EXPLORATIONS

Activity 2

Follow the Golden Rule

Objectives

- To use technology to find ratios
- To use technology to find measures of central tendency
- To use technology to plot a box-and-whisker plot

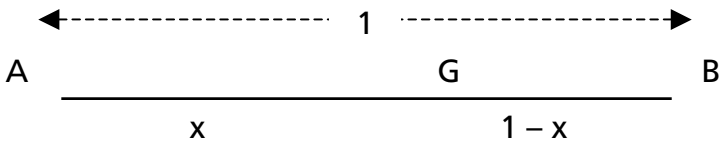
Materials

- TI-73 graphing device
- Metric tape measure (meter stick)

Introduction

What could the *Mona Lisa* painting, sunflowers, pine cones, the family tree of the drone bee, the Great Pyramid of Giza, and the human body have in common? The answer is the *Golden Ratio*. Early Greek mathematicians were fascinated by this ratio. Euclid, the Greek mathematician, showed how to *divide a line in mean and extreme ratio*, which is called *finding the golden section G point on the line.* This means that *the ratio of the smaller part of a line (GB) to the larger part (AG) is equal to the ratio of the larger part (AG) to the whole line (AB)*. This ratio is approximately 1.618033989. The exact value of the Golden Ratio is $\frac{1+\sqrt{5}}{2}$.

$$\frac{GB}{AG} = \frac{AG}{AB} \quad \text{or} \quad \frac{1-x}{x} = \frac{x}{1}$$



The Golden Ratio is said to be one of the most visually pleasing geometric forms. Masterpieces from ancient times as well as more recent works of art include examples of the Golden Ratio. A golden spiral and the *Fibonacci sequence* are closely related to the Golden Ratio and can be found in sunflowers and pine

cones. The family tree of the drone bee can be linked to the *Fibonacci sequence*, which can be used to find the Golden Ratio.

The *Rhind Papyrus,* dating from 1650 B.C., is one of the oldest mathematical records in existence, giving evidence that the Egyptians had knowledge of the Golden Ratio or, as they referred to it, the *Sacred Ratio*. The Egyptians used the Golden Ratio when building the pyramids, temples, and tombs. Egyptian history shows how proportions of the human figure are related to the width of the palm of the hand. These measurements are based on the *Golden Ratio*. For example, the Egyptians believed the height of a person from the feet to the hairline was equal to eighteen palms. Is your height equal to eighteen of your palms?

Problem

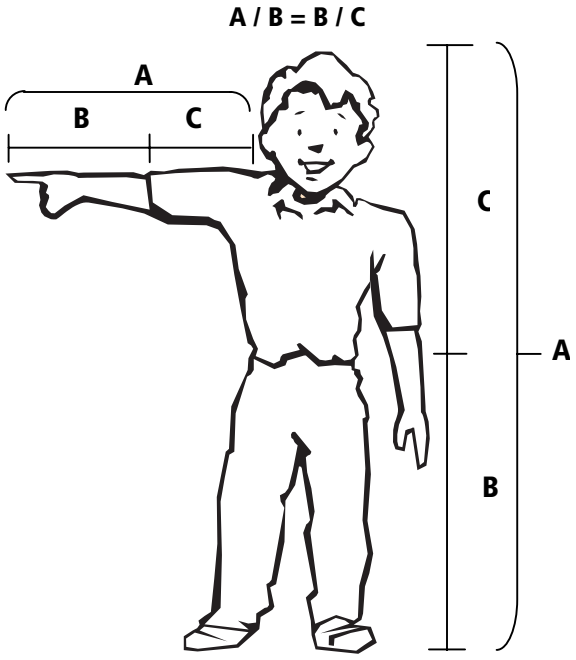
Were the Egyptians correct in relating the Golden Ratio to the human body? Are the proportions in your body related to the Golden Ratio?

Collecting the data

1. You should have at least one partner for this activity. Obtain a tape measure from your teacher. Tape the tape measure to the wall. Make sure the tape measure has the lowest measurement starting from the floor.

2. Measure (a) the height of your partner; (b) the distance from your partner's navel to the floor; and (c) the distance from the top of your partner's head to his/her navel. Record these values in the table on the **Data Collection and Analysis** page.

3. Measure (a) the distance from your partner's shoulder to the tip of his/her hand; (b) the distance from your partner's elbow to the tip of his/her hand; and (c) the distance from your partner's shoulder to his/her elbow. Record these values in the table on the **Data Collection and Analysis** page.

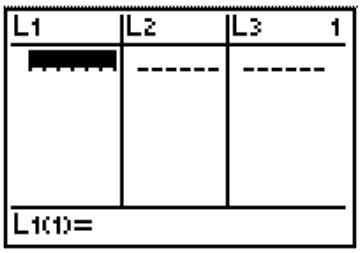


Setting up the TI-73

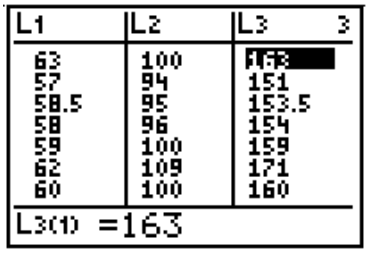
Before starting your data collection, make sure that the TI-73 has the STAT PLOTS turned OFF, Y= functions turned OFF or cleared, the MODE and FORMAT set to their defaults, and the lists cleared. See the Appendix for a detailed description of the general setup steps.

Entering the data in the TI-73

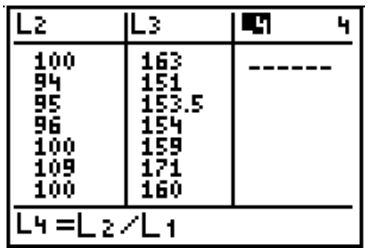
1. Press [LIST].



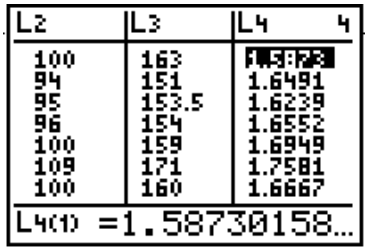
2. Enter the data from number 2 (a), (b), and (c) of the **Collecting the data** section in **L1**, **L2**, and **L3** respectively.



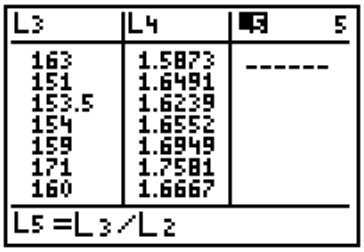
3. To find the ratio of **L2** to **L1**, press ▶ ▲ to highlight **L4**. Press [2nd] [STAT] **2:L2** ÷ [2nd] [STAT] **1:L1**.



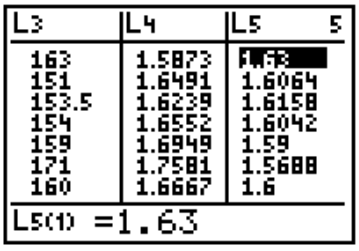
4. Press [ENTER] to complete the ratio calculation. The list is displayed as shown.



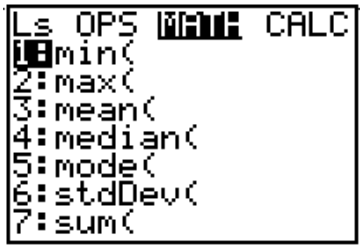
5. To find the ratio of **L3** to **L2,** press ▶ ▲ to highlight **L5**. Press [2nd] [STAT] **3:L3** ÷ [2nd] [STAT] **2:L2**.



6. Press [ENTER] to complete the ratio calculation. The list is displayed as shown.

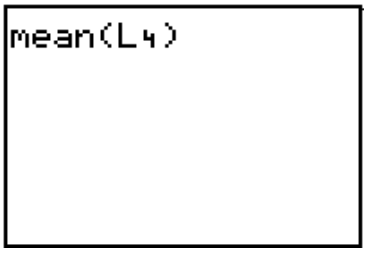


7. Find the mean of the class data for **L4**. Press [2nd] [QUIT] to return to the Home screen. Press [2nd] [STAT] [▶] [▶] to move the cursor to the **MATH** menu.

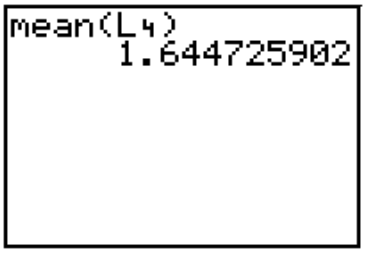


8. Select **3:mean(** by pressing **3**.

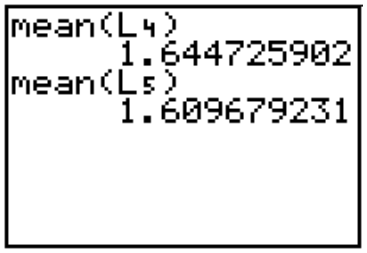
9. Press [2nd] [STAT] **4:L4** [)].



10. Press [ENTER] to calculate the mean.



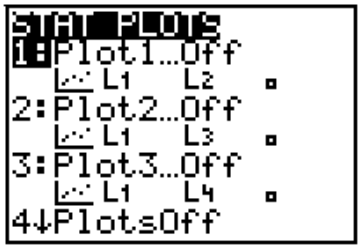
11. Repeat Steps 7 – 10 to calculate the mean of **L5**.



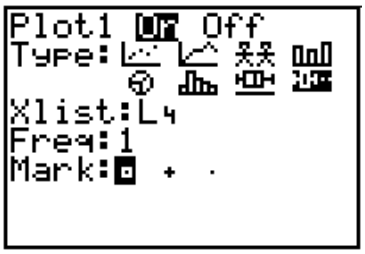
Answer questions 1 through 4 on the **Data Collection and Analysis** page.

Graphing the data: Setting up a box-and-whisker plot

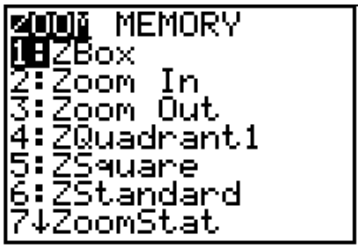
1. Plot a box-and-whisker plot for the data in **L4**. Press [2nd] [PLOT]. Select **1:Plot1** by pressing **1** or [ENTER].



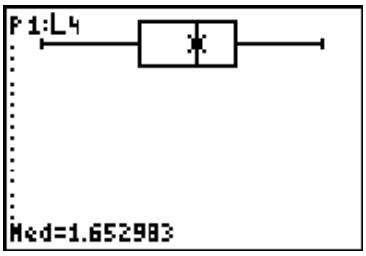
2. Set up the plot, as shown, by pressing ENTER ▼ ▶ ▶ ▶ ▶ ▶ ▶ ▶ ENTER ▼ 2nd [STAT] **4:L4** ▼ **1** ▼ ENTER.



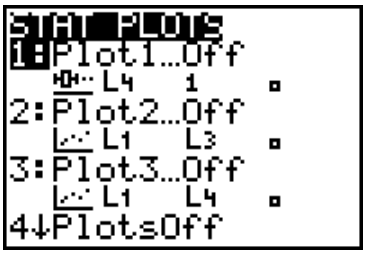
3. Press ZOOM. Select **7:ZoomStat** by pressing **7**.



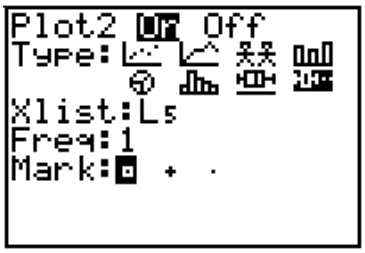
4. Press TRACE. Use ◀ and ▶ to see the values of the median, quartiles, and extreme values.



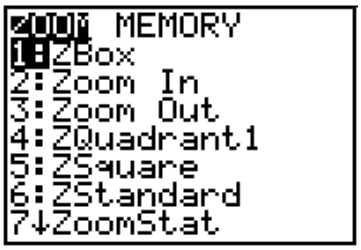
5. Plot a box-and-whisker plot for the data in **L5**. Press 2nd [PLOT]. Select **2:Plot2** by pressing **2**.



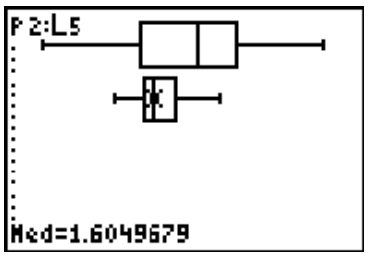
6. Set up the plot, as shown, by pressing ENTER ▼ ▶ ▶ ▶ ▶ ▶ ▶ ▶ ENTER ▼ 2nd [STAT] **5:L5** ▼ **1** ▼ ENTER.



7. Press ZOOM. Select **7:ZoomStat** by pressing **7**.



8. Press [TRACE]. Press [▼] to move to Plot2. Use [◀] and [▶] to see the values of the median, quartiles, and extreme values.



Answer questions 5 and 6 on the **Data Collection and Analysis** page.

Data Collection and Analysis

Name _____

Date _____

Activity 2: Follow the Golden Rule

Collecting the data

Record your data in the table below. You may use inches or centimeters.

Distance from head to navel	Distance from navel to floor	Distance from head to floor	Distance from shoulder to elbow	Distance from elbow to tip of hand	Distance from shoulder to tip of hand

Analyzing the data

1. What is the mean of the data for the list containing the ratio for the head to navel and navel to floor data?

_____

2. Is the number that you entered in number 1 close to the Golden Ratio? Explain why the number might be different from the Golden Ratio.

_____

_____

3. If you used more students in your data collection, would you expect your value to be closer to the Golden Ratio? Why or why not?

_____

_____

4. Follow the directions in the **Entering the data in the TI-73** section for the shoulder to elbow, elbow to tip of hand, and shoulder to tip of hand data. What is the mean, to three decimal places, of the ratios between the shoulder to elbow measurements and the elbow to hand measurements? Is this value close to the Golden Ratio?

_____

_____

5. What are the lower quartile Q_1, the median, the upper quartile Q_3, and the two extreme values of the head/navel data?

Lower quartile Q_1: _____ Upper quartile Q_3: _____

Median: _____ Lower extreme: _____

Upper extreme: _____

6. What are the lower quartile Q_1, the median, the upper quartile Q_3, and the two extreme values of the navel/floor data?

Lower quartile Q_1: _____ Upper quartile Q_3: _____

Median: _____ Lower extreme: _____

Upper extreme: _____

Extensions

- Collect data on the distance from your chin to the point between your eyes and from your chin to your hairline. Set up a proportion to determine if the ratios form a Golden Ratio.
- Collect some leaves and research to find which ratios form a Golden Ratio. Determine if your leaves contain Golden Ratios. Find other species that contain the Golden Ratio, such as pine cones and the family tree of the drone bee.

Teacher Notes

Activity 2

Follow the Golden Rule

Objectives

- To use technology to find ratios
- To use technology to find measures of central tendency
- To use technology to plot a box-and-whisker plot

Materials

- TI-73 graphing device
- Metric tape measure (meter stick)

Answers to Data Collection and Analysis questions

Collecting the data

Sample data, in centimeters:

Distance from head to navel	Distance from navel to floor	Distance from head to floor	Distance from shoulder to elbow	Distance from elbow to tip of hand	Distance from shoulder to tip of hand
63	100	163	27.5	46	73.5
57	94	151	27	43	70
58.5	95	153.5	26	42	68
58	96	154	27	41.5	68.5
59	100	159	27	45	72
62	109	171	32	44	76
60	100	160	26	42	68
56.5	96	152.5	25	42	67
62	107	169	22	44	66
63	98	161	26	40.5	66.5
68	100	168	25	43	68
63	104	167	27	45	72
57	93	150	23	40	63
62	107	169	27	42	69
69	103	172	24	41	65
65	101	166	26	43.5	69.5
59	98	157	22	39	61
66	119	185	30	49	79

Analyzing the data

1. What is the mean of the data for the list containing the ratio for the head to navel and navel to floor data?

The mean of the data is 1.645.

2. Is the number that you entered in number 1 close to the Golden Ratio? Explain why the number might be different from the Golden Ratio.

Yes. Answers may vary. The measurements could be inaccurate.

3. If you used more students in your data collection, would you expect your value to be closer to the Golden Ratio? Why or why not?

Yes. This would minimize the effect of any outliers.

4. Follow the directions in the **Entering the data in the TI-73** section for the shoulder to elbow, elbow to tip of hand, and shoulder to tip of hand data. What is the mean, to three decimal places, of the ratios between the shoulder to elbow measurements and the elbow to hand measurements? Is this value close to the Golden Ratio?

The mean of the data is 1.655. Yes.

5. What are the lower quartile Q_1, the median, the upper quartile Q_3, and the two extreme values of the head/navel data?

Lower quartile Q_1: *1.587* Upper quartile Q_3: *1.699* Median: *1.653*

Lower extreme: *1.471* Upper extreme: *1.803*

6. What are the lower quartile Q_1, the median, the upper quartile Q_3, and the two extreme values of the navel/floor data?

Lower quartile Q_1: *1.589* Upper quartile Q_3: *1.630* Median: *1.605*

Lower extreme: *1.555* Upper extreme: *1.680*

Answers to Extensions questions

- Collect data on the distance from your chin to the point between your eyes and from your chin to your hairline. Set up a proportion to determine if the ratios form a Golden Ratio.

  Answers may vary.

- Collect some leaves and research to find which ratios form a Golden Ratio. Determine if your leaves contain Golden Ratios. Find other species that contain the Golden Ratio such as pinecones and the family tree of the drone bee.

  This could be assigned as a student research project.