Name ______________________________ Date ___________ Period _____

5-Number Summary

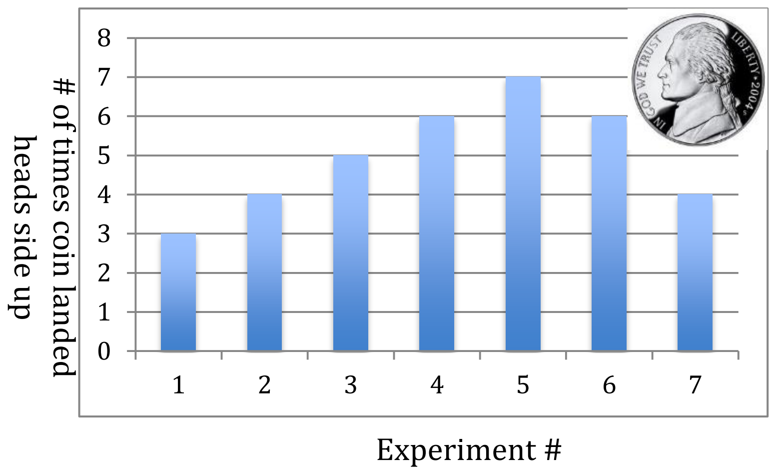
Opening Question

The center divider of a highway or road is called a *median*. In the picture at the right, this is the floral area that the arrow is pointing at.

How else could you describe the word *median*?

Revisiting Traci's Experiment

Previously, we found out that the average or ***mean*** number of times Traci's coin landed heads up was 5 out of 10 flips.



Is there perhaps a better number that we could use to describe the approximate number of heads she got?

a) Let's list the number of heads for each experiment in sequential order.

_____, _____, _____, _____, _____, _____, _____

Circle the number that is in the middle of the 7 numbers.

b) The middle number is _______. This number also represents a ***measure of central tendency***, known as the ***median***.

c) In my own words, the ***median*** of a data set is ____

____

Mathematical Medians

1) a) Write down the 11 numbers that the students in the front of the class are holding. (Do not record the numbers until instructed by your teacher to do so.)

_______, _______, _______, _______, _______, _______, _______, _______, _______, _______, _______

b) Prediction: I think the ***median*** is _________ because it is the number_______________________.

c) Actual ***median***: ______ d) Write the word ***median*** under the median number.

2) Explain how to find the ***median*** if there are an odd number of numbers in the data set:

3) The median is also known as ***Quartile 2*** **(Q2).** **Quartile 2** is exactly half way between all of the numbers in the set of data.

a) Q2: _______ b) Write Q2 under the appropriate number.

4) To find ***Quartile 1*** **(Q1),** we find the median of the first half of the set of data, not inclusive of Q2. Find Q1.

a) Q1: _______ b) Write Q1 under the appropriate number.

5) a) To find ***Quartile 3*** **(Q3),** we find the median of the second half of the set of data, not inclusive of Q2. Find Q3.

b) Q3: _______ c) Write Q3 under the appropriate number.

6) Are there any *outliers* for this set of data, or a number or numbers that do not fit the trend of the majority of the data set?

7) a) What is the ***maximum value*** of the data? __________

b) What is the ***minimum value*** of the data? __________

8) a) The ***range*** of the data set is the difference between the smallest (*minimum value)* and greatest (*maximum value)* number in the data set.

What is the range of the data set? _______ - ________ = _______

b) What does the value of the range mean in terms of the data set?

9) The ***interquartile range*** **(IQR)** is the difference between the first (Q1) and third (Q3) quartiles. (IQR = Q3 – Q1)

What is the interquartile range (IQR) of the data set? ________ - _________ = ________

Creating a Box Plot

Using the data recorded above, your teacher is going to help you construct a ***box plot.***

It is helpful to have a ***5-Number Summary*** complete before constructing a ***box plot***. Record the values from the prior page into the table below.

5-Number Summary

Minimum Value	Lower Quartile (Q1)	Median (Q2)	Upper Quartile (Q3)	Maximum Value

Reflection

10) a) What do you think would happen to the data set, and the ***box*** plot if we used data from a 3rd grade class?

b) What if you used data from the teachers and staff on campus?

11) Find the ***mean*** of the data set. How does the ***mean*** compare to the ***median***?

What if there is an Even Number of Numbers in the Data Set?

11) a) Write down the 10 numbers of that the students in the front of the class are holding. (Do not copy down the numbers until your teacher instructs you to do so.)

_______, _______, _______, _______, _______, _______, _______, _______, _______, _______

b) Prediction: I think the ***median*** is _________ because it is the number______________________.

c) Why is finding the ***median*** for this data set not as easy?

> To find the ***median*** for a data set with an even number of numbers, we take the ***mean*** of the two numbers closest to the middle.
>
> For example, in the following data set, 2, 4, 6, 8, 10, 12 the ***median*** will be the ***mean*** of 6 and 8.
>
> $6 + 8 = 14$ and $14 \div 2 = 7$ The ***median*** is 7! Q2 = 7
>
> Q1 is the ***median*** of the lower half of the data, which would be **4**. Q1 = 4
>
> Q3 is the ***median*** of the upper half of the data, which would be **10**. Q3 = 10

d) Actual *Median*: _______

e) Write the word *median* under the median number.

12) Explain how to find the *median* if there is an even number of numbers in the data set:

13) a) Find Q2: ________
(Hint: You already found it!)

b) Write Q2 under the appropriate number.

14) a) Find Q1: ________

b) Write Q1 under the appropriate number.

15) a) Find Q3: ________

b) Write Q3 under the appropriate number.

16) Are there any *outliers* for this set of data, or a number or numbers that do not fit the trend of the majority of the data set? Explain.

17) Find the ***range*** for the data set: ______ - _____ = _______

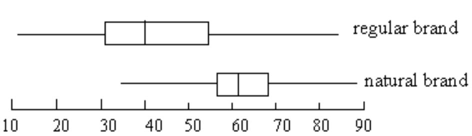
18) Find the ***interquartile range*** (IQR): _________ - _______ = ________

19) Find the ***minimum value*** ___________; ***maximum value*** ______________

20) Construct a ***box***plot for the data using your ***5-Number Summary***.

21) Find the ***mean*** of the data set. How does this compare to the ***median***?

22) Looking at the ***box***plot above, is the data skewed to the right? To the left? Or is it symmetric? What does this mean in terms of the data?



Data skewed to the left.

Data skewed to the right.

<u>Reflection</u>

23) What do you think the name ***quartile*** has to do with the way numbers are grouped?

24) Why do you think it is important to put the numbers in sequential order when finding a 5-number summary?

25) If one of the ***whiskers*** of the ***box***plot is longer than the other, does that mean that there is more data on that part of the plot?

<u>Practice</u>: Find the 5-Number Summary for each of the data sets below, as well as the mean, range, and IQR. Use this information to make a box plot.

26) 18 27 34 52 54 59 61 68 78 82 85 87 91 93 100	27) 8, 25, 17, 6, 9, 13, 9, 13, 12, 10
Mean (review) = Median = Q1 = Q3 = IQR = Range = Maximum Value = Minimum Value = MAD Value =	Mean (review) = Median = Q1 = Q3 = IQR = Range = Maximum Value = Minimum Value = MAD Value =

#26 Box Plot

#27 Box Plot

Teacher Directions: 5-Number Summary

Materials:

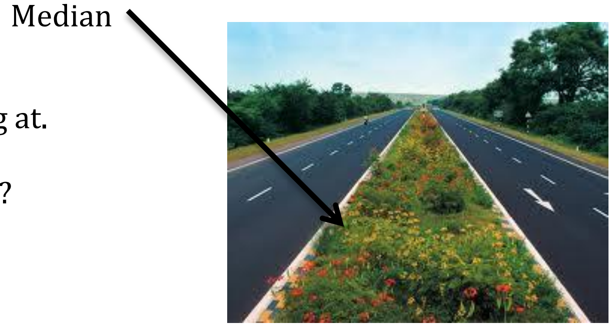
- Tape Measure in Inches, or Yard Sticks (Long Enough to Measure Student Height)
- Copies of 5-Number Summary Worksheet (1 per student)
- Blank Paper (about 50 sheets)
- Markers
- Printed Set of Vocabulary Words (see attached documents)

Opening Question

- Place the following picture, or a picture of a median that you have downloaded up for students to see. Ask them to write down their response to the following question.

The center divider of a highway or road is called a *median*. In the picture at the right, this is the floral area that the arrow is pointing at.

How else could you describe the word *median*?



- While students are answering the question, randomly measure the height of 11 students in the class. Give them a blank piece of paper and a marker and have them write their height in inches in large font on the piece of paper.
- After you have measured 11 students, have students discuss with an elbow partner the answer to the opening question. After 1 minute, randomly select pairs to share what how they could describe the word *median*.

Revisiting Traci's Experiment

- Have students silently read the first statement and first question. Let students know that they will be working with another *measure of central tendency* today to find another way to approximate a central value.
- Have students rewrite Traci's values in sequential order on the lines provided. You may want to stop and define the word *sequential* for students.
- Have them circle the median value, which is 5 and record this value in letter (b). Have a student read aloud (b) and then discuss this *other definition* of the word *median*.

Mathematical Medians

- Have the 11 students come up to the front of the class and hold up their numbers. They do not need to stand in numerical order.
- Ask the class how they can figure out what the *median* number is, or the number that falls in the middle, numerically. Take responses until a student suggests that it might be easier to rearrange the students in numerical order.
- Have the students rearrange themselves in numerical order and then have the students record the 11 numbers in problem 1 on their worksheet. Ask them to predict the

median. Remind them of how they thought about what a median was in the opening task.

- Have the 11 students "fold the line in half" with students with the first and last value meeting, the next numbers meeting, etc. There should be one student in the middle, left without a partner. Explain to the class that this is the *median*. Have them record the actual median in problem 1c, and then instruct them to write the word *median* under the 6th number, which was the person without a partner, in the middle.
- Unfold the line, and hand the student who represents the *median* the vocabulary card labeled *median*.
- Have students complete number 2 alone. Once everyone has had a chance to write something down, have students discuss with an elbow partner.
- Have a volunteer read problem 3 and then have a class discussion about how you can also label the *median* as Quartile 2. Hand the student who is holding the *median* vocabulary card the *Quartile 2* card as well. (You can tape vocabulary cards under their number card so the student does not have to hold 3 cards individually.)
- Have students complete #3, recording the answer for what Q2 is and writing Q2 under the appropriate number.
- Have a volunteer read problem 4 and then have a discussion, asking students how they might find the number that represents Quartile 1. Have the first half of the line physically fold in half to see the median of the 1st half, or Q1. You might want to ask the students what the word *quartile* means; does it sound like any other words that we know? Once the class has agreed upon the number have them complete #4, recording the answer for what Q1 is and writing Q1 under the appropriate number.
- Hand the student who is holding the Q1 number the *Quartile 1* vocabulary card.
- Repeat the process you did in #4 for #5 but for Quartile 3, this time having the upper half of the line fold in half to reveal the median of the upper half.
- For problem 6, have a class discussion asking students if there are any numbers that do not fit with the trend of the others, or are all of the students relatively the same height. **Note**: if a student is sensitive about being shorter or taller than the rest of the class, do not use them for this activity as an example of an outlier. Perhaps you can mention a particularly tall teacher on campus, how would they fit in with the student data? Or a professional basketball player. If there is an outlier, have them hold the *outlier* vocabulary card.
- Have a class discussion about the maximum and minimum values of the data set, and have students record those values.
- Using the maximum and minimum values, have students find the range of the data set.
- Direct students to answer question 8a. Once students have had a chance to write something down, randomly select students to share their answer. The *range* is the smallest interval that contains all of the data set.
- Have students complete question 9; ask for a volunteer to come up and share their work and answer.

Creating a Box Plot

At this time you will help students create a boxplot using the data collected at the opening of the class period.

- Have students fill in the 5-number summary chart with the values recorded on page 2.
- Let students know that they must create a number line on which they will then graph the data.

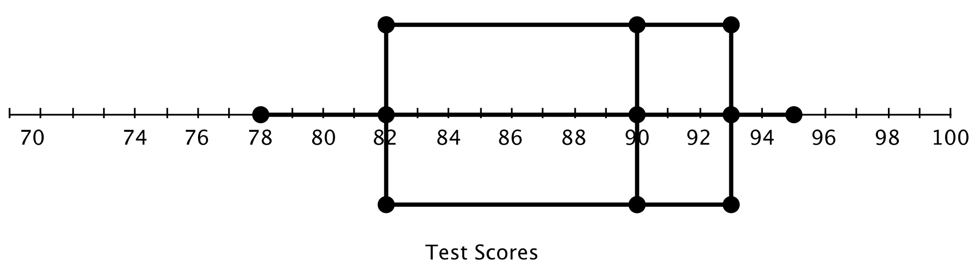
The following is a sample Box Plot based upon the data set below.

Sample Student Grades on 11-different Tests over the Course of a School Year

82, 90, 80, 94, 85, 78, 91, 88, 95, 90, 93

- Scores written in sequential order:
    - 78, 80, 82, 85, 88, 90, 90, 91, 93, 94, 95

Minimum Value	Lower Quartile (Q1)	Median (Q2)	Upper Quartile (Q3)	Maximum Value
78	82	90	93	95



Reflection

- Have students answer questions 10a and 10b with a partner or in a group. Randomly select groups to share how they think measuring the heights of 3rd grades would change the boxplot, as well if they had used the data of the heights of the staff and faculty at the school site. Would there be any outliers? (Particularly tall or short teachers; how would they skew the data?)
- As a review, have students find the *mean* of the data set and compare it to the median. If you'd like to save time, ask students how they would find the mean and then do it for them. The important part of this question is how does the mean compare to the median and what might account for the difference and why.

What if there is an Even Number of Numbers in the Data Set?

Students practiced finding the median if there are an odd number of numbers in the data set, but will now see that there is a slightly different procedure for finding the median of the set of data with an even set of numbers.

- You can have students give you 10 random numbers, or you can ask students a question, have them write the number in larger font on a piece of scratch paper and then randomly select 10 students to come to the front of the room. Possible questions are:
  - How many pets do you own?
  - How many cousins do you have?
  - What's your favorite number between 1 and 50?
  - What's your shoe size?
- Follow the same directions as in *Mathematical Medians*; you will want to help students identify the difference between find the median, Q1 and Q3 with an even set of numbers as compared to an odd set, in the first task. After the majority of the class has finished the problems, have a class discussion to double-check answers and to clear any misconceptions students might be having about finding Q1, Q3, outliers, interquartile range, minimum and maximum values or range. Confirm class data before having students move on to the boxplot.
- Once the class has the same set of values for the 5-number summary, have students construct a boxplot. It would be valuable to have a discussion about what number to start the number line with, and what intervals should be used along the number line.
- After students have constructed the box-and whisker plot, have several students come up and share their plots, especially if some students used different intervals. Ask questions as to if the different intervals make the data look different when plotted.
- Once again for review, have students find the mean and discuss how it relates to the median.
- Have students look at the diagram of a boxplot that is skewed to the right and one that is skewed to the left. Have them analyze if the boxplot they just created is skewed, and if it is, how so.

Reflection

- You may choose to have the students answer these individually and then compare with an elbow partner, and then share with the class or answer each question in terms of a class discussion.

Note: A common misconception amongst students is that the longer a whisker is, or the larger a quartile or section of the box is, the more data values it contains. This is not the case, as each portion of the box and whisker contains approximately 25% of the data set. Quiz students as to what a larger box, or longer whisker really means. (The data has more variance, or has a larger spread (how stretched or squeezed a distribution is).)

Practice

- Students now have an opportunity to try two problems on their own. Note that the data in #26 is in sequential order, but #27 is not. Walk around and monitor students as they are solving these two problems.

median

Quartile 2

Quartile 1

Quartile 3

Outlier

Minimum Value

Maximum Value

Mean