Lesson 12: Modeling Using Similarity

Classwork

Example

Not all flagpoles are perfectly *upright* (i.e., perpendicular to the ground). Some are oblique (i.e., neither parallel nor at a right angle, slanted). Imagine an oblique flagpole in front of an abandoned building. The question is, can we use sunlight and shadows to determine the length of the flagpole?

Assume that we know the following information: The length of the shadow of the flagpole is 15 feet. There is a mark on the flagpole 3 feet from its base. The length of the shadow of this three-foot portion of the flagpole is 1.7 feet.
Mathematical Modeling Exercises 1–3

1. You want to determine the approximate height of one of the tallest buildings in the city. You are told that if you place a mirror some distance from yourself so that you can see the top of the building in the mirror, then you can indirectly measure the height using similar triangles. Let point $O$ be the location of the mirror so that the person shown can see the top of the building.

![Diagram of similar triangles]

a. Explain why $\triangle ABO \sim \triangle STO$.

b. Label the diagram with the following information: The distance from eye level straight down to the ground is 5.3 feet. The distance from the person to the mirror is 7.2 feet. The distance from the person to the base of the building is 1,750 feet. The height of the building is represented by $x$.

c. What is the distance from the mirror to the building?
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d. Do you have enough information to determine the approximate height of the building? If yes, determine the approximate height of the building. If not, what additional information is needed?

2. A geologist wants to determine the distance across the widest part of a nearby lake. The geologist marked off specific points around the lake so that the line containing $\overline{DE}$ would be parallel to the line containing $\overline{BC}$. The segment $\overline{BC}$ is selected specifically because it is the widest part of the lake. The segment $\overline{DE}$ is selected specifically because it is a short enough distance to easily measure. The geologist sketched the situation as shown below.

a. Has the geologist done enough work so far to use similar triangles to help measure the widest part of the lake? Explain.
b. The geologist has made the following measurements: $|DE| = 5$ feet, $|AE| = 7$ feet, and $|EC| = 15$ feet. Does she have enough information to complete the task? If so, determine the length across the widest part of the lake. If not, state what additional information is needed.

c. Assume the geologist could only measure a maximum distance of 12 feet. Could she still find the distance across the widest part of the lake? What would need to be done differently?

3. A tree is planted in the backyard of a house with the hope that one day it is tall enough to provide shade to cool the house. A sketch of the house, tree, and sun is shown below.

a. What information is needed to determine how tall the tree must be to provide the desired shade?
b. Assume that the sun casts a shadow 32 feet long from a point on top of the house to a point in front of the house. The distance from the end of the house’s shadow to the base of the tree is 53 feet. If the house is 16 feet tall, how tall must the tree get to provide shade for the house?

c. Assume that the tree grows at a rate of 2.5 feet per year. If the tree is now 7 feet tall, about how many years will it take for the tree to reach the desired height?