

Key Idea: Converting fractions

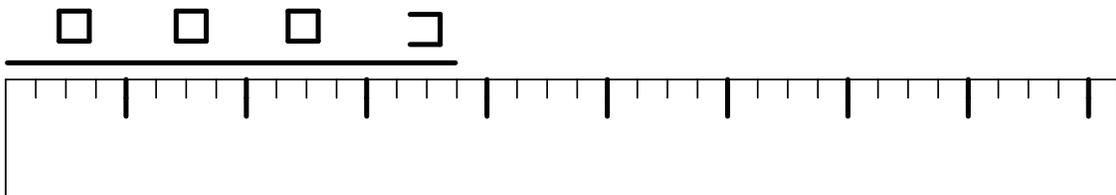
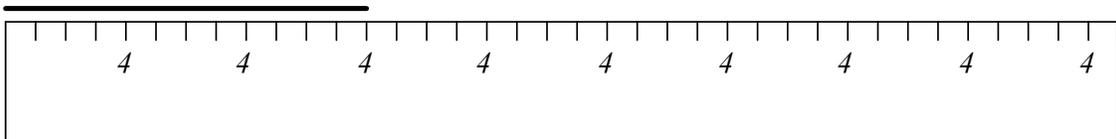
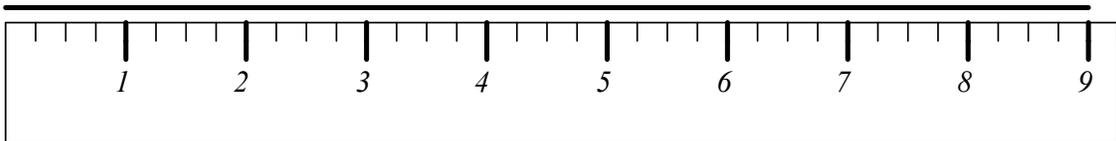
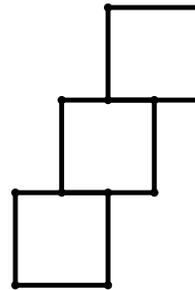
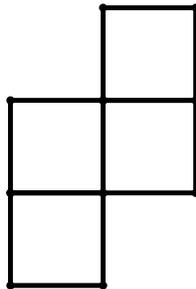
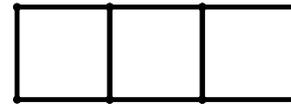
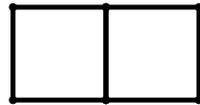
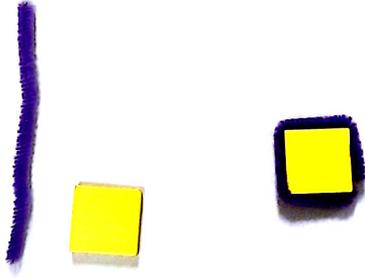
Learning Trajectory Level: Conceptual Ruler Measurer

Essentials: For this tasks you will need 1-inch square tiles, pipe cleaner for the teacher to demonstrate (additional pipe cleaners for students if desired), 1-inch grid paper (www.printablepaper.net/category/graph).

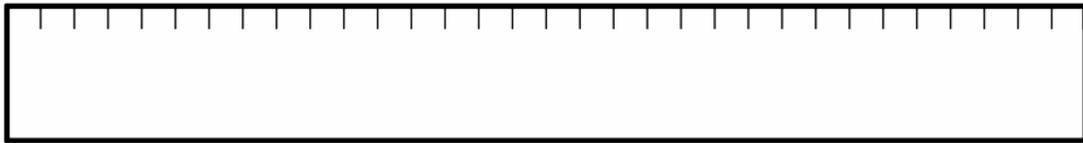
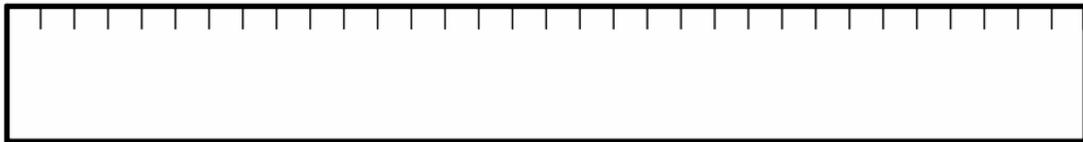
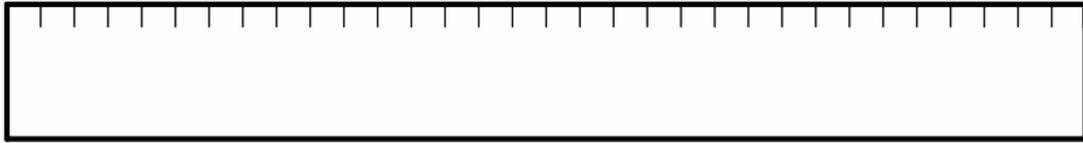
Engage: Imagine that you are making a community garden with separate plots made up of individual square sections. Each group will be allotted four square sections and allowed to place them so that complete sides are joined. Give each group four square tiles and a piece of 1-inch grid paper. Ask students to create all of the different shapes they can make and then make a record on the grid paper. You may want to check with the students before they make their records to avoid repetitions of shapes, for example “J” shape versus an “L”, and cases where the whole square sides are not touching. How many different garden plots are possible? (See image below for the five distinct shapes that can be made.)



Explore: “Let’s pretend that the border material for your garden plots will be this piece of pipe cleaner, called a wrap, because it can wrap around one square completely.” Notice that each wrap is made up of a total of 4 sides. (Cut the pipe cleaner to be four inches long and demonstrate that it can be wrapped around a square tile once, see figure below.) How much border material (perimeter) would be needed to enclose each of the garden plots you designed? Give your answers in sides, wraps and sides, and finally wraps. For example, given two squares next to each other, the total perimeter will be 6 sides, which is equivalent to 1 wrap and 2 sides, and is also equivalent 1 and $\frac{1}{2}$ wraps. (Note that giving answers in wraps will require students to reason about fractions and you may decide to save this piece for a later date or for a subset of your students when differentiating instruction.)



Wraps-and-Sides Rulers



From A Pleasure to Measure: Tasks for Teaching Measurement in the Elementary Grades.
Copyright © 2017 by the National Council of Teachers of Mathematics, Inc., www.nctm.org.
All rights reserved. This material may be used for personal and classroom use only.