Using Your Hair to Understand Descriptive Statistics

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Learning Objectives

The purpose of this activity is to enhance students' understanding of various descriptive measures. This activity will appeal to students with various learning styles. Students who complete this activity will…

- Discover the concepts of a mean, median, outlier, and distance-to-mean with minimal use of numbers
- Gain a visual understanding of descriptive measures used in statistics.

Motivation

GAISE Recommendations:

- Rec. 3: Stress conceptual understanding, rather than mere knowledge of procedures
- Rec. 4: Foster active learning

Various Learning Style Dimensions (Felder, 1993):

Sensing Learners	vs.	Intuitive Learners
• Focus on sensory input • Practical • Observant • Concrete: facts and data • repetition		• Focus on subconscious • Imaginative • Look for meanings • Abstract: Theory and models • Variety

Motivation, cont.

Various Learning Style Dimensions (Felder, 1993):

Visual Learners vs. **Verbal Learners**

- "Show me."
  - Pictures
  - schematics
- "Explain it to me."
  - Spoken words
  - Written words

Active Learners vs. **Reflective Learners**

- Process actively
- Think out loud
- Like group work
- Process introspectively
- Work quietly
- Like solo or pair work

Starting the Activity

Required Materials:

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

Instructions:

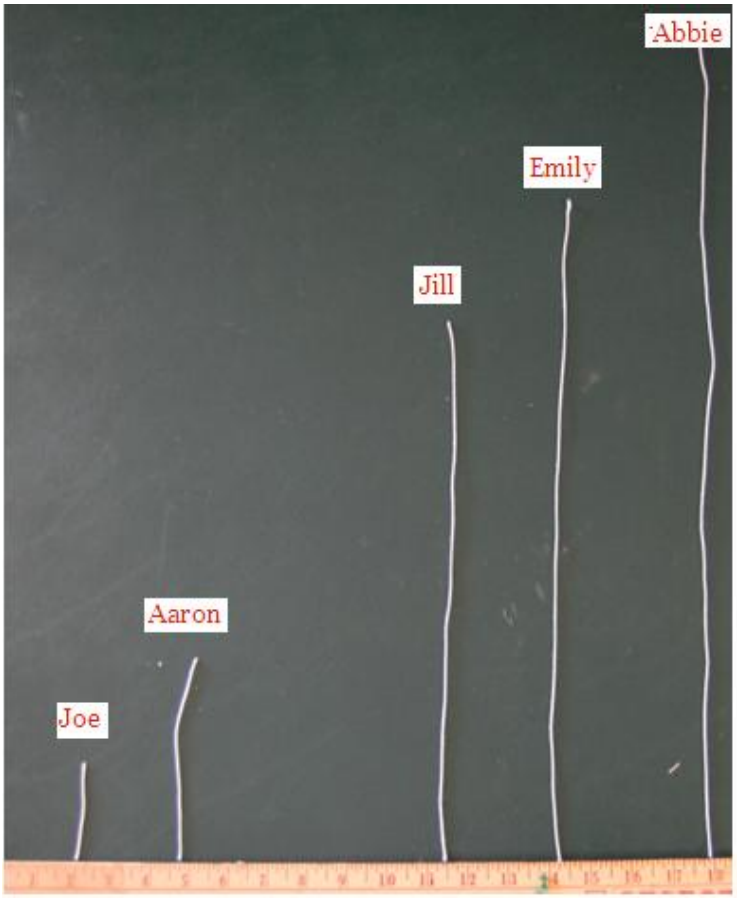
- Remove one strand of your hair and measure the length of this strand (in mm).
- Cut a piece of white string that matches your hair length, and label the string with your name.

Results from 5 hypothetical students:

Person	Hair Length (mm)
1. Emily	356
2. Jill	285
3. Aaron	115
4. Joe	47
5. Abbie	450

Activity: Introductory-Level

Order the pieces of white string from shortest to longest:



Questions:

1. Find the piece of white string that is in the middle. What is the length of this string?
2. What does the length of this string represent?
3. Which group member does this piece of string belong to? What does this imply about this person's hair?

Activity: Introductory Level, cont.

"Calculating" the Mean:

- Set the white strings aside, and have each group cut a single piece of green string whose length equals the sum of all hair lengths in the group.

Questions:

4. How would you determine the average (or mean) hair length using only this piece of green string?
5. Explain how we could obtain the average hair length for the entire class without using any formulas or calculations.

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

Questions:

6. What is the length of each piece of green string, and what does this represent?
7. Compare the median hair length to the average hair length. Is there much of a difference?

Activity: Intermediate Level

The individual on the right is Tran Van Hay from Vietnam. He stopped getting haircuts in 1973. Thirty-one years later, his hair measured 6200 mm.

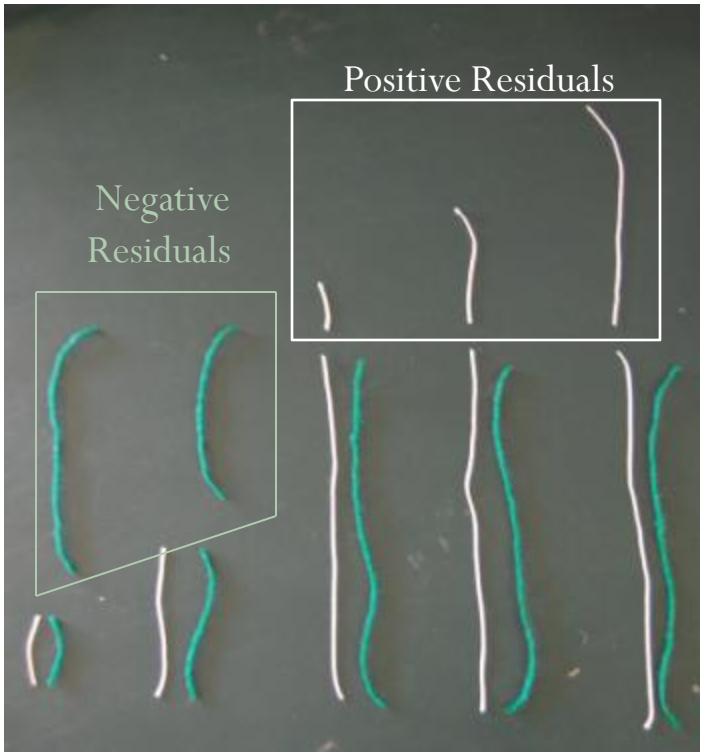
Questions:

8. What would happen to the initial piece of green string if Tran Van Hay was in your group?
9. What effect would Tran Van Hay have on the average or mean hair length?
10. Tran Van Hay's extremely long hair would not affect the median. Give a justification as to why this is true using your strings.

Activity: Intermediate Level

Investigating the Residuals:

- Align your piece of white string next to your green string. Cut whichever string is necessary so that the two pieces are of the same length. Keep the residual piece of string.



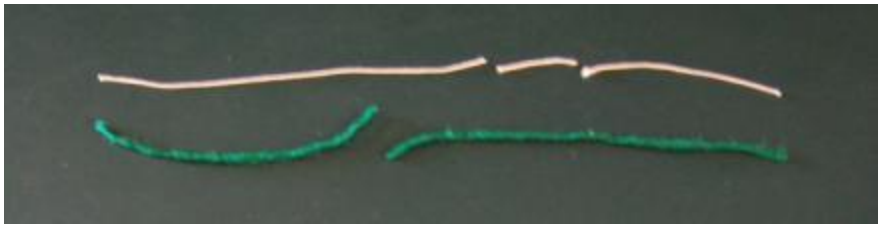
Questions:

11. What does your residual piece of string represent?
12. Who has the shortest piece of residual string? Is this the person whose hair length is closest to the mean?
13. Why do some of your group members have green residuals and others white residuals?

Activity: Advanced Level

Align the white residual strings end-to-end. Do the same for the green residual strings. What do you notice?

Realize this is a visual proof that $\sum_{i=1}^{n}(x_i - \bar{x}) = 0$.



This is important because when measuring variation in data, we must use either $\sum_{i=1}^{n}|x_i - \bar{x}| = 0$ or $\sum_{i=1}^{n}(x_i - \bar{x})^2 = 0$.

More Assessment Items

Introductory Level:

1. What would likely happen to the white pieces of string if your group consisted of all boys? What about a group of all girls?
2. What differences would you expect in the green string for a group of all boys versus a group of all girls?
3. Give a definition of "average" without using a formula.

Intermediate/Advanced Level:

4. Would a group of all boys have mostly green residual string? Would a group of all girls have mostly white residual strings? Why or why not?
5. Use your strings to explain why the standard deviation cannot be less than zero.

Discussion

Challenges:

- Students with short/layered/no hair?
- Can be challenging for students to divide green string into five equal pieces; however, having an odd number in each group makes visualizing the median easier.
- Measurement errors?

Benefits:

- Fosters an active learning environment.
- Appeals to more than one learning style.

References

- Felder, Richard. "Reaching the Second Tier: Learning and Teaching Styles in College Science Education." *J. College Science Teaching*, 23(5), 286-290 (1993).

- GAISE (2005). GAISE college report. [Online: http://www.amstat.org/education/gaise/GAISECollege_Recommendations.pdf].

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