How can we use scale and proportion to help us measure the size of an object?

Dinosaur Valley State Park in Glen Rose, Texas

Dinosaur Footprint – How can we use scale and proportion to help us measure the size of an object?

Look at the poster picture. Discuss with a partner what you observe in the picture.

1. *Why do you think there is a one-dollar bill in the picture?*

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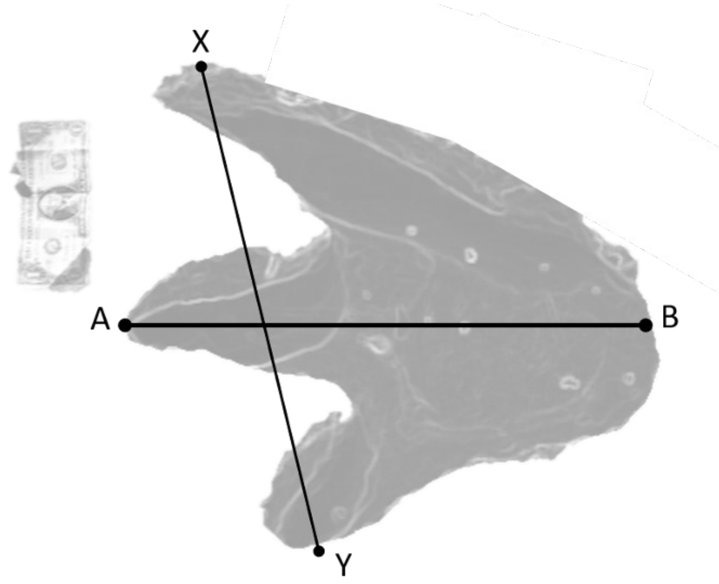
2. *All American paper currencies have the same size dimensions. They are 15.6 cm long x 6.6 cm wide (or 6.14 in x 2.61 in). Using this information and the picture below, what is the length (Line AB) of the dinosaur footprint? What is its span (Line XY) from toe to toe?*

The footprint is ____________ *long.The footprint span is* ____________ *wide.*



3. *Describe how you figured out the actual dimensions of the dinosaur footprint?*

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Dinosaur Footprint – Exploring scale, proportion and quantity

Image Information: The poster image shows an imprint of a dinosaur foot located in Dinosaur Valley State Park in Somervell County, Texas. Today, this area is covered by the Paluxy River but it was once the shoreline of an ancient sea. The one-dollar bill is placed in the picture to provide a known comparison (or standard dimension) to the size of the imprint. How does knowing the dimensions of the dollar bill help you to estimate the size of the dinosaur imprint?

Question: *How can we use scale and proportion to help us measure the size of an object?*

Possible student answers:

1. The one-dollar bill is placed in the picture next to the dinosaur footprint as a comparison for the size of the dinosaur footprint. Notice the dollar bill is held down by a small pebble. The bill is placed next to the imprint in the same relative plane and the image picture is taken looking down, from almost directly above it. This technique provides the greatest accuracy for the scale measurement.

2. The imprint length (line AB) is approximately the length of 3 one-dollar bills or 46.8 cm (18.4 in). The span of the imprint (line XY) is also about 46.8 cm (18.4 in) or 3x the length of a single dollar bill.

3. By knowing the dimensions of the dollar bill, you can estimate the size of the footprint. Students may describe different ways to calculate their measurements. Accept all methods that are reasonable. One method may be using a cm ruler to measure the dollar bill in the image and then measuring the line AB. Dividing the measurement of AB by the length of the dollar bill should be approximately 3. Since the dollar bill length is 15.6 cm, then 3 x 15.6 = 46.8. Another method might be to mark off the length of the dollar bill along an edge of a small piece of paper (like a Post-it note) and then see how many of those lengths can be placed along line AB. Students should see that there are approximately 3 of those lengths. Again, since the actual dollar bill is 15.8 cm long, the imprint size is 3 x 15.6 or 46.8 cm.

Interesting Info: Students may be familiar with using a known object as a scale device (like a ruler) in photos from having seen police dramas where crime scene photographs include a ruler. The accuracy of such a technique depends on the clarity of the scale device and the size of the object. A good scale device should have a flat, rigid shape with a dull (not glossy or shiny) surface. Using a measurement scale consistent with the size of the object is recommended, such as a meter stick for large objects or a small ruler for small objects. Without having a measurement tool handy, any standard object makes a good scale device (like the dollar bill in the poster image). Make sure that the scale device is at the same plane (on the same surface) as the object being photographed. Lastly, the picture should be taken perpendicular to the surface of the objects being compared. That is, being directly above, so both the scale device and the object are flat in the same plane in the picture.

Support the Phenomena:

NGSS: Crosscutting Concept #3 - Scale, Proportion and Quantity: In K-2, students **use relative scales to describe objects;** in 3-5, students **use standard units to measure and describe physical quantities;** in 6-8, students **use proportional relationships to gather information about the magnitude of properties;** in 9-12, students **use orders of magnitude to understand how a model at one scale relates to a model at another scale.**

- In K-2, have students use connecting cubes to measure objects around the classroom like a desk, chair, book, the width of the door, etc. Provide a picture of the classroom door with a short "tower of 10" connecting cubes next to it. Have students estimate how many "tower of 10" tall the door is from the picture. Have students describe their thinking in terms of the relative size. Verify their predictions by using actual "tower of 10" cubes to show how many towers it takes to measure the height of the classroom door.

- In 3-5, have students create a series of pictures using technology (phones or tablets) that show an object and scale device (ruler, either standard or metric) like in the poster image. Have the students write a description of their image and then exchange pictures with others to see if they can estimate the dimensions of the object in the image using the scale device pictured.

- In 6-8, students create a series of images from around the school using technology (phones or tablets) that show an object in nature using a variety of scale devices. Have the students share their images with others and estimate the dimensions of the object pictured. Students should explain how they derived their solutions, citing the mathematics they used.

- In 9-12, students find (or create) a scale model of a natural phenomenon (like a mountain, city landscape, cell, virus, etc.). Have students share their model with others. Students should be able to explain the relationship of the magnitude of the scale between their model and the object.

More information: To learn more about this Crosscutting Concept, see **NGSS Appendix G – Crosscutting Concepts**; **Scale, Proportion, and Quantity** from the Wonder of Science; or **Concepts Across the Sciences: Scale, Proportion, and Quantity**.