Representing Data Using Boxplots

Strand: Probability and Statistics

Topic: Collect and analyze data using a boxplot.

Primary SOL: 8.12 The student will
   a) represent numerical data in boxplots;
   b) make observations and inferences about data represented in boxplots; and
   c) compare and analyze two data sets using boxplots.

Materials

- Creating a Boxplot (Box-and-whisker Plot): Problem 1 activity sheet (attached)
- Boxplots: Problems 2 activity sheet (attached)
- Boxplots: Problems 3 activity sheet (attached)
- Rulers
- Calculators

Vocabulary

extreme data values, mean, median, range (earlier grades)

interquartile range, lower quartile, maximum, minimum, upper quartile (8.12)

Student/Teacher Actions: What should students be doing? What should teachers be doing?

1. Distribute the Boxplot activity sheets (1, 2, and 3). Have students follow along as you complete the first problem in creating a boxplot (box-and-whisker plot) with the whole class. Students will not need familiarity with boxplots in order to complete the first page. As a class, discuss the answers and reasoning behind the answers to the first problem. *Note: This problem has an odd number of data entries. Make sure to point that out to the students.*

2. Have students complete the second problem in pairs or small groups. As a class, discuss the answers and reasoning behind the answers to the second problem. As students are discussing how they compared the two boxplots, listen for and encourage talk about percentages (e.g., 75 percent of the students scored higher than 77 percent), the spread of the data (e.g., interquartile range, range), Class 2 not having a right whisker, and the boxplot not showing the mean. *Note: This problem has odd-numbered and even-numbered sets of data. Make sure you go over the differences between the two.*

3. *Have students complete the third problem in groups of four. To reduce the time spent on constructing the boxplots, direct two students in each group to create boxplots of the men's data and check accuracy, while the other two create boxplots of the women's data. Make sure all students are using the same number line in order to make it possible to compare boxplots later. As groups make conclusions about the experiment, encourage them to use of the boxplots to justify their conclusions. Have each group write their conclusions on chart paper for whole-class discussion. During class discussion of the third problem, allow each group to present and justify a conclusion they made.*

Encourage discourse by asking students to restate their conclusions and the reasoning behind them and asking other students whether they agree or disagree with the conclusions and/or reasoning. *Note: This problem has four data sets, all with even numbers of data.*

Assessment

- **Questions**
  - What information can you obtain from a boxplot?
  - What information can you *not* obtain from a boxplot?
  - In what situation might you want to use a boxplot?

- **Journal/Writing Prompts**
  - Explain the advantages and disadvantages of using boxplots.
  - Describe how you might compare two boxplots.

- **Other**
  - Have students gather data related to two groups and present the data in boxplots. Then, have them analyze and compare the plots, noting their observations. Finally, have them exchange plots, analyze each other's plots, and compare observations. Data collection could involve students gathering information from their classmates and then splitting the data into two groups based on gender. Other possibilities include gathering data about two sports teams, salary data of men and women, life expectancies in two different areas of the world, etc.

Extensions and Connections (for all students)

- After gathering and displaying data in boxplots, have students eliminate an outlier to see what effect that has on the plot.

- Have students explore what happens to the mean when an outlier is removed.

- Have students represent the same data with a different graphical representation. Have them explore the difference between the representations and list any advantages or disadvantages of one over the other.

- Have students create boxplots of their quiz grades. Then, have them compare these plots to plots of their grades in other subjects or to plots of their grades during a previous marking period.

Strategies for Differentiation

- Have students create a graphic organizer illustrating the process of constructing a boxplot.

- Allow students to use graph paper when constructing boxplots.

- Provide number lines (*x*-axis) and straight edges to those students who need them.

- Clarify and simplify the description of data and directions for problem 3.

Note: The following pages are intended for classroom use for students as a visual aid to learning.

Virginia Department of Education © 2018

Creating a Boxplot (Box and Whisker Plot): Problem 1

A restaurant owner wants to know how far his customers are traveling to eat at his restaurant. He recorded their miles traveled for a day.

19, 2, 3, 7, 3, 1, 23, 5, 10, 15, 11, 18, 3, 2, 5, 12, 14

Use the steps below to make a boxplot for this data.

1. Start by drawing an ***evenly scaled*** number line horizontally along the bottom of the page. This should represent your data appropriately. It should start just below the minimum piece of data and end just after the maximum piece of data. It should be evenly scaled, by an amount that is most helpful.

2. Label or title this horizontal axis.

3. Sort your data from the smallest to the largest value. Then find these five pieces of data: **minimum, lower (first) quartile, median, upper (third) quartile, and the maximum** (*See note below to help with calculations.)

4. Two lines **above** the number line place points at the min (minimum) and max (maximum).

5. From 1 to 3 lines **above** the number line, draw a vertical line at the each of the following: lower quartile (LQ), median, and upper quartile(UQ).

6. To form the "**box**", draw horizontal lines connecting the top of the LQ to the top of the UQ and the bottom of the LQ to the bottom of the UQ. Note: these lines will also touch the top and bottom of the median vertical line.

7. The "**whiskers**" are drawn from the center of the sides of the box to the points above the min and max.

8. Title the graph.

Note: To find the minimum (min), lower (or first) quartile (LQ), median, upper (or third) quartile (UQ), and the maximum (max):
   - To find the **median**, line up the data from least to greatest. Then, the median is the middle piece of data. If there are an even number of data values, take a mean of the middle two.
   - The median divides the data into two halves. To divide the data into quarters (finding the upper and lower quartiles), you then find the medians of these two halves. Note: If you have an even number of values (meaning the first median was the average of the two middle values), then you include the middle values in your submedian computations. If you have an odd number of values (meaning the first median was an actual data point), then you do not include that value in your submedian computations.
   - The **minimum**, or min, is the smallest value.
   - The **maximum**, or max, is the largest value.

Boxplots: Problem 2

Name _____Date_____

Scores on the first mathematics test are as follows:

Class 1

Student	A	B	C	D	E	F	G	H	I	J
Score	55	64	83	92	100	77	86	95	80	98

Class 2

Student	A	B	C	D	E	F	G	H	I
Score	52	79	71	100	100	76	100	78	76

1. Make a boxplots of each set of data.

2. Sketch each boxplot, identifying the Min, Q1, Med, Q3, and Max of each.

3. Which class did better? _____ Why?

4. What is the average (mean) score for each class?

5. Does this change your opinion about which class did better? _____ Why, or why not?

6. Can the wording affect how one perceives the overall picture of "which class did better?"

    _____ If so, in what way?

Boxplots: Problem 3

Name _____Date_____

An experiment found a significant difference between men and women with regard to their ability to identify unseen objects held in their left hands. The left hand is controlled by the right side of the brain, while the right hand is controlled by the left side of the brain. The test involved 20 small objects that participants were not allowed to see. First, they held 10 of the objects, one by one, in their left hands and guessed what they were. Then, they held the other 10 objects, one by one, in their right hands and guessed what they were.

Correct Guesses

Women, Left	Women, Right	Men, Left	Men, Right
8	4	7	10
9	1	8	6
10	8	7	10
6	9	5	10
10	6	7	7
8	10	8	9
9	4	10	10
7	9	4	8
9	8	10	10
10	9	8	9

1. Make boxplots that will allow you to compare the data.

2. Draw conclusions about the experiment, based on analyzing the boxplots and comparing them to one another.