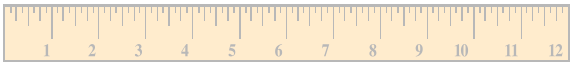
Unit 2

From Here to There

This unit is designed to give students a common measurement experience, finding the distance between two landmarks, in order to support further discussion about the principles of measurement. The landmarks are set far enough apart so that choice of a measuring unit has visible consequences. Now that we have an initial assessment of students' prior knowledge about measurement, our goal is to give them some experience measuring that we can use to facilitate their development of "big ideas" or principles of measurement, such as the nature of a unit or the need to iterate a unit. This activity is another opportunity to see how students invent measurement procedures, think about unit, and how they talk about these inventions as they discuss things they considered when they measured. We can use what we have learned from the previous assessment to guide our observation of students' activity and to inform instruction.

Materials

2 flags or cones
Teacher math journal (for note taking)
Chart paper
Student math journals
Pens or pencils



Task: Part One

Students use their bodies or other nonstandard tools to measure the length of the playground.

Task: Part Two

Students reason about measurement principles based on their experience with measuring the playground.

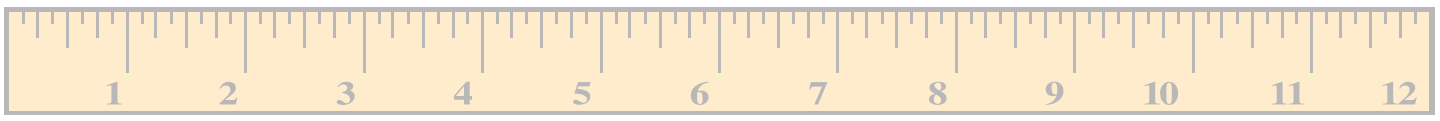
In this lesson. . .

Part One: Measuring Distance

Students use their bodies (such as footsteps) or other tools that they invent (e.g., some think to use notebooks, others pencils) to measure the distance between two landmarks.

Part Two: Things We Think About When We Measure

Students reason about measurement principles based on their experience with measuring distance.



Part One: Measuring the Playground

1 – Outdoor measuring (partner work) → **2 –** Student writing (individual): showing the measurement process → **3 –** Teacher reflection

1 Take students to a large open space such as a playground or a field. Set up two flags (or cones) at opposite ends of the space, making sure that they are set far enough apart to make measurement challenging – so that different choices of units have consequences that are visible. Ask students to work with their partner to find out how far it is from one flag to the next. Mention that they can try out anything that they like or use any tool that they like, except for rulers. Some students will walk heel-to-toe, others will stride. Some may use non-standard tools, such as pencils, clipboards, and lanyards. It is important to not allow students to use rulers or other standardized measuring tools.

Measurement big ideas likely to surface in this activity. . .

Iteration – A unit is repeatedly applied to obtain a measure. For example, a measure of length is obtained by moving (translating) a unit-distance a finite number of times. Iteration is the means by which units accumulate.

Identity – The units must be identical in order for the iteration to yield a single measure.

Tiling – The units are translated "end-to-end" with no gaps. Units tile the line, plane, volume etc.

Attribute-Unit Relation – Some units may be more suitable than others for measuring a long distance, For example, pencils will work, but they are difficult to apply to long distances.

Partial Units – Units can be partitioned to result in partial units. What do students do if the number of units is not a whole number?

2 When partners are finished measuring, ask each student to record his or her measurement in the math journal. Also ask students to spent about 15 minutes writing an independent summary about what they did to measure the distance. Ask students to draw a representation that would *show* their measurement process (for example, some students may draw a picture of themselves enacting a measure, others may choose to be more schematic and just show the unit used) and add any additional information that will help them talk about the activity during the next measurement lesson.

Part One: Measuring the Playground (continued)

3 Read student summaries and your observation notes about students' measurement methods. Write a short summary about your focus students' measurement methods and analyze them in relation to the principles of measure using the Measurement Progress Map. Think about the students' actions and comments during the activity to help you plan a conversation.

- **What big idea (principle) question do I want to start with?**
- **Who was doing something that will exemplify a big idea in measurement?**

If students appear to understand fundamental ideas, such as the role of identical units and tiling in iteration, then a discussion of how different methods and tools all measure these criteria might be profitable. A thought-provoking question often is: "What is the relationship between the length of the unit and the measure of the distance traveled?"

Part Two: Things We Think About When We Measure

1 – Whole-group guided discussion about outdoor measurement → **2 –** Student writing (individual): reflection on discussion → **3 –** Link student thinking from Unit 1 to Unit 2 → **4 –** Teacher reflection

1 To start the discussion, ask a student to summarize the activity they were asked to do in unit 2, part 1 (measuring the playground). Then, to open up the discussion, ask the class, "What things did we think about when we measured?" First listen to the directions in which students take the conversation and then consider questions you prepared to support further discussion.

Conversation Starters

- **What did we do?**
- **What were your measures? (Record on board or chart paper.)**
- **Why did we all get different measures?**
- **What were some important things you did when you measured?**
- **Would someone else get the same measurement if they did what you did?**

Continuing the Conversation

Ask three of the pairs, based on what you observed, to present their methods. Try to select methods that allow for ready comparison of key measurement principles. As each pair presents their method, ask students to point out one positive feature of the method and one thing that might be improved so that someone else could use the method. For example, when using their bodies, it might be important for students to tell other students to walk heel-to-toe and to keep moving without changing direction. (It is sometimes helpful for the teacher to enact a method that changes direction, so that this tacit assumption of "straight" can be made explicit.) Following presentation, compare and contrast methods and try to highlight important ideas, such as iteration, tiling, accumulating units by counting the number of iterations, identical units and the suitability of the unit for the task (Was it feasible? Could other people do it easily? What if we used a pencil to measure the distance—would it work? Would you want to be the one using it? What is the relationship between unit length and the measure of the distance traveled?)

Part Two: Things We Think About When We Measure (continued)

2 After the group discussion draws to a close, ask students to spend about 15 minutes writing a reflection in their math journal about one (or all) of the following prompts:

- I used to think _____ about measurement. Now I think _____.
- What did you like most about your method for measuring the distance traveled?
- If you measured again, what would you change?
- What does straight mean? Is it important to keep in mind when measuring distance traveled? Why do you think so?

Teacher Note: Often, the geometry of measuring distance is tacit. But this is a good opportunity to develop straight as meaning no change in direction. (We can measure the length of paths with bends (angles) by measuring each of the straight segments.)

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3 The below points have been suggested as ways to promote conversations that link student thinking from Unit 1 to Unit 2.

(1) Use the chart paper of student thinking from Unit 1 to support conversation. Link actions students describe about measuring the playground to "rules" or points they made about measurement in the initial lesson. Ask students if they still agree with these points and for examples to promote reasoning. If they changed their thinking, what was it that helped them to think differently?

(2) Have students demonstrate their measurement methods to support communication clarity and "thinking along" with the different methods.

4 Read the summaries of your three focus students (selected in reflections done in Unit 1) and reflect on the whole-class discussion. Write a summary about student discoveries and changes in thinking in relation to the Measurement Progress Map – where are students in their thinking? List on chart paper the unanswered measurement questions students wrote about and post in a public space in the classroom.