EXPLORATIONS

ACTIVITY 9

Measure Up!

What is the average height of the students in your class? How does your height compare? How does your teacher's height compare? You can use statistics to answer these questions and describe the general characterists of a set of measurements.
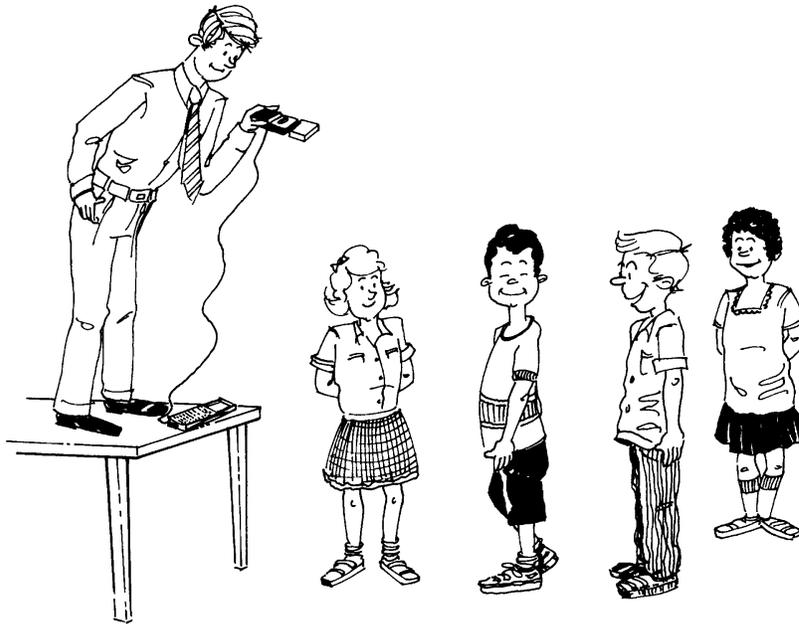
Objectives

In this activity you will:

♦ Create a plot showing the heights of some students in your class.

♦ Calculate the extreme values and *median* for the height data.

♦ Construct a *box-and-whisker* plot to summarize the height *statistics*.

You'll Need

♦ CBR unit

♦ TI-82 or TI-83 and calculator-to-CBR cable

CBR Setup

1. Connect the CBR to the calculator using the link cable.

2. Turn on your calculator. If you have not already loaded the **RANGER** program into your calculator, follow these steps:

    a. Press [2nd] [LINK] [▶] [ENTER]. The calculator displays **Waiting …**

    b. Press the (82/83) transfer button on the CBR.

3. Run the **RANGER** program on your calculator:

    a. Press [PRGM].

    b. Choose **RANGER**.

    c. Press [ENTER].

4. From the **MAIN MENU**, select **1: SETUP/SAMPLE**.

5. Use the arrow keys to move the selector arrow (▶) to a setting you need to change. Press [ENTER] to select or change a setting. Enter 25 to change time. Adjust the settings so that they exactly match those shown to the right.

```
MAIN MENU     ▶START NOW

REALTIME:  NO
  TIME(S):  25
 DISPLAY:  DIST
 BEGIN ON:  [TRIGGER]
SMOOTHING:  NONE
   UNITS:  METERS
```

6. When you have finished adjusting the settings, position the selector arrow (▶) at **START NOW** and press [ENTER] to prepare the CBR for data collection.

Collecting the Data

1. Detach the CBR from the calculator and press [ENTER].

2. In this activity, a group of 12 students will walk beneath the CBR, one at a time, as the CBR records motion data. To start, line up 12 students as shown in the setup diagram. Students should be spaced about 1 foot apart.

3. Hold the CBR in the air with the detector pointing toward the ground, as shown. Be sure to hold the CBR at least 0.5 meters higher than the tallest student. To ensure accurate measurements, the CBR must be held perfectly still during sampling.

4. When you are ready to start, press (TRIGGER) on the CBR and have the students walk under the CBR slowly, one at a time. You will have 25 seconds to collect data. If you run out of time before everyone has passed beneath the CBR, you will have to sample again. Be patient; it may take more than one trial to obtain a satisfactory result.

5. To retrieve the data, reattach the CBR to the calculator and press [ENTER]. Your plot should show 12 distinct spikes.

6. If you are satisfied with your plot, press ENTER, select **5: QUIT**, then go to the next section. If not, press ENTER, select **3: REPEAT SAMPLE** from the **PLOT MENU**, and try again.

Looking at the Results

1. During sampling, the CBR recorded distance from the motion detector. Since you wish to measure distance from the floor, it will be necessary to invert the distance values before you analyze the data. To do this, follow these steps:

  a. From the home screen, press MATH ▶ and select **7: MAX(**.

  b. Press 2nd [L2]) − 2nd [L2] STO▶ 2nd [L2].

  c. The command **max (L2) - L2 ➔ L2** should appear on your calculator screen. Press ENTER to execute this command.

2. Press ZOOM **9:ZOOMSTAT** to see the student height values. Sketch your plot to the right.

3. Press TRACE and use the arrow keys to move the cursor along the plot. Each spike represents one of the students who walked under the CBR. Identify the peak y-value for each spike and record it below. Round to the nearest hundredth of a meter.
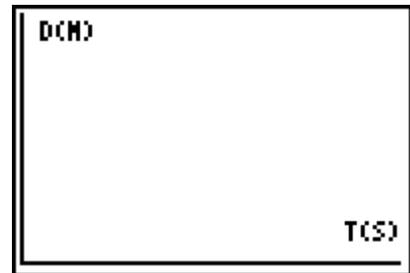
Student Heights

4. Before you try to characterize the height data, it will be necessary to arrange the heights in order from lowest to highest. Record the ordered heights in the space below. Convert your answers to centimeters. (There are 100 centimeters in one meter.)

Student Heights

5. Find the values for this data set. The smallest height is the lower extreme and the largest height is the upper extreme. Record these values below.

   Lower extreme: _____ cm

   Upper extreme: _____ cm

6. Find the middle number, or median. When the number of data items is even, the median is the average of the two middle values. Record your answer below.
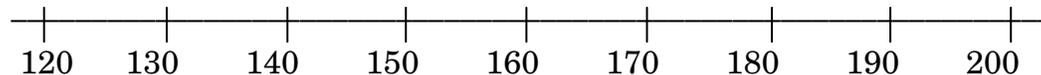
   Median: _____ cm

7. Two other important values that describe a set of data are the *lower quartile* (denoted Q1) and the *upper quartile* (denoted Q3). The lower quartile is the median of the lower half of the data; the upper quartile is the median of the upper half of the data. Find the quartiles of the ordered list of heights and record them below.

   Lower quartile (Q1): _____ cm

   Upper quartile (Q3): _____ cm

8. A special type of plot called a box-and-whisker plot shows a statistical picture of the data by graphically representing the lower extreme, lower quartile, median, upper quartile, and upper extreme. To create a box-and-whisker plot for the height data you collected, follow these steps:

   a. On the dotted line above the number line shown below, use dots to mark the lower extreme, lower quartile (Q1), median, upper quartile (Q3), upper extreme.

   b. Draw vertical lines through the points marking Q1, the median, and Q3.

   c. Draw a box from the lower quartile to the upper quartile, using the vertical lines through Q1 and Q3 as sides.

   d. Draw line segments (whiskers) from the box to the extremes.

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   120    130    140    150    160    170    180    190    200
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9. Approximately what percentage of the heights are greater than the upper quartile? About what percentage are less than the lower quartile?

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_____

_____

10. Notice that the box part of the plot represents the middle 50 percent of the data set. The size and location of the box tell you certain things about the data. A wider box indicates that the data is spread out, while a smaller box means the data is clustered. Discuss the size and location of the box part of your plot; describe how it relates to the measured heights.

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11. The lengths of the whiskers on the box plot gives a hint as to the distribution of the data. If one whisker is significantly longer than the other, we say the data is skewed in the direction of the longer whisker. This just means that the data is bunched together near the shorter whisker. Describe the whiskers on your plot. What do the whisker lengths tell you about the heights?

_____

_____

_____

Going Further

Answer these questions on a separate piece of paper. Show all work.

1. If the heights in this activity were measured in feet rather than centimeters, how would your box plot be affected? Explain your reasoning.

2. The nature of a box-and-whisker plot can sometimes be distorted by data values known as *outliers*. An outlier is a value that is set apart from the rest of the data set because it is significantly lower or higher than any other number in the set. Describe how your box-and-whisker plot would be affected if one of the 12 students were replaced with a professional basketball player. Would the median, lower quartile, and upper quartile values change?

3. Suppose that this activity is repeated with two different classes. The average heights, in centimeters, are listed below.

Class A: 193, 141, 161, 152, 179, 153, 167, 146, 184, 197, 147, 149

Class B: 195, 128, 164, 189, 162, 129, 178, 143, 154, 144, 187, 170

Above a number line, construct box-and-whisker plots for heights in these two classes. Based on these plots, write three statements comparing the heights in the two classes.

4. Repeat the sampling process described in this activity until everyone in your class has their height recorded. Make a box-and-whisker plot to represent the height statistics for your class.

5. Collect height data for one or more other classes. Construct box-and-whisker plots for each above a number line. Write as many statements as you can to compare the height characteristics of these groups.

6. Your calculator has a built-in feature for plotting box-and-whisker plots. Consult the TI-82 or TI-83 Guidebook for details about this procedure. Use your calculator to make box-and-whisker plots of the data you have collected in this activity.