Using Your Hair to Understand
Descriptive Statistics: Teacher's Copy

Purpose: The purpose of this activity is to enhance students' understanding of various descriptive measures. In particular, by completing this hands-on activity students will experience a visual interpretation of a mean, median, outlier, and the concept of distance-to-mean.

Learning Ojectives:
Students who complete this activity will
- discover the concepts of a mean, median, outlier, and distance-to-mean with minimal use of numbers, and
- gain a visual understanding of descriptive measures used in statistics.

Required Materials: Two different colors of string, scissors, masking tape, and ruler for each group of 5 students

Consider the following line segment which is approximately 50mm long.

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Questions:

1. What is your guess for your hair length (in millimeters)?

2. Which group member will have the longest or shortest hair length?

3. Discuss with your group what a reasonable guess is for the average or mean hair length.

4. Which group member will be closest to the average or mean hair length?

Remove one strand of your hair. Measure the length of your hair (in millimeters) using the ruler provided. Record the results from your group here.

Person	Hair Length (mm)
1.	
2.	
3.	
4.	
5.	
Sum =	

Next, have each group member cut a piece of white string that matches their hair length. Using a piece of tape, label each string with your name. Order the pieces of white string on your table from shortest to longest. Place the shortest on the far left and the longest on the far right.

Questions:

5. Find the piece of white string that is in the middle. What is the length of this piece of string?

6. What does the length of this string represent? Which group member does this piece of string belong to? What does this imply about this person's hair?

Set the white strings aside and have each group cut a single piece of red string that has a length equal to the sum all hair lengths.

Questions:

7. How would you determine the average or mean hair length using only this piece of red string?

8. Explain how we could obtain the average or mean hair length for the entire class without using any formulas? How many times would the string need to be folded for the entire class?

Cut the folded red string so that each group member has a piece that represents the average or mean hair length.

Questions:

9. What is the length of each piece of red string? How close is this measurement to your initial guess of the average or mean hair length?

10. Compare the median hair length (i.e. middle piece of white string) to the average or mean hair length (red piece of string). Is there much of a difference?

Teacher's Note:

The following questions are optional and allow for comparisons to be made.

- What would likely happen to the white pieces of string if your group consisted of all boys? How about a group with all girls?

- Having all boys or girls in a group would also affect the red pieces of string. What differences would we expect in the red string for a group of all boys versus a group of all girls?

The individual to the right is Tran Van Hay from Vietnam. He stopped getting hair cuts in 1973. Thirty-one years later his hair measured 6200 millimeters (i.e. 6.2 meters or about 20 feet).

Questions:

11. What would happen to the initial piece of red string if Tran Van Hay was in your group?

12. What effect would Tran Van Hay have on the average or mean hair length?

13. Tran Van Hay's extremely long hair would not affect the median. Give a justification as to why using your strings.

Align your piece of white string next to your red string. Cut whichever string is necessary so that the two pieces are of the same length. Keep the residual piece of string (i.e. the piece of string that is not the same length as the other two).

Questions:

14. What does your residual piece of string represent?

15. Who has the shortest piece of residual string? Is this the person you suggested earlier as having hair length closest to the average or mean?

16. Why do some of your group members have red residual string and others white residual string?

Teacher's Note:

The following questions may not be appropriate for all grade levels.

- Would a group of all boys have mostly red residual string? Would a group with all girls have mostly white residual strings? Why or why not?

- Align the white residual strings end-to-end. Do the same for the red residual strings. Are these two sets the same length?

  Comment: Realize this is a visual proof to the fact that residuals or deviances from the mean sum to zero, i.e. $\sum_{i=1}^{n}(X_i - Mean) = 0$. This fact is important because when measuring variation in data, using something like $\sum_{i=1}^{n}(X_i - Mean)^2$ or $\sum_{i=1}^{n}|X_i - Mean|$ is necessary.

A visual understanding of the average distance-to-mean (i.e. standard deviation) for hair length can be done by asking students to repeat the determination of an average using the residual string instead of hair length. Realize, this average distance-to-mean will be slightly bias as standard deviation uses (n-1) in the denominator whereas the average uses n in the denominator.

Potential Assessment Items:

Assessment items that are centered on various group characteristics.
- What would likely happen to the white pieces of string if your group consisted of all boys? How about a group with all girls?
- Having all boys or girls in a group would also affect the red pieces of string. What differences would we expect in the red string for a group of all boys versus a group of all girls?

Other possible assessment items for students of various mathematical abilities.
- Give a definition of an average or mean without using a formula.
- Would a group of all boys have mostly red residual string? Would a group with all girls have mostly white residual strings? Why or why not?
- Align the white residual strings end-to-end. Do the same for the red residual strings. Are these two sets the same length? What is the consequence of this result when attempting to measure distance-to-mean.
- Ask students to give a visual proof as to why the Sum of (Data-Mean) over all observations is equal to 0.
- Ask students to visually explain why the standard deviation cannot be less than 0.

Reference
Understanding Mean Activity, TeacherVision. [Online:
www.teachervision.fen.com/statistics/mathematics/4913.html]