Title:	**Grade:** 6	**BIG Idea:**
Toy Frogs Take the Court: A Culminating Task	**Author(s)**: Mary Lou Wilson & Hope Phillips	Scale Factor

Real-World Connection:

The world of animation and children's game, both video and board, involves the need to miniaturize elements of the real world. Miniaturization involves the mathematical concept of scale factor. Action figures, Barbie dolls, animal toys, etc., in order to appear realistic, require designers to translate between the real world and the miniature world. In this lesson, students will scale a real basketball court to one sized appropriately for toy frogs.

How Students will Experience the Connection: highlight in yellow all that apply

Video Clip	Photo	Podcast
Print Media (article, ad, etc.)	Vodcast	Other *Websites – see *Materials*

GPS Standards:

M6G1: Students will further develop their understanding of plane figures.

a. Use the concepts of ratio, proportion, and scale factor to demonstrate the relationships between similar plane figures.

e. Solve problems involving scale drawings.

M6M2: Students will use appropriate units of measure for finding length, perimeter, area, and volume and will express each quantity using the appropriate unit.

a. Measure length to the nearest half, fourth, eighth, and sixteenths of an inch.

M6P3: Students will communicate mathematically.

Objectives:

1. Students will measure the dimensions of a toy frog.
2. Students will determine the scale factor between objects in the real-world and objects in a miniature world.
3. Students will determine measurements of selected features of a basketball court appropriate for a toy frog.
4. Students will draw to scale a basketball court for a toy frog.

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M6P4: Students will make connections among mathematical ideas and to other disciplines.	

Materials:

small plastic, toy frogs (this lesson used frogs measuring approximately 1 ½ " long)

NOTE: *Any* miniaturized toy will suffice for this activity.

markers – several per group of 2 or 3 students

large paper for drawing court (large enough on which to draw a 12 ½" x 21" court) – one sheet per small group

rulers – one or more per small group

calculator – one per student or student group

yard stick – two for teacher

handout – one per student

Related Task:

Discuss with students the links between the mathematics and the world of board games, action figures, and other toys. Ask questions like, "When someone creates an action figure or plastic/plush animal toy, was there mathematics involved in producing that item?" "Does a toy designer/video graphics designer have to know any mathematics?" Students will very likely be surprised at the amount of mathematics involved in the creation/design of these items. Remind them that the toy items resemble the real items on which they are based. This *similarity* is based in mathematics, and students need to know this before the lesson begins.

Using the suggested website(s) or ones of your choosing, pique students interest. The teacher or students must decide whether to use a high school or professional court. Students will need to know the following information to begin the activity:

- Selection of an average height for a basketball player
- Width (vertical length) of a high school court (50')

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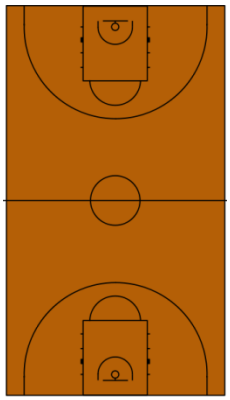
- Length (horizontal length) of a high school court (84')
- Additional measurements the teacher/class decides to include on the scale drawing such as the following: three-point line; half court; the key (also called "the paint")
- Dimensions of plastic frogs – vertical length



NOTE: This lesson can be differentiated based on the complexity of the scale drawing. The drawing may be as simple or complicated as the teacher deems appropriate.

NOTE: For the following narrative, the vertical length of a plastic frog will be 1 ½" and the height of an average basketball player is 6' tall. All calculations are based on the dimensions of a high school/college basketball court.

Pass out toy frogs. Ask students what information they will need to know about their frogs and the basketball court in order to design a court "appropriate" for these toys. Lead a discussion about what it means to move from the real world to a miniaturized world. A comparison of dimensions must be examined. Ask students what mathematical term is used to describe the comparison of two quantities – i.e. *ratio*. They must look at the ratio of the real-world height of a basketball player to the height of the toy frog.

This basic ratio will represent all calculations that will need to be figured in this problem: $\frac{real\ world}{toy\ world}$

For the height of the "players," $\frac{real\ world}{toy\ world} = \frac{6'}{1\ 1/2"}$

Discuss with students the large discrepancy between 1 ½" and 6'. Using two yard sticks, tape toy frogs, end-to-end, to visually show students how many times taller the 6' player is than the toy frog (see picture). Have students predict the total number of frogs that it will take to fill the yard sticks. Some students may need to see all frogs taped to the yard sticks. Others may understand the use of proportional reasoning.

For example, if it takes approximately 4 frogs to cover six inches, it would take about 8 frogs to cover 1 foot. Since there are 6 feet in two yard sticks, how many total frogs will it take to cover the yard sticks? 48

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$\frac{8\ frogs}{1'} \times \frac{6}{6} = \frac{48\ frogs}{6 feet}$

Discuss with students that the values in the ratio are not in the same units. Here, students have two choices. First, they may simplify the ratio "as is."

$\frac{6'}{1\ 1/2"} = \frac{4'}{1"}$ Interpretation: Every 1 inch in the toy world represents 4 feet in the real world. Here, students will have to remember to multiply every toy measurement by a factor of four to find the corresponding real-world measurement.

Some students may prefer to convert feet to inches and use this ratio:

$\frac{6'}{1\frac{1}{2}"} = \frac{72"}{1\frac{1}{2}"} = \frac{48}{1}$

The scale factor between the real world and toy world is 48:1

Often, students are asked to look at a scale factor in only one direction. However, it is critical to their understanding to see both of ratios as representative of the situation. Students should interpret the scale factor in two ways. First, the basketball player is 48 times as tall as the frog. Second, the frog is $\frac{1}{48}$ as tall as the basketball player.

Ask students how they will apply this new-found knowledge to the drawing of their basketball courts. Encourage multiple strategies for determining measurements of their scale drawings. Setting up proportions is *one* option but should not be viewed as the *only* option.

Below are a few ways of determining the length of the court. There are, however, other ways to approach this problem.

A. $\frac{Real\ player\ height}{Real\ court\ length} = \frac{Toy\ world\ height}{Toy\ world\ court\ length}$

$\frac{6'}{84'} = \frac{1\ 1/2"}{x}$

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6x = (84)(1½")
6x = 126
x = 21

B. $\frac{Real\ player\ height}{Toy\ world\ height} = \frac{Real\ world\ court\ length}{Toy\ world\ court\ length}$

$\frac{6'}{1\ 1/2"} = \frac{84'}{x}$

6x = (84)(1.15)
6x = 126
x = 21

C. If every 4 feet in the real world is equal to 1 inch in the toy world, then the toy world is 1/48 the real world. If the length of a basketball court is 84', that is equivalent to 1008 inches. 1/48 of 1008" is 21".

*Note: Whole numbers are written as fractions with denominators of "1" because the units can be shown more clearly.

$\frac{84'}{1} \times \frac{12"}{1'} = 1008"$

$\frac{1}{48} \times \frac{1008"}{1} = 21"$

D. It takes approximately 8 frogs to cover 1'. If a high school court is 84' long, it would take 672 frogs to cover that length. 672 frogs represent 1008" inches. If the frog world is 1/48 of the real world, the frog court length is 21".

$\frac{8\ frogs}{1'} \times \frac{84'}{1} =$ 672 frogs

672 frogs $\times \frac{1\frac{1}{2}"}{frog} =$ 1008"

1008" $\times \frac{1}{48} = 21"$

The width of a toy court would be 12 ½" and can be found by any of the methods

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above, as well as others.

Encourage students to be creative with their drawings, although mathematically correct. Having students show their work and explain how they determined the court dimensions is an important part of this task. Explanations can be written, oral, or both. Student presentations in front of the class help student articulate their strategies and allow the teacher to ask questions for the benefit of all students.

At some point in the lesson, discuss with students the connections *scale factor* has with the real-world. See examples below –

- Road maps where scales such as 1" = 100 miles are common
- Die Cast Metal Cars where a scale such as 1:32 is common
- Media reports where statistics are reported such as, "The number of women is four times the number of men" for a particular characteristic

Remind students that they will see scale factor references in both "directions" –

$\frac{replica\ world}{real\ world}$ and $\frac{real\ world}{replica\ world}$ and should be comfortable working with both.

Although the example of "The number of women is four times the number of men" is not a *real world: replica world* (or vice versa) situation, present the situation like this:

$\frac{women}{men}$ It is less common to present this situation as "One-fourth the number of men as women…" or $\frac{men}{women}$

Learn More:

website with frog sounds – optional
http://www.amnh.org/exhibitions/frogs/frogsounds/

website with basketball court dimensions and how dimensions affect the playing of the game – optional (example:
http://www.ehow.com/video_5238665_basketball-court-regulations.html
running time 2:13)

high school/college basketball court schematic with dimensions
http://www.atlantatennis.com/yourtenniscourt/basketball%20dimensions.gif

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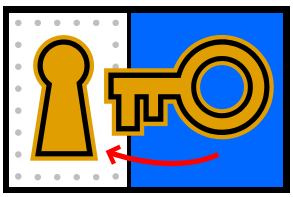
TOY FROGS

TAKE THE COURT



Key Question:

How could you draw a basketball court scaled to the size of a toy frog?

1. What is the length of a high school court?
2. What is the width of a high school court?
3. What is the average height of a high school basketball player?
4. Measure the “height” of your toy frog. Height: _____
5. Make an accurate scale drawing of a basketball court for toy frogs using the information above.

Extension:

6. Use your scale drawing to determine how far a player (frog) would have to throw a pass from one corner of the court to a teammate on the center line on the opposite side?