How Big Should I Be?

Proportional Reasoning

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Grade Level	7th – 9th Grade	**Time Frame**	2-3 class period(s)
Subject	Mathematics	**Duration**	120 minutes
Course	Algebra 1, Middle School Mathematics		

Essential Question

How and why do animators and toy makers use proportions in their craft?

Summary

Students will take measurements of themselves and then use what they know about proportions to find out if they are proportional to a doll, action figure, or other "toy" human model. To learn more about proportions and dimensions, students will then create an accurate model or visual of their "toy self." Throughout the process, students will also focus on why proportional reasoning is important for animators or toy makers who mimic and exaggerate the human figure.

Snapshot

Engage

Students watch a video trailer from the animated game "Fortnite" and discuss whether or not the avatars look "real." Other games, animated movies, toys, and depictions of humans in media, as well as what they have in common, are included in the discussion.

Explore

Using a doll, action figure, stuffed plush, or other toy, students determine whether their model looks real and proportional based on the average measurements (height, waist, arms, legs) of those in their group.

Explain

The class shares data and uses that collective data to determine if any of the toys are mathematically proportional.

Extend

Students calculate what their own dimensions would be if they were as tall as their group's toy.

Evaluate

Students use their calculations to create, draw, or otherwise model themselves as a doll, action figure, stuffed plush, or another toy.

Standards

Oklahoma Academic Standards for Mathematics (Grade 7)

7.GM.4.2: Apply proportions, ratios, and scale factors to solve problems involving scale drawings and determine side lengths and areas of similar triangles and rectangles.

Attachments

- Lesson Slides—How Big Should I Be.pptx
- Model and Report Rubric—How Big Should I Be - Spanish.docx
- Model and Report Rubric—How Big Should I Be - Spanish.pdf
- Model and Report Rubric—How Big Should I Be.docx
- Model and Report Rubric—How Big Should I Be.pdf
- Toys vs. Us & Your Toy Self—How Big Should I Be - Spanish.docx
- Toys vs. Us & Your Toy Self—How Big Should I Be - Spanish.pdf
- Toys vs. Us & Your Toy Self—How Big Should I Be.docx
- Toys vs. Us & Your Toy Self—How Big Should I Be.pdf

Materials

- A small number of dolls, action figures, plush toys, figurines, or other representations of human bodies
- Tape measure and rulers
- "How Big Should I Be?" lesson slides (attached)
- Toys vs Us/Your Toy Self handout (attached, two-sided)
- Graph paper (or whiteboard space)
- Model and Report Rubric (attached)
- Craft and art supplies

Engage

Teacher's Note: Lesson Preparation

This lesson requires a small number of dolls, action figures, plush toys, figurines, or other representations of human bodies. Have enough toys on hand to supply one to each group of students in the class, with about three students per group. Consider also having materials on hand for students to create their own models, such as poster board and drawing materials, clay, fabric, collage materials, etc.

To begin the lesson, ask students about to consider the question on slide five while watching the linked video. Play the trailer linked in the slide (or use the link here). Stop the video at 1:20. The full video URL can also be found in the Resources below.

Embedded video
https://www.youtube.com/watch?v=qpKtzf5fXn4

Ask students to use the Think-Pair-Share strategy to discuss and answer the questions: *"Do the characters look real? Why or why not?"* Allow a few minutes for discussion. Then, invite groups to share their ideas with the class.

To add to the class discussion, ask how the characters are made to look real or exaggerated in a mathematical sense. Further, what other animated movies, games, toys, or other media feature characters or figures that look real? What about characters that look exaggerated? Ask students to think about why it matters, and to share their ideas with the class.

Explore

Show the class one of the dolls, action figures, plush toys, figurines, or other models. Ask the class if the toy looks real or exaggerated, and why it looks that way. Follow up by asking whether it looks mathematically proportionate to a real person.

Move to slide seven. Sort students into groups of two to three. Give each group a measuring tape and a ruler, and have each group select a toy. Give each student a copy of the attached **Toys vs. Us** handout. Have students measure the toy, then measure their group members, and record their findings on the front side of the handout. Then, have groups discuss how they could figure out how to use those measurements to compare their own proportions to the toys.

Teacher's Note: Guiding The Explore Phase

For now, try not to teach students how to set up proportions. Let them find ways to support their decision. If some groups struggle with the activity, ask guiding questions ("Let's say you were 60 inches tall with an arm length of 20 inches. If I made a model of you that was 6 inches tall, how long would the model's arm be?"). Suggest how they might think about the problem, but don't give them an equation to use.

Give the class time to take measurements and record data. Remind students to be thorough and accurate, and to take as many measurements as possible.

Ask each group to make a claim in response to the question on slide seven: *Is your toy proportional to the members of your group?* Support your claim with evidence.

Explain

Guide the class in a discussion on proportions and ratios. Begin by prompting the class with the problem on slide nine: You have two proportional picture frames. If the smaller of the two frames is 10 inches wide and 8 inches tall, and the larger is 20 inches wide, how many inches tall is the larger picture frame? (Answer: 16 inches tall.)

Let students work the problem out alone or with their groups.

Interpreting Student Responses

If students arrive at the answer 16 inches, they are thinking proportionally. If students arrive at 18 inches instead, they are thinking in terms of adding numbers.

Move to **slide ten**, with a similar problem: *You're making a scale model of a blue Studebaker car. The real car is 15 feet long and 9 feet wide. If your scale model were 10 inches long, how wide should it be?* (Answer: 6 inches wide.) Again, let students work alone or in groups to solve the problem.

Interpreting Student Responses

If students answer with 4 inches, they may still be thinking in terms of adding numbers instead of working proportionally.

If the majority of your class still seems to be using additive reasoning instead of proportional reasoning, have them draw rectangles (10 by 8, 20 by 16, and 20 by 18) on grid paper.

Optional Activity

If students struggle with proportional reasoning, consider asking them to draw rectangles on grid paper as directed on slide 11. Alternatively, you can draw them on any whiteboard space. This method better illustrates the difference between adding numbers and working with them proportionally. Students should see that, while 10x8 and 20x16 rectangles look proportional, a 20x18 rectangle looks different.

Tell the class that there is a standard way of testing for proportionality—by setting up a pair of ratios, or fractions, in a proportion.

Move to slide 12. Ask students to work with an Elbow Partner to come up with a way to compare two equal fractions, using the rectangles on slide 11 as examples. Allow 2–3 minutes, then ask partners to share their solutions. Find pairs who used the same numbers but arranged them differently. Move to **slide 13** to show two solutions.

Use slide 14 to demonstrate the cross-multiplication method for solving proportions. Move to slides 15 and 16 to demonstrate the dilation method for solving proportions.

Ask students to rejoin their data collection groups from the Explore section to re-check their math via the instructions on **slide 17**. Allow time for students to check several instances of proportional relationships in their data (toy arm length to group member arm length, toy height to group member height, etc.). Did any groups change their initial claims?

Extend

Move to **slide 19**. Play the video linked in the slide (or use the link here). Then, ask students to consider the questions under the link: What are the pros and cons of toy makers and animators using proportions correctly? What about skewing them on purpose? Use these questions to begin a brief class discussion.

Embedded video
https://www.youtube.com/watch?v=OfQu8pq0kok#t=58

Move to **slide 20**. Ask students what they think a doll or action figure proportional to them would look like. Pass out the attached **Model and Report Rubric**. Invite students to calculate their own proportions using the height of the toy their group measured. Then, using the Model and Report Rubric and the table on the back of the Toys vs. Us handout (the sheet titled **My Toy Self**), have students create a toy version of themselves. Invite students to use whatever medium they'd like in the time allowed—a poster, a clay figure, a digital drawing, etc.—to fulfill the requirements listed in the rubric. Ask them to include a written report on the back of the Toys vs. Us handout, on the lines below where they recorded their toy self measurements.

In the written report, students should answer the questions on the rubric and on **slide 21**.

Depending on classroom needs, have students work independently, in pairs, or in groups to create their models and reports.

Evaluate

Methods of evaluating this lesson include students' model projects and written reports.

In the written report, students should answer the following questions:

1. What does it mean for two things to be proportional?
2. How do you determine whether two things are proportional?
3. What are three reasons why a toy maker or animator would need to understand the mathematics behind proportions or understand how to use proportions (or skew them) in their work?

Resources

- Fortnite Official Cinematic Trailer. (2017). Retrieved from https://www.youtube.com/watch?v=qpKtzf5fXn4
- K20 Center. (n.d.). Elbow partners. Strategies. Retrieved from https://learn.k20center.ou.edu/strategy/ccc07ea2d6099763c2dbc9d05b00c4b4
- K20 Center. (n.d.). Think-pair-share. Strategies. Retrieved from https://learn.k20center.ou.edu/strategy/d9908066f654727934df7bf4f5064b49
- Lamilly – Average is Beautiful. (2014). Retrieved from https://www.youtube.com/watch?v=OfQu8pq0kok#t=58