

Ratios and the Art of the Mogao Caves

Class

7th Grade CC Math, Accelerated 7th Grade CC Math, or 6th Grade CC Math

Standards

CC Math Standards 6RP3d, 6SP5c, 7RP1, 7RP2c, 7RP2d, 7RP3, as well as mathematical modeling of real-world situations.

Organizing Questions

1. Is there a relationship between arm span and height?
2. What is the ratio of arm span to height in general?
3. Is there a different relationship for people of different regions?
4. Is there a difference in these proportions over time?.
5. How and why do people change body ratios in art?

Introduction

Students have previous knowledge about genotypes and phenotypes. This will combine observable physical characteristics with measurements and numerical manipulation. This set of activities should be introduced after students have learned about scale factors and ratios. They should already be comfortable working with data sets and determining averages and MAD (mean absolute deviation).

Students will measure their arm span and height, take ratios, and find statistical measures. Students will do this for traditional western art and eastern art (using drawings and figurines from the Mogao caves and terra cotta warriors). Students will then compare phenotypes for different ethnicities, and for different periods over time.

Objectives

1. Students will take accurate measurements and successfully manipulate data in a statistically significant way.
2. Students will appreciate the aesthetics and cultural implications of ancient Chinese artwork.
3. Students will differentiate between full-sized and scale models and successfully convert between the two scales.

Materials:

1. Ruler and tape measure, 1 set per pair of students
2. Models of terra cotta warriors, 1 set to show class
3. Terra cotta warrior postcards, 10 unique cards
4. Mogao cave figures postcards, 10 unique cards
5. Western art drawings or color copies of the art images, 10 unique images
6. Daily handout, 1 copy per student (see attached)
7. Poster paper and pens, one set per group of 3-4 students

Equipment

1. A method of displaying the lesson's art images of western art (must be clearly visible to each student), i.e. a teacher computer connected to a projector and screen, a list of

websites with half a class set of iPads or laptops, a physical set of postcards or posters for students to use directly in the classroom etc.

Teacher preparation

1. Obtain materials.
2. Familiarize yourself with the history of the Silk Road in China and more specifically with the history of the Mogao Caves in Dunhuang
3. Study and become familiar with the basic tenets of Buddhism and characteristics of the body in Chinese and Tibetan Buddhist art (proportions, aesthetics, relationship to sutras etc.)

Time

4-6 days of 45-50 minute periods with daily homework assignments: 4 days for guided measurements and comparisons, a 5th day for gallery walk or test, and a 6th day for additional body shape ratio explorations.

Procedures

Day 1

1. Pass out "Body Measurements" worksheet (attached).
2. Divide students into pairs.
3. Direct students to measure their partners' arm spans according to the instructions in the "Body Measurements" worksheet.
4. Challenge students to come up with strategies that will ensure their measurements are accurate, for example, if the student's arms are by their sides, their partner can measure their arms span by adding up measurements of the left fingertips to left shoulder, left shoulder to right shoulder, right shoulder to right fingertips.
5. After students complete the "Body Measurements" worksheet, lead a class discussion about ruler use and accuracy.
6. Compile students' arm span and height measurements on the board and have students write down at least 7 other data points in addition to their own and their partners' arm span and height measurements before leaving class.
7. Calculate the ratio of arm span to height as a class and lead a class discussion on unitless dimensions for ratios
8. Homework: Have students find the average and MAD of the 9 ratios that they wrote down on their worksheets (arm span and height for themselves, their partner, and 7 other students).

Day 2

1. Ask students to share their data. Take the MAD divided by the mean and discuss statistical significance.
2. Show artwork and ask if people look like they have the same proportions thousands of years ago.
3. Discuss how height has changed over the generations. Discuss height variations regionally.
4. Ask again if body proportions look similar. Start with terra cotta warrior figurines. Use Terra cotta warrior figurine worksheet (attached). Discuss measurement units. Demonstrate measurements as a guided note activity.
5. Give students postcards of warriors and have them measure arm span and height, calculate ratio and get on board. Each pair of students is responsible for one data point.
6. Calculate class average and MAD together, or take photo of data to finish at home before start of next class.

Day 3

1. Pass out "Mogao Cave Art" worksheet (attached - I would photocopy this on the back of the terra cotta warrior figurine worksheet.)
2. Ask students to measure the height and arm span of a cave drawing figure and calculate the ratio.
3. Ask students to measure the height and arm span of a figure from western art and make the same calculations.
4. Collect the class results and put them on the white board or in a shared Google doc.
5. Homework: Students must come up with a statement about arm span to height ratios, i.e. I believe that all people have similar arm span to height ratios regardless of time they lived in or part of the world. Or, I believe people who lived thousands of years ago had proportionally longer arms than students today. They must defend that statement next class.

Day 4

1. Divide students into pairs to share their statements, and then have them share with slightly larger groups of 3-5 students.
2. Lead a class-wide discussion on the students' statements. Determine if differences in ratios are statistically significant (within 5 %).
3. Look at artwork images of buddhas and bodhisattvas as a whole class, and predict whether the ratio of arm span to height is similar. (Use Buddha drawing worksheet.)
4. Measure and calculate the buddhas and bodhisattvas' arm span to height ratios as a whole class and discuss the difference between reality and symbolic representation. (Maybe look at models in advertising to see how the images are manipulated for effect, but this would be an additional day and you would want to hand students specific images to look at.)

Day 5

1. Divide students into small groups of 3-4.
2. Have each group make a poster about one of the following topics: taking body measurements and calculating ratios, class mean and MAD calculations, proportion and scale model of terra cotta warrior figurines, ratio of warrior in postcard compared to body ratio, ratio of cave drawing figures compared to body ratio, ratio of western art drawing figure compared to body ratio, ratio of Buddha or Bodhisattva figure compared to body ratio, and (maybe) ratio of model figure compared to body ratio. (I have not yet written a rubric for this portion, but I would base it on the direction the classroom conversation takes.)
3. Take students on a gallery walk and have them give feedback on different posters and methods of calculations. (Did any new evidence or thinking change your views?)

Assessment

1. Student writing assignment summarizing their findings--I'd allow students to do this as words (3 paragraph minimum), graphics (poster with diagrams or illustrations), cartoon, video blog, or other format of their choosing. Again, I would base this on the direction of the class conversation, but I'd include a rubric so students know what's expected.
2. Exit ticket listing individual belief statement backed up by at least 2 different ratios-- Students may use class average data as one of their data sets. This could be at the end of day 2, 3, or 4.
3. Quiz--Give a quiz question with 2 drawings (one cave and one more contemporary) and

have the arm length and leg length labeled. Have students calculate ratios and compare for the two drawings.

4. Homework and class participation--Grade for completed homework assignments and in-class participation since students have already been tested on ratios, proportions, mean and MAD calculations, and comparison skills.

Notes

I haven't done any of these activities with students yet. I'm sure there will be adjustments. If you have ideas or input, please email me at bbergen@srvusd.net and thank you for your feedback.

Name: _____

Per.: _____

Partner: _____

Body Measurements

Partner A is the person with the later birthday. Have partner A stand with her arms outstretched.

Look at partner A. How will you measure her arm span?

What if her arms are down by her sides?

What if her arms are bent?

Now have partner B stand up straight.

Look at partner B. How will you measure his height?

What if he is sitting down?

What if he is sitting with legs crossed?

Measure the arm span and height for your partner. Write the information in the chart on the other side of this page. Get your own data into the chart as well.

Take the ratio of arm span to height for your partner. Does it matter what units you use?

Now fill out the chart with information from at least 7 other people in your class period.

Name									
arm span									
height									
ratio of arm span to height									

What is the average ratio of arm span to height?

What is the MAD of these numbers?

Name: _____

Per: _____

Terra cotta warrior figurine

What units will you use? Does it matter?

Arm span:

Height:

ratio of arm span to height:

class average:

class MAD:

If the warrior were a model of you, what would the scale factor be?

How does the warrior's ratio compare to yours?

Mogao cave art figure drawing

What units will you use? Does it matter?

Arm span:

Height:

ratio of arm span to height:

How does this ratio compare to the warrior figurine's?

How does this ratio compare to yours?

Western art image

What units will you use? Does it matter?

Arm span:

Height:

ratio of arm span to height:

How does this ratio compare to the warrior figurine's?

How does this ratio compare to the cave art's?

How does this ratio compare to yours?

Homework Question

Do you think body proportions have changed over time? Why? Use evidence in your argument.

Name: _____

Per: _____

Buddha art figure drawing

What units will you use? Does it matter?

Arm span:

Height:

ratio of arm span to height:

How does this ratio compare to yours?

Bodhisattva art image

What units will you use? Does it matter?

Arm span:

Height:

ratio of arm span to height:

How does this ratio compare to the Buddha's?

How does this ratio compare to yours?

Homework Question

Why do you think that these images are exaggerated? What effect do you think the artist is trying to convey? Is it effective?