# Lesson Five: Sweeping Space

## Overview and Big Ideas

The previous lessons considered area as an enclosed region measured by coordinating units of length to constitute a square unit. In this lesson, area is developed as the result of sweeping one length through another. This area is partitioned into unit squares. This activity is intended to help students develop a more dynamic view of how area is generated, more like what we do when we use, for example, a paint roller. A dynamic view of area helps children think about the surface area of 3D shapes, such as cylinders, and is additionally an important form of thinking for volume (as an area swept through a length).

## Materials

Squeegees (one per pair of students)
Light ceramic tile measuring 1 ft x 1 ft (one per pair)
Finger paint (it is recommended that the colors contrast the color of the tile)
String (cut into 12-inch pieces)
Rulers

## Activity Structure

### Pairs Work

Put students in pairs and give each pair a tile, two rulers, a squeegee, about 15 pieces of string, and a bottle of finger paint. Demonstrate for the students how to place the rulers along the height and width of the tile (see Figure 1a). Ask students to smear a thin layer of finger paint on the tile, covering the entire surface (see Figure 1b). Give students a series of problems where they first construct the area, then find the area measure and finally show the units of area measure. For each problem, the area is constructed by positioning the squeegee at the base of the tile (see Figure 1c) and then pulling the squeegee up a specified length (Figure 1d), leaving a rectangular section of the tile exposed. Units are created by laying down pieces of string horizontally and vertically along each inch of the rulers (see Figure 1e).

## Activity Structure *(continued)*

The following shows a possible set of questions to pose for 5-inch squeegees:

### Problem 1

What is the area of a 5-inch by 4-inch rectangle?

Show the units for the area.

### Problem 2

What is the area of a 5-inch by 6 ½-inch rectangle?

Show the units for the area.

### Problem 3

Show the following with your squeegee and tile: 5 inches x (2 inches + 6 inches)

Describe how you created that area.

Show the units for the area.

**Discussion Questions:**

1. Why does an area result from moving a length along another length?
2. Does it matter if we start from the bottom of the tile and pull up or start from the side of the tile and pull sideways?

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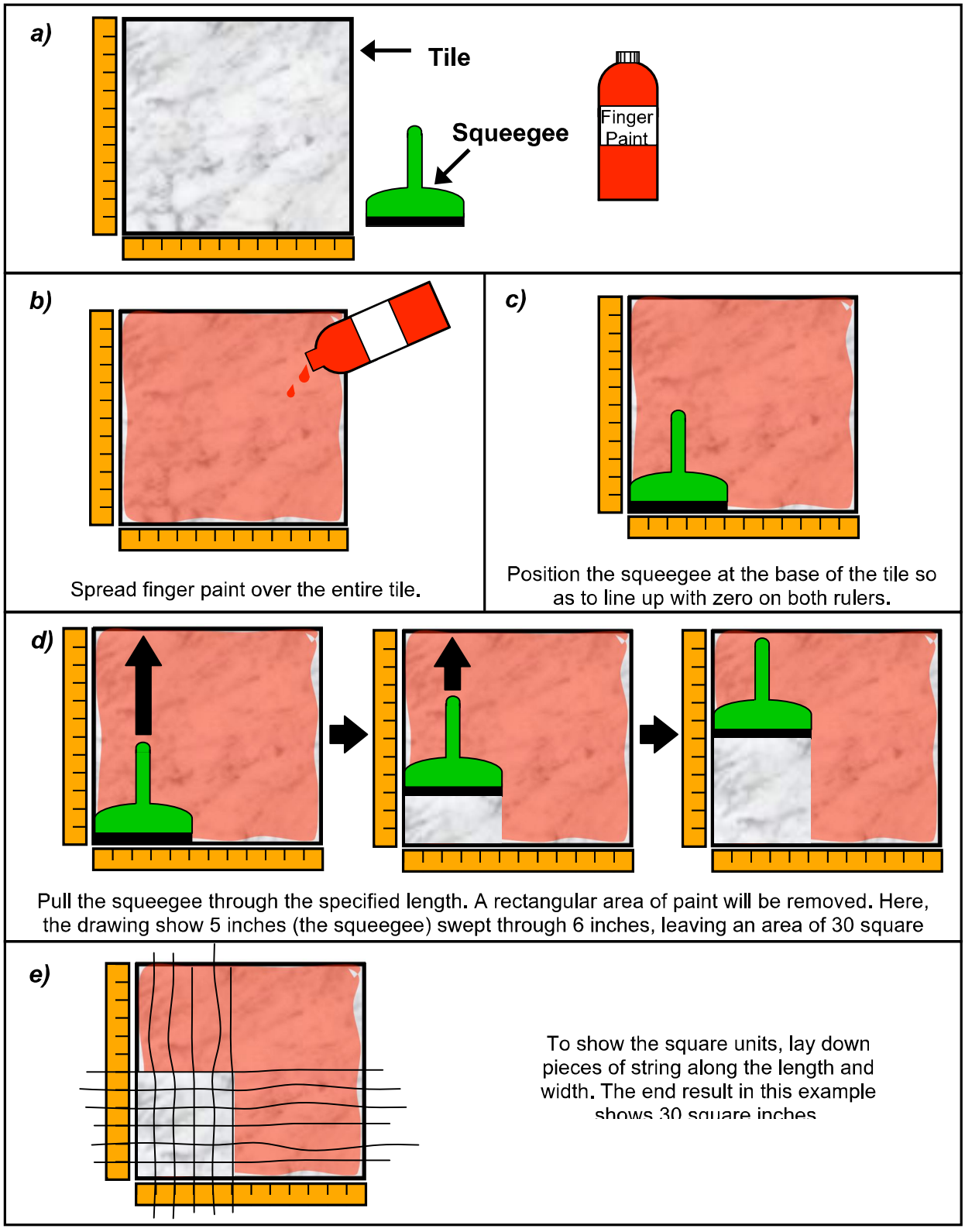



*Figure 1 a-d. Progression of pulling one length through another length.*

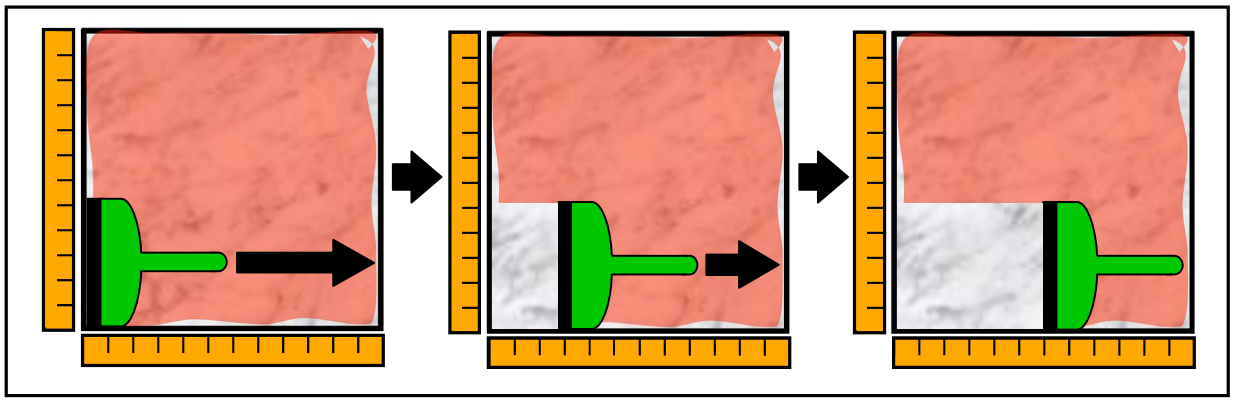
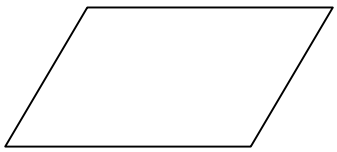


*Figure 2. Changing the direction of that the squeegee is pulled.*

## Extension Activity

Pairs Work – Ask students to create the following shape (a parallelogram) by pulling one length through another.



After letting the students try it out, ask them to create one with specific lengths. For instance, create the shape by pulling 5 inches (the squeegee) through a length of 6 inches. Ask the students to show the units of area measure using the string.

## Teacher Note

*Creating the Parallelogram:* When creating the area of the parallelogram, it is important to keep track of the length the squeegee is pulled through. Sometimes students create parallelograms but with the wrong dimensions. In the following figure, the first panel shows how to create a parallelogram where a 5-inch squeegee length is pulled through 6 inches. The second panel shows how a student may pull the squeegee in a way that creates a height of 6 inches (instead of the side length).

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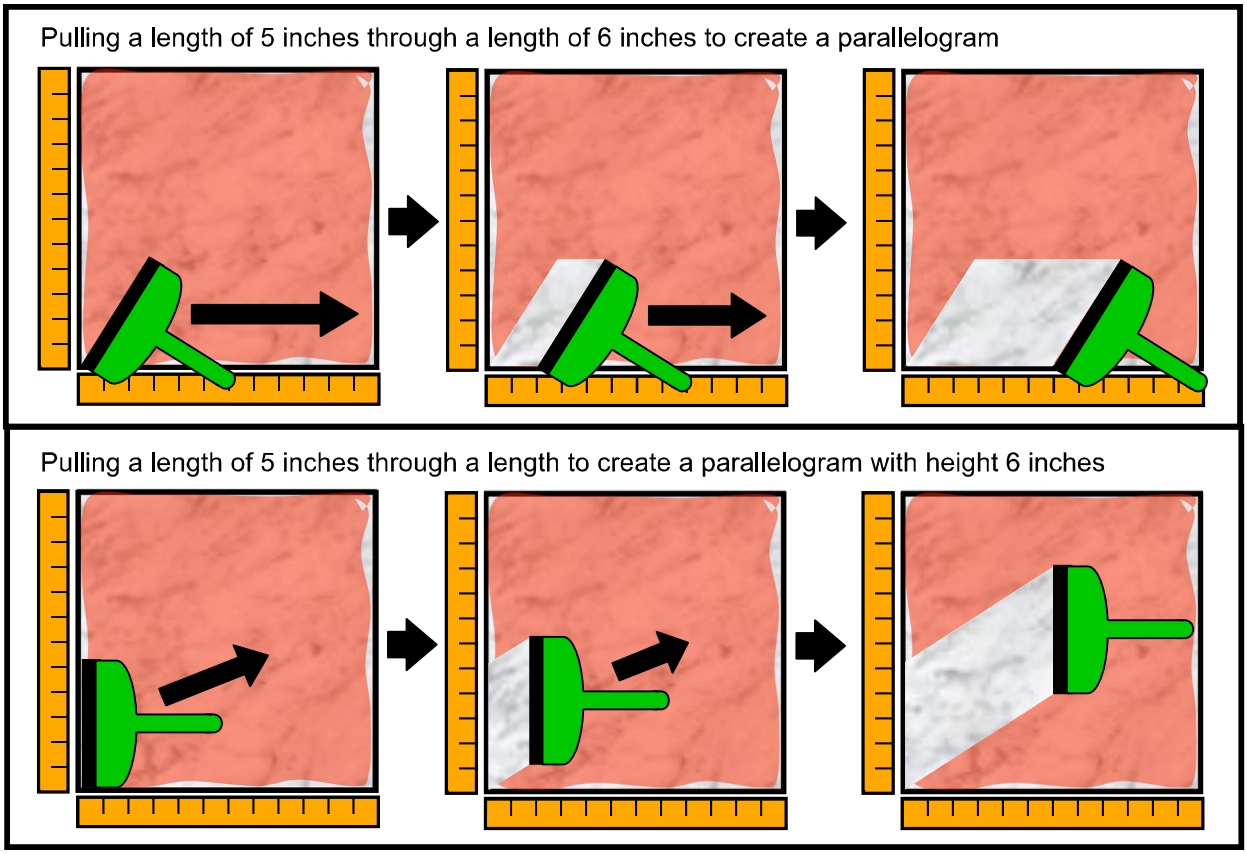
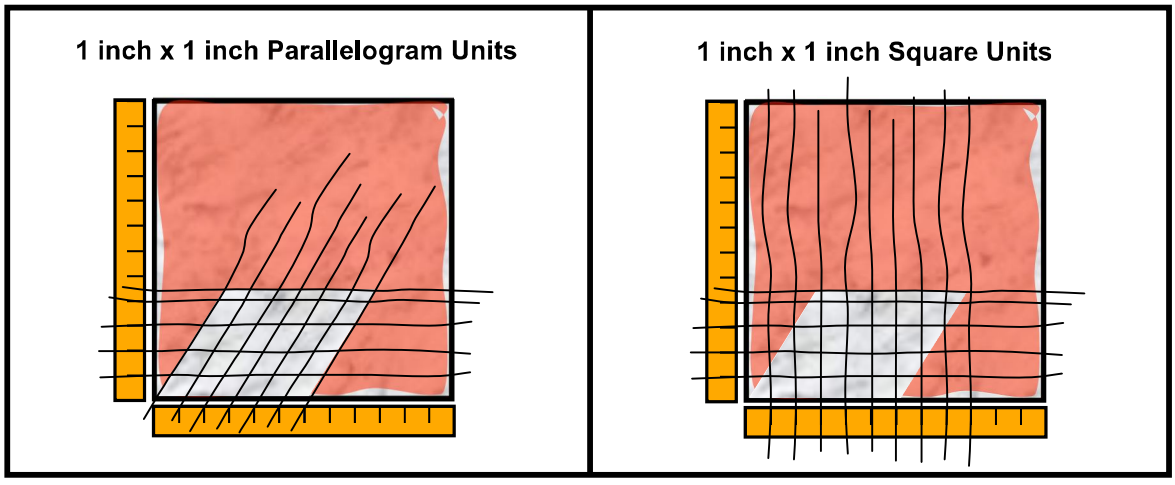



*Showing Units in the Parallelogram: There are multiple ways to show the area units in the parallelogram. One way is to use 1 inch x 1 inch parallelogram units. In this case, the area is partitioned by laying strings along the inch markings of the ruler parallel to the sides. Students may also create 1 inch squares. Both solutions are shown below.*



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## Challenge

As a challenge, ask the students the following question: "What is the surface area of the portion of a cylinder that excludes its base?" As a probe, ask the students how they could create the area by sweeping one length through another. Provide paper towel rolls as tools for thinking about the problem. The solution (pulling the circumference of the base through the height) is shown below.