Mean or Median? – The Great Box-and-Whisker Plot

An activity to introduce students to box-and-whisker plots.

Goals/Objectives:

Data Analysis and Probability Standard

Benchmarks grade 5-7

A. Read, create and use line graphs, histograms, circle graphs, box-and-whisker plots, stem-and-leaf plots, and other representations when appropriate.

E. Collect, organize, display and interpret data for a specific purpose or need.

F. Determine and use the range, mean, median and mode to analyze and compare data, and explain what each indicates about the data.

Indicators grade 7

1. Read, create and interpret box-and-whisker plots, stem-and-leaf plots, and other types of graphs when appropriate.

3. Analyze a set of data by using and comparing combinations of measures of center (mean, mode, median) and measures of spread (range, quartile, interquartile range), and describe how the inclusion or exclusion of outliers affects those measures.

Benchmarks grade level 8-10

A. Create, interpret and use graphical displays and statistical measures to describe data; e.g., box-and-whisker plots, histograms, scatterplots, measures of center and variability.

C. Compare the characteristics of the mean, median and mode for a given set of
data, and explain which measure of center best represents the data.

D. Find, use and interpret measures of center and spread, such as mean and quartiles, and use those measures to compare and draw conclusions about sets of data.

Indicators grade 8

1. Use, create and interpret scatterplots and other types of graphs as appropriate.

4. Compare two sets of data using measures of center (mean, mode, median) and measures of spread (range, quartiles, interquartile range, percentiles).

5. Explain the mean’s sensitivity to extremes and its use in comparison with the median and mode.

**Rationale:**

Most students have a limited understanding of how different data sets with different characteristics can effect the mean and median. They tend to only think of the procedures used to find these two measures of central tendency when asked about them. The series of activities contained in this lesson are designed to help students gain an understanding of what is being measured by both of these statistics and how each is affected by different aspects of the data.

**Materials/Resources:**

- calculator
- adding machine paper
- tape
- overhead projector
- worksheets

Resources: Show-Me Center (http://www.showmecenter.missouri.edu/)

Trashketball video (http://www.mmmproject.org/data.htm)

Ohio Mathematics Academy Program-Module 3: Data Analysis and Probability, Number, Number Sense and Operations 2004-2005
Procedures:

1. You will need to look up an interesting fact from the internet or encyclopedia to use in this lesson. The fact used for this particular lesson was “how many people visit Cedar Point Amusement Park during its 140 day season”. You can change the wording to reflect your interest.

2. Ask students, “How many of you are planning to visit Cedar Point this summer?” “Have you ever wondered how many people actually visit Cedar Point Amusement Park in a season?” Then, tell them that today they’re going to make an educated guess about that number so that as a class they can collect and use the data to come to a better understanding of mean and median as it pertains to their guesses.

3. Pass out the student worksheets.

4. Have students look up the definitions to the first four words and put them in their own words. Tell them that they’ll define the last three later. When they’ve finished, they can answer the first question on their worksheet.

5. Discuss their definitions with them and answer any questions they may have.

6. Have the class choose a recorder to keep track of student responses to the first question on the overhead. The rest of the class can write the responses on their worksheet.

7. Have students put the data in ascending order. When they’ve finished, they can answer the second question on their worksheet.

8. Make sure every student has a calculator (I prefer the graphing ones due to the view screen) and have them work through the calculations section. When finished, ask them if anyone knows the special names we give to the median of the lower_ and
median of the upper __. If there are no responses or incorrect ones, tell them we call them the first and third quartile. Then, ask them if they can guess what we call the actual median of the data.

9. Have students answer the third question and define the last three terms on their worksheet. While they are doing that, tear off a long piece of adding machine paper and tape it horizontally to the middle of the chalkboard. Mark the lowest data value on the left edge and the highest data value on the right edge.

10. Discuss students’ thoughts on the third question. Ask them if there was one particular value(s) that influenced their choice. This may be a good time to talk about outliers.

11. Explain to the students that what you have created on the chalkboard is a “number line” and as a class they’re going to “plot” their three quartiles on it. Choose a student to plot the lower quartile data point. Next, choose one to plot the median (second quartile), and then another to plot the third quartile data point.

12. Extend lines vertically from these three points and connect the first and third quartiles to form a “box”. Connect the lowest data point to the box with a horizontal line, then do the same with the highest data point. Tell the students that this is what we call a box-and-whisker plot.

13. Have students copy this box-and-whisker plot onto their worksheet. When they have finished, ask them what the box represents. Discuss the lengths of the whiskers and why they might not be the same. Have them locate the mean of the data. Discuss its location and what that might mean.

14. Have students answer the set of questions on their worksheet about the plot they
drew. When they have finished, have them discuss their thoughts with fellow classmates, then share with the rest of the class.

15. Assign the two practice and application problems for homework.

Assessment:

To assess whether students have learned the material, have them complete the extension activity independently. Reteach anything that they didn’t understand.
Mean or Median? – The Great Box-and-Whisker Plot

Definitions:
Mean-
Median-
Range-
Outlier-
First quartile-
Second quartile-
Third quartile-

Question:
How many people per year visit Cedar Point Amusement Park during its 140 day season?
Guess = ________________________________

Data Collection:

Question:
Do you think the mean or the median of the data collection is closer to the actual answer?
Response = ________________________________
Calculations:
Mean of the data collection = __________________________

Median of the data collection = __________________________

Range of the data collection = __________________________

Median of the lower _ of the data collection = __________________________

Median of the upper _ of the data collection = __________________________

Question:
What group of guesses would you consider “average” or “typical”? If you had to choose the “typical” half of the data and consider the other half to be not typical, how would you choose?
Response = ______________________________________________________

____________________

Draw a Box–and–Whisker Plot for the data collection.

Questions:
What does a box-and-whisker plot tell you about the set of data that a single number like the range does not?

When might the median be a better measure of the “center” of a set of data than the mean?

When might the mean be a better measure?
Practice and Applications:

For each set of data: draw a box-and-whisker plot, find the range, find the mean, and find the first, second, and third quartiles.

1. 10, 5, 9, 50, 10, 3, 4, 15, 20, 6

   Range =
   Mean =
   First quartile =
   Second quartile (median) =
   Third quartile =


   Range =
   Mean =
   First quartile =
   Second quartile (median) =
   Third quartile =
Mean or Median? – The Great Box-and-Whisker Plot

Extension Activity:

For the following two sets of data, create a box-and-whisker plot for each. Compare and contrast the two plots by answering the questions that follow.

a) 27, 33, 15, 29, 56, 17, 49, 21, 38

b) 36, 56, 41, 29, 18, 15, 43, 54, 35

1. Are the upper quartiles of each box-and-whisker plot equal? How do you know?

2. Are the lower quartiles of each box-and-whisker plot equal? How do you know?

3. Do both box-and-whisker plots have the same median? How do you know?

4. What is the range of each box-and-whisker plot?

5. Based on your answers to the previous questions, what conclusion(s) can you make about the two sets of data?