

About the Lesson

In this activity, students create and analyze a box plot and histogram for a data set. They then compare the two data displays by viewing them together and use the comparison to draw conclusions about the data. As a result, students will:

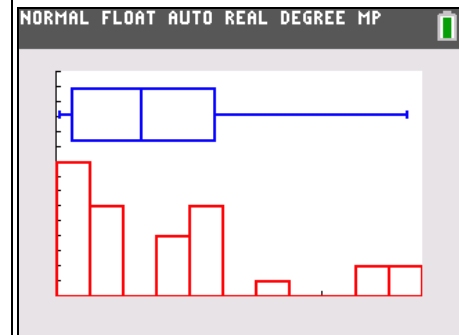
- Represent and interpret data displayed in histograms and box-and-whisker plots.
- Analyze plots of a data set to determine properties such as center, spread, and shape.
- Determine the mean, mode, extremes, and quartile of a data set.

Vocabulary

- mean
- median
- skew
- histogram
- minimum
- interquartile
- box plot

Teacher Preparation and Notes

- You should seat your students in pairs so they can work cooperatively on their calculators. You may use the following pages to present the material to the class and encourage discussion. Students will follow along using their calculators.
- The student worksheet is intended to guide students through the main ideas of the activity. It also serves as a place for students to record their answers. Alternatively, you may wish to have the class record their answers on separate sheets of paper, or just use the questions posed to engage a class discussion.



Tech Tips:

- This activity includes screen captures taken from the TI-84 Plus C Silver Edition. It is also appropriate for use with the TI-84 Plus family with the latest TI-84 Plus operating system (2.55MP) featuring MathPrint™ functionality. Slight variations to these directions given within may be required if using other calculator models.
- Access free tutorials at <http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials>
- Any required calculator files can be distributed to students via handheld-to-handheld transfer.

Compatible Devices:

- TI-84 Plus Family
- TI-84 Plus C Silver Edition

Associated Materials:

- BoxPlotHistograms_Student.pdf
- BoxPlotHistograms_Student.doc
- WKND.8xl (list)

June collected the distances she drove each weekend for 30 weekends. The distances, stored in the list **WKND**, are listed below.

31, 8, 93, 69, 75, 2, 33, 194, 83, 17, 2, 207, 99, 32, 8,
2, 75, 126, 30, 9, 211, 93, 8, 75, 198, 25, 32, 71, 9, 98

If you choose to have students store the numbers manually, they need to press **[STAT]** **[ENTER]** to access the List Editor. Then arrow to the top of **L1** and arrow over to the top of the 7th list which has no heading. The calculator will be in Alpha Mode, so students should type the heading **WKND**. Then, they can enter the numbers as usual.

NORMAL FLOAT DEC REAL DEGREE MP					
L2	L3	L4	L5	WKND	6
-----	-----	-----	-----	31	
				8	
				93	
				69	
				75	
				2	
				33	
				194	
				83	
				17	
				2	

WKND={31, 8, 93, 69, 75, 2, 33, 19

Tech Tip: Before beginning the activity, the list **WKND.8xI** needs to be transferred to the students' calculators via handheld-to-handheld transfer or transferred from the computer to the calculator via TI-Connect.

Part 1 – Create a Box Plot

First students will set up and investigate a box plot of the distances in the **WKND** list using **Plot1**. They should make sure that all other plots and equations have been turned off.

Have students create a box plot of the distances.

Students should press **[2nd]** **[STAT PLOT]** and select **Plot1**. Then, they should press **[ENTER]** to turn the plot on. Have students select the box plot icon and arrow down to **Xlist**.

To select **WKND** as the Xlist, press **[2nd]** **[LIST]**, arrow down **WKND**, and then press **[ENTER]**.

Have students press **[WINDOW]**. An appropriate window would include x-values that range from 0 to 220. The box plot is not affected by the y settings because it is not paired with a second set of numbers.

The window settings that are given on the worksheet will enable students to view the box plot and the histogram later in the activity without having to change the settings. Have students press **[GRAPH]**.

Students should press **[TRACE]** to view the values of each section of the plot.

NORMAL FLOAT DEC REAL DEGREE MP					
Plot1 Plot2 Plot3					
On Off					
Type: [] [] [] [] [] []					
Xlist: WKND					
Freq: 1					
Mark: [] + [] []					
Color: BLUE					

NORMAL FLOAT AUTO REAL DEGREE MP					
WINDOW					
Xmin=0					
Xmax=220					
Xscl=20					
Ymin=0					
Ymax=15					
Yscl=1					
Xres=1					
ΔX=.8333333333333333					
TraceStep=1.66666666666667					

1. Minimum: ____ Q1: ____ Median: ____ Q3: ____ Maximum: ____

Answer:

Minimum: 2 Q1: 9 Median: 51 Q3: 95 Maximum: 211

2. Why is the first whisker so short? What does it mean for the other whisker to be so long?

Answer: Approximately 25% of the data are in the first quartile. The small size of the whisker indicates the higher density of the data there compared to the other quartiles. The other whisker is so long because there is a wide gap between Q3 and the maximum distance traveled, which means June did not often travel very long distances. This suggests that much of June's weekend traveling was shorter distance travel.

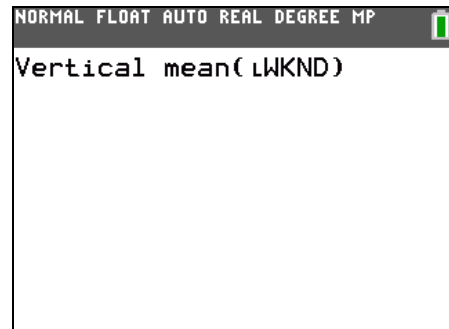
3. What does the median value say about the distances traveled? Since this point is the "middle" point in the data, why is the box plot not balanced at this point?

Answer: The median value is the middle point in the list of data. It informs us that half of the distances traveled were greater than 51 and half of the distances was less than 51. The box plot is not balanced at this point because half of the data are concentrated into a smaller range from 2 to 51, and the remainder are spread out over a larger range from 51 to 211.

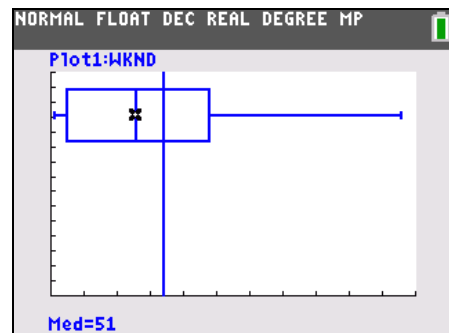
4. Plot the mean of the distances by entering the command shown at the right. Press $\boxed{2nd} \boxed{DRAW}$ to access the **Vertical** command and press $\boxed{2nd} \boxed{LIST}$ and arrow to the MATH menu for the **mean** command.

Where is the mean located on this plot?

Answer: The mean is located to the right of the median. The value of the mean distance is greater than the median distance.



After answering the questions on the worksheet, students will draw a vertical line on the graph to show where the mean is located in the box plot compared to the median.



Part 2 – Create a Histogram

Now students will set up and investigate a histogram of the distances in the **WKND** list using **Plot2**. They need to turn off Plot1 (the box plot) before viewing the graph.

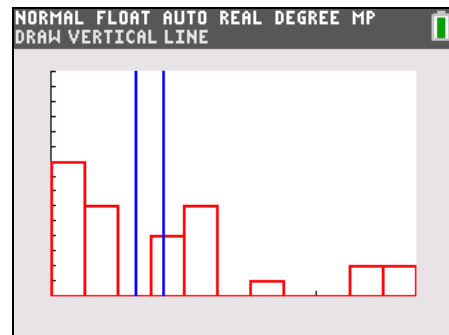
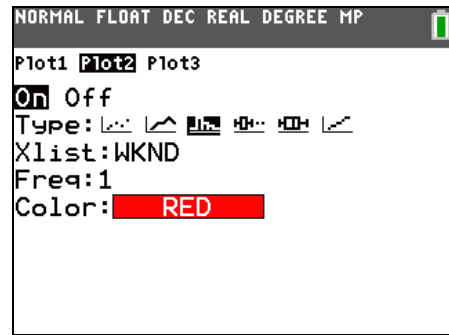
The **Xscl** of the graph is 20. Explain to students that this means each bar is an interval of 20 (i.e., 0 to 19, 20 to 39).

To Create a histogram of the distances, have students press **2nd** [STAT PLOT] and select **Plot1**. They should press **ENTER** to turn the plot off.

Have students press **2nd** [STAT PLOT] and select **Plot2**. They should press **ENTER** to turn the plot on. Have students select the histogram icon, arrow down to **Xlist**, and then select **WKND**.

After answering the questions on the worksheet, students will draw two vertical lines; one line represents the mean and the other represents the median of the distances.

Students can use the commands **mean(LWKND)** and **median(LWKND)** on the Home screen to see the exact values of the mean and median (67.83 and 51, respectively).



Have students press **GRAPH**. Then, they should press **TRACE** and use the arrow keys to view the number of entries per bar.

5. How many weekends did June drive between 20 and 40 miles? ____

Answer: In the bin from 20 to 39, $n = 6$. This means that June drove between 20 and 39 miles a total number of 6 times.

6. How many weekends did June drive less than 60 miles? ____

Answer: For bin 1 (from 0 to 19 miles), $n = 9$. For bin 2 (from 20 to 39 miles), $n = 6$. For bin 3 (from 40 to 59 miles), $n = 0$. So June drove less than 60 miles a total of $9 + 6 + 0 = 15$ times.

7. How many weekends did June drive more than 120 miles? ____

Answer: There are 5 weekends where she drives more than 120 miles: one between 120 to 139, 2 between 180 and 199, and 2 between 200 and 219.

Have students plot the mean and median of the distances.

Tech Tip: To plot the mean and median distances, have students use the **Vertical** command in **2nd** [DRAW]. They should then press **2nd** [LIST], MATH menu for the **mean** or **median** command.

8. Where are the median and mean on this plot?

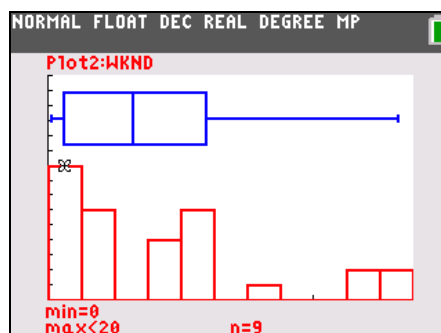
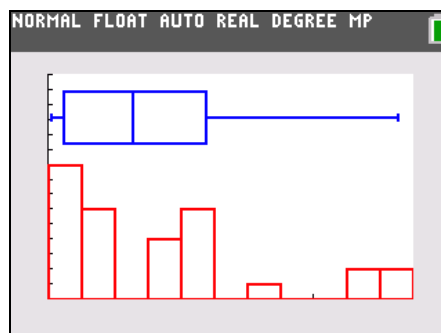
Answer: The mean is 67.833, and the median is 51.

9. The interval from 40 to 60 should contain the median of 51, but it shows zero entries. How is that possible?

Answer: There are 30 weekends of distance data, which is an even number of data points. The median of a data set with an even number of data points is the average of the two middle values, which are 33 and 69. So, the median value is 51 despite the fact that the two middle values are outside of the bin range from 40 to 60. This can be more easily seen by sorting the data. Press $\boxed{2\text{nd}}$ [LIST], OPS, SortA(, then choose WKND list from $\boxed{2\text{nd}}$ [LIST]. Examine the data in the WKND column by pressing $\boxed{\text{STAT}}$ $\boxed{\text{ENTER}}$.

Part 3 – Compare a Box Plot and a Histogram

Students are directed to turn **Plot1** (box plot) back on so that they can view the box plot and histogram on the same screen. Have students press $\boxed{2\text{nd}}$ [STAT PLOT] and select **Plot1**. Press $\boxed{\text{ENTER}}$ to turn the plot on.



Teaching Tip: Use this view to guide a discussion about the relationship between the box plot and the histogram. Begin with more obvious connections. For example, a taller bar in the histogram corresponds with more points on the box plot than a shorter bar.

Then, lead students to make deeper conclusions about the shape of the data. For example, the largest bars on the histogram are grouped mostly in the lower value region. This corresponds with the shorter whisker shown on the box plot. This shows that there are mostly shorter distance data points. There are fewer data points grouped into any specific bin in the larger distance region of the histogram. This shows that the larger distance data points are more spread out, and it corresponds with the larger whisker in the box plot.

10. How does the shape of the histogram compare to the shape of the box plot?

Answer: It is evident by comparing the two that there is a great frequency of shorter distances. The data are skewed to the left.

11. How does the tallness of the first bar relate to the shortness of the first whisker?

Answer: The tall first bar shows that there are many data points in the region from 0 to 19. The first whisker is the distance between the minimum data point and Q1. The shortness of the first whisker indicates that there are a significant amount of data points located very close to the minimum data point. Both of these indicate that June took mostly short distance trips.

12. What do you see now about why the other whisker is so long?

Answer: In the histogram, the longer distance data points are spread out over many bins in the histogram, indicating that they did not occur as frequently as the shorter distance trips. In the box plot, the longer whisker shows that there is a large range between Q3 and the maximum data point, which also indicates that there are fewer long distance data points.