Ratio and Proportional Reasoning

Activity Set 3

Trainer Guide

RATIO AND PROPORTIONAL REASONING
ACTIVITY SET #3

NGSSS 3.G.5.2
NGSSS 6.A.2.1
NGSSS 6.A.2.2
NGSSS 7.A.1.1
NGSSS 7.A.1.3
NGSSS 7.G.4.4
NGSSS 7.A.5.2

Human Body Ratios

In this activity, participants will determine the ratios of various human body parts to each other and verify that the ratios remain true among people.

MATERIALS
- *Transparency/Page: Body Parts Ratios*
- string and scissors for each pair
  (enough to cut pieces for each measurement)
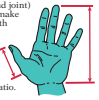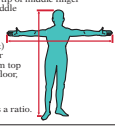- masking tape
- chart paper
- pens

VOCABULARY
- ratio
- proportion

TIME: 20 minutes

INTRODUCE

- Review the definition of ratio: a comparison of two quantities.

- Point out how ratios are expressed, especially the importance of order and clarity related to which element is mentioned first (e.g., peanuts to nonpeanuts).

- Explain to participants that now they will measure and record ratios that relate to the human body.

RATIO AND PROPORTIONAL REASONING
ACTIVITY SET #3

Transparency: Body Parts Ratios

DISCUSS AND DO

- Display *Transparency: Body Parts Ratios* and ask participants to take out their matching pages.

- Look at each measurement requirement and clarify the exact places from which measurements begin and end. It is very important that everyone take the measurements the same way.

- Have a volunteer come forward.

- Demonstrate how to cut a piece of string for each of the two parts of one ratio. For example:
  - Cut a piece of string that is the length of the volunteer's thumb.
  - Cut a second piece the length of the volunteer's hand.
  - Determine how many of the short pieces (thumb) it takes to make a long piece (hand).
  - Write this ratio, on the transparency, as an example.

- Explain to participants that they will do this for each person for each set of measurements.

- Have participants record the ratios on their pages once they have completed a ratio.

- Ask participants to find a partner and then complete their pages.

- Give participants 5–10 minutes to complete their pages.

CONCLUDE

- Call the group together.

- Post three pieces of chart paper (one for each set of ratios).

- Label the charts:
  - Thumb to Hand
  - Arm Span to Height
  - Foot to Lower Arm

- Call six volunteers to each chart to record their ratios.

- Point out the similarities in the ratios on each chart.

- Explain how the use of string, rather than a finite measuring tool (e.g., tape measure), can account for minor differences.

- Have the group agree to a summary ratio for each chart.
  - Thumb to Hand   1 : 3
    (The thumb length is the unit of measure.)
  - Arm Span to Height   1 : 1
  - Foot to Lower Arm   1 : 1

- Write the summary ratio on each chart.

End of Human Body Ratios

TEACHING TIP: Suggest that, although the ratios among the group members were similar, the group members were different in size. Mention that ratios could be applied to determine the size of the parts of people of diverse heights.

Lilliput and Brobdingnag

In this activity, participants will use proportions to determine the size of various body parts belonging to characters from Jonathan Swift's *Gulliver's Travels*.

MATERIALS
- *Transparency/Page: Lilliputian, Human, and Brobdingnagian*
- *Transparency/Page: Lilliput–Brobdingnag Data Table*
- *Transparency/Page: Lilliput–Brobdingnag Answer Key*
- *Gulliver's Travels* by Jonathan Swift
- calculator

VOCABULARY
- proportion

TIME: 25 minutes

TEACHER TIP: This activity calls for the use of a book, *Gulliver's Travels*. This book illustrates some of the mathematics content from this activity within a literature context. However, the book is not required by the mathematics content of the activity, which may be completed without the book. If this book is not available, you may substitute another, similar book, or you may complete the activity without the literature. In either case, you should mention this book to participants as being a literature connection for their classrooms.
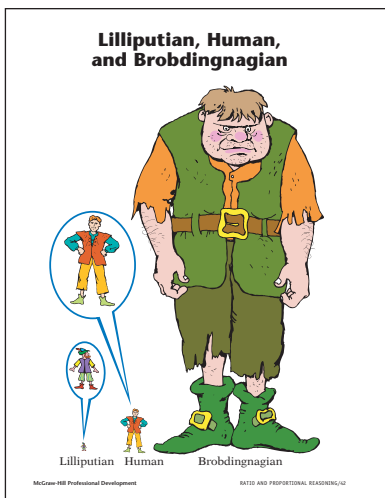
RATIO AND PROPORTIONAL REASONING
ACTIVITY SET #3

INTRODUCE

Transparency: Lilliputian, Human, and Brobdingnagian

Transparency: Lilliput–Brobdingnag Data Table

- Remind everyone about the story of *Gulliver's Travels.*

- Ask if they can remember the two lands that Gulliver visited. (Lilliput and Brobdingnag)

- Display *Transparency: Lilliputian, Human, and Brobdingnagian.*

- Remind participants that the Lilliputians were about 6 inches tall and that the Brobdingnagians were 60 feet tall.

- Tell participants that Swift did not provide many more details about the characters, but as participants they will use proportions to determine more about these little people and big people.

- Remind participants of the ratios that they completed in an earlier activity—their body parts.

- Display *Transparency: Lilliput–Brobdingnag Data Table.*

- Have participants take out their matching pages.

- Ask participants what information they can add to the chart without completing any calculations. (the height for both Lilliputians and Brobdingnagians)

- Point out to participants the lists of ratios on chart paper from the Human Body Ratios activity.

- Ask them how they can use any of this information to help them fill in more of their charts. (Arm span is equal to height.)

- Suggest that, as they fill in the data table, they make use of other ratios from the Human Body Ratios charts, using the consensus or summary ratios.

DISCUSS AND DO

- Have participants work in pairs to complete the charts.

- Assign half the pairs to fill in the numbers for the Lilliputians and half to complete the column for the Brobdingnagians.

- Remind participants, as they begin, that the most important ratio they use will be the relationship of Lilliputian to human or Brobdingnagian to human.

- Remind them that they can use cross multiplication to solve for the missing numbers.

- Suggest that, if they complete their columns before time is called, they begin to fill in the other column.

- Give participants 5–10 minutes to complete their calculations.

CONCLUDE

- Call the group together.

- Have a volunteer participant come up and show the process and solution for finding the length of a Lilliputian thumb.

- Ask if anyone has another way to solve the problem. (Some people may simply divide the human measurements by 12 to get the Lilliputian numbers or multiply by 10 to get the Brobdingnagian numbers. This is jumping to the final step of the proportional method and is not a wrong approach. See example below.)

$\frac{1}{12} = \frac{l}{h}$ So, to find the length of the thumb, do the following:

$$12 \text{ thumbs} = 2.6$$
$$1 \text{ thumb} = 2.6 \div 12$$
$$1 \text{ thumb} = 0.22 \text{ inches}$$

- Repeat the process for all the Lilliputian numbers. Be prepared for someone to point out that the lower arm should be approximately the same as the length of the foot.

- Repeat the process for the Brobdingnagian numbers.

- Display *Transparency: Lilliput–Brobdingnag Answer Key*.

- Discuss the participants' answers.

Lilliput–Brobdingnag
Answer Key

A Lilliputian is approximately 6 inches tall.
A Brobdingnagian is approximately 60 feet tall.

Create proportions and use cross multiplication to find the following information for the Lilliputian and the Brobdingnagian.

Body Part	Human	Lilliputian	Brobdingnagian
height	6.0 feet	6.00 inches	60.0 feet
arm span	6.0 feet	6.00 inches	60.0 feet
thumb	2.6 inches	0.22 inches	26.0 inches
hand	7.8 inches	0.65 inches	78.0 inches
foot	10.3 inches	0.86 inches	103.0 inches
lower arm	10.3 inches	0.86 inches	103.0 inches

Measurements are approximate.

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Transparency: Lilliput–Brobdingnag Answer Key

- Ask participants if they can think of other works of literature that could lead to lessons on proportions. Some examples include:

  - *The Indian in the Cupboard* by Lynne Reid Banks

  - *The Borrowers* by Mary Norton

  - *Stuart Little* by E.B. White

- Point out to participants that as they have solved proportions, they have also solved equations. Proportions are related directly to algebraic thinking.

- Point out to participants that an assessment can occur in an interesting context. Using literature to create a concept for mathematics makes math fun and shows that mathematics is not composed of isolated skills.

End of Lilliput and Brobdingnag

1:4

2:8

3:6

Mathematics, YES!

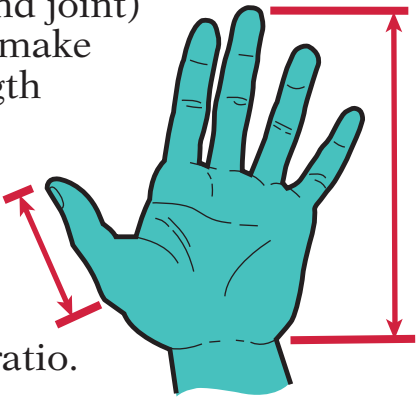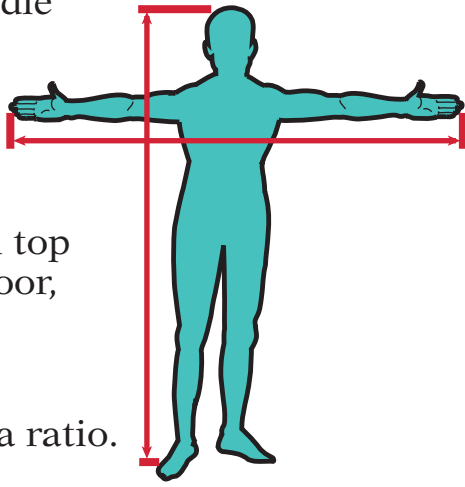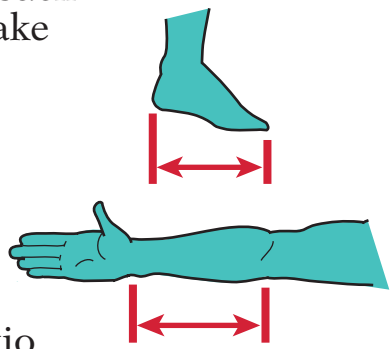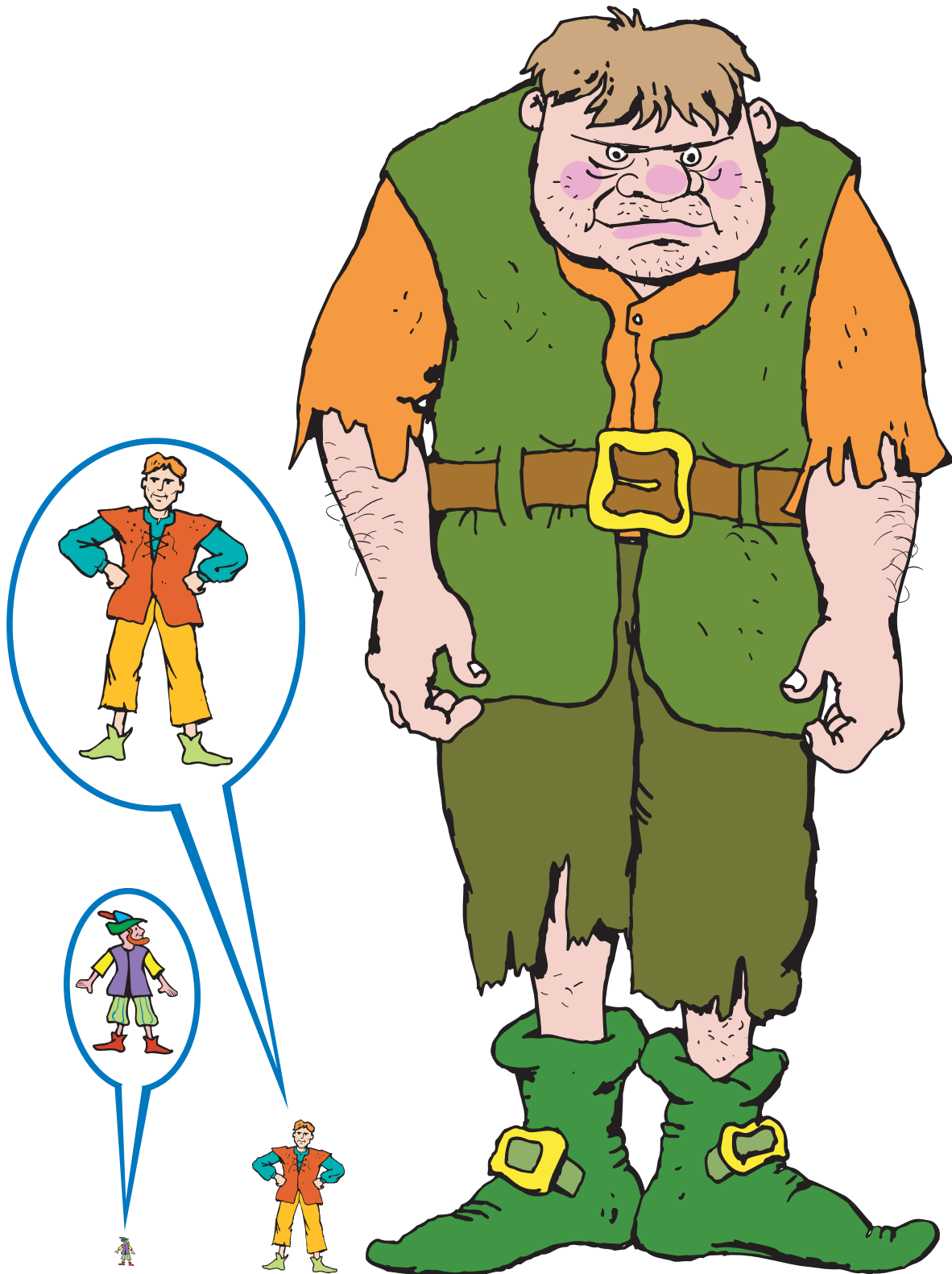*Ratio and Proportional Reasoning – Activity Set 3*

1:8

7:10

4:5

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Body Parts Ratios

Measure	Person A	Person B
How many of your thumb lengths (from tip of thumb to second joint) does it take to make your hand length (from tip of middle finger to line at base of palm)? Write these numbers as a ratio.	**Thumb : Hand** ____ : ____	____ : ____
How many times does your arm span (from tip of middle finger to tip of middle finger with both arms extended straight out) fit into your height (from top of head to floor, no shoes)? Write these numbers as a ratio.	**Arm Span : Height** ____ : ____	____ : ____
How many foot lengths (from big toe to back of heel) does it take to fit your lower arm length (between wrist and inside joint of elbow)? Write these numbers as a ratio.	**Foot Length : Lower Arm** ____ : ____	____ : ____

Lilliputian, Human, and Brobdingnagian

Lilliput–Brobdingnag Data Table

A Lilliputian is approximately 6 inches tall.
A Brobdingnagian is approximately 60 feet tall.

Create proportions and use cross multiplication to find the following information for the Lilliputian and the Brobdingnagian.

Body Part	Human	Lilliputian	Brobdingnagian
height	6.0 feet		
arm span		6.00 inches	
thumb			26.0 inches
hand			78.0 inches
foot	10.3 inches		
lower arm		0.86 inches	

Measurements are approximate.

Hint: Remember to use all the same units of measure when creating your proportions for height.

Lilliput–Brobdingnag
Answer Key

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Glossary
Ratio and Proportional Reasoning

cross multiplication   A method of verifying whether 2 fractions are equivalent.

equivalent fractions   2 fractions which, when reduced to lowest terms, are equal.

equivalent ratios   Ratios that can be expressed by equivalent factions.

pi   The ratio of the circumference of a circle to its diameter (approximately 3.14).

proportion   A statement that 2 ratios are equivalent.

rate   A ratio comparing two different units of measure.

ratio   A comparison of 2 quantities.

sample   A subset of items taken at random from a complete set.