



### Math Objectives

- Students will analyze data represented in a histogram.
- Students will recognize that changing class width (bin width) and/or alignment affects the shape and spread of a distribution in a histogram.
- Students will interpret histograms displayed with frequency, percent, and density on the vertical axis.

### Vocabulary

- class alignment/bin alignment
- class width/bin width
- density
- frequency
- histogram
- relative frequency
- skew (right or left)
- symmetric

### About the Lesson

- This lesson involves the interpretation of different types of histograms: frequency histograms, relative frequency histograms, and density histograms. As a result, students will:
  - Hover over a class/bin to determine the number of observations in that class/bin.
  - Change the class/bin width by dragging the edge of the class.
  - Compare the histograms with different settings including class/bin width, class/bin alignment, and y-scales.

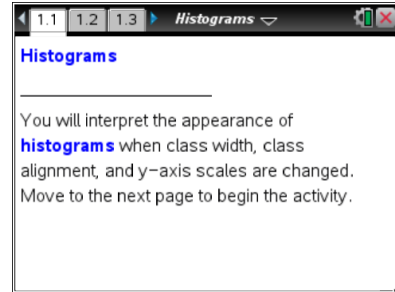


### TI-Nspire™ Navigator™

- Send out the *Histograms.tns* file.
- Monitor student progress using Class Capture.
- Use Live Presenter to spotlight student answers.
- Send questions from *Histograms\_QP.tns* as Quick Polls

### Activity Materials

- Compatible TI Technologies: TI-Nspire™ CX Handhelds, TI-Nspire™ Apps for iPad®, TI-Nspire™ Software



### Tech Tips:

- This activity includes screen captures from the TI-Nspire CX handheld. It is also appropriate for use with the TI-Nspire family of products including TI-Nspire software and TI-Nspire App. Slight variations to these directions may be required if using other technologies besides the handheld.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at <http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials>

### Lesson Files:

#### Student Activity

- Histograms\_Student.pdf
- Histograms\_Student.doc
- Histograms\_Create.doc

#### TI-Nspire document

- Histograms.tns
- Histograms\_QP.tns



## Discussion Points and Possible Answers

**Teacher Tip:** TI-Nspire terminology is different from traditional histogram vocabulary. 'Bin' is used instead of 'class'; therefore, bin width is the same as class width and bin alignment is the same as class alignment.

### Move to page 1.2.

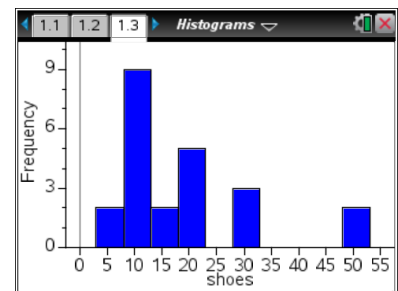
Twenty-three high school girls were selected at random and each was asked to report the number of pairs of shoes owned. The data are given in the following table.

Number of Pairs of Shoes		
20	12	31
21	12	8
10	10	5
10	51	30
5	20	20
12	12	20
50	15	9
30	15	

**Teacher Tip:** Students can create their own TI-Nspire documents using the instructions in the Histograms\_Create.doc. Or, students can use the pre-made TI-Nspire document that is provided.

### Move to page 1.3.

- Page 1.3 shows a frequency histogram for the shoes data. Use this histogram to describe the shape and center of the distribution. Explain your answer.



**Sample Answers:** The distribution of the number of pairs of shoes is skewed right. The majority of the girls have between 3 and 23 pairs of shoes, including 3 but not 23. However, two girls have between 48 and 53 pairs of shoes, including 48 but not 53. There is a gap in the distribution between 32 and 48 pairs of shoes. The median is between 13 and 18 pairs of shoes (including 13 but not 18).



**Tech Tip:** Moving the cursor over the plot will display the bin interval and the number of data points contained in a bin.



**Tech Tip:** Tapping a bin will display the bin interval and the number of data points contained in the bin.

2. a. Use the histogram to find the number of girls who have fewer than 13 pairs of shoes. Explain your reasoning.

**Sample Answers:** Nine girls have between 8 and 13 pairs of shoes, including 8 but not 13, and two girls have 3 to 8 pairs of shoes, including 3 but not 8. All together, 11 of the girls own fewer than 13 pairs of shoes.

**Note:** As the cursor hovers over a bin, the bin, or class, is shown along with the number of observations in that bin. For example, “[8, 13) 9 points” means the bin from 8 up to, but not including, 13, contains 9 observations.

**Teacher Tip:** Students might not be familiar with the interval notation [8,13). This could also be written as  $8 \leq x < 13$ .

- b. What interval will contain the median number of pairs of shoes? Explain how you determined your answer.

**Sample Answers:** The interval from 13 to 18 (including 13 but not including 18) will contain the median. There are 23 girls in the sample, so the median would be the 12<sup>th</sup> value in the ordered list. 11 values are in the first two bins so the third bin would contain the 12<sup>th</sup> value or the median. You could also go back to the spreadsheet on Page 1.2 and sort the entries in ascending order, then find the 12<sup>th</sup> entry.

3. a. What is the width of each bin in the histogram? Explain how you know.

**Sample Answers:** The bin width is five. As you move the cursor over each bin, the bin interval is displayed. For example [3, 8), [8, 13), etc.

- b. Make a conjecture about the histogram if the bin width is set to two. Explain your reasoning.

**Sample Answers:** Some students might state that the histogram would contain more bins because each bin would only have a width of 2; however, the shape of the histogram would remain the same. The bins would be labeled [3, 5), [5, 7), [7, 9), etc.

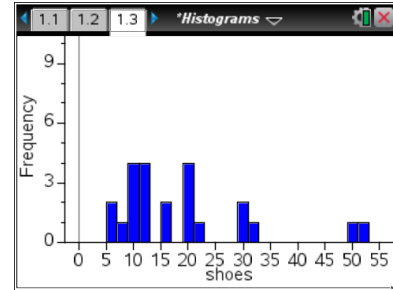


- c. Change the bin width to 2 to check your answer. Select **Menu > Plot Properties > Histogram Properties > Bin Settings > Equal Bin Width**. Enter 2 for the width, and select **enter**.

Does the histogram support your conjecture in part b?

**Sample Answers:** The histogram supports my conjecture.

There are more bins and the histogram is still skewed right, but it doesn't appear to be as skewed as before.



**Tech Tip:** To change the bin width to 2, select **Plot Properties > Histogram Properties > Bin Settings > Equal Bin Width**. Enter 2 for the width and select **OK**.

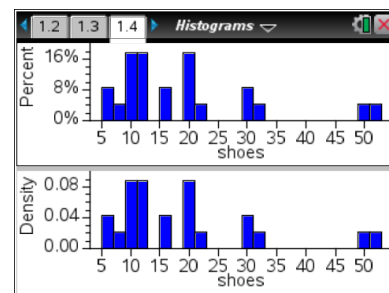
- d. The bin width can also be changed by dragging the vertical edge of the bin. Drag the right edge of the left-most bin so that it appears as if the histogram has only one gap. Explain whether this is a good representation for these data.

**Sample Answers:** By eliminating the gaps in the histogram, we have also reduced the number of bins, or classes. This does not present a good graphical description of the data. It is now more difficult to describe the shape, determine the center, assess variability, and detect outliers.

**Move to page 1.4.**

4. Two histograms (associated with the shoes data) are displayed in a split screen. The top work area displays a histogram with percent on the vertical scale; the bottom work area displays density on the vertical scale. Analyze the two screens to determine similarities and differences.

- a. What is similar about the two distributions?





**Sample Answers:** The distributions of number of pairs of shoes have identical shapes.



**Teacher Tip:** A density histogram is constructed such that the area of each rectangle, or bar, is equal to the bin relative frequency. Therefore, since the sum of all relative frequencies is 1, the sum of the area of all rectangles is 1. The density scale in a histogram guarantees that the total area of all of the bins is 1. The percent scale guarantees that the total height of all of the bins is 1.

You might ask students to explain how they could find the area of a bin and whether it is possible to do so from the percent histogram. This might be a good opportunity to ask students some probability questions to get them thinking about the relationship between area under a distribution and probability.

- c. If you were to add up the percents in each bin in the top work area, what value should you get? Add the actual percent values to check your conjecture, and explain why the answer makes sense. (**Note:** On the TI-Nspire handheld, you can select  and add the values using the Scratchpad. Select  to return to the Histograms.tns document.)

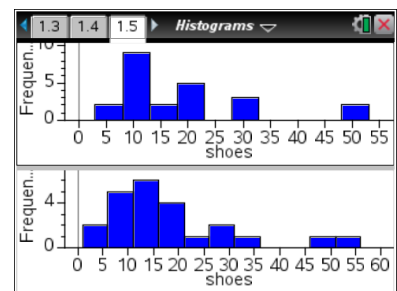
**Sample Answers:** The sum should total to 100% because each bin shows the percentage of the total number of pairs of shoes in that bin. If you add all of the percents, you should get 100% of the numbers of pairs of shoes.  $8.7\% + 4.35\% + 17.39\% + 17.39\% + 8.7\% + 17.39\% + 4.35\% + 8.7\% + 4.35\% + 4.35\% + 4.35\% = 100\%$ . (Note that, due to rounding, the sum of the displayed values is 100.02%.)

- d. What is the total area of the bins in the density histogram? Explain your reasoning.

**Sample Answers:** The total area should be 1.00 square unit since the density values are the decimal equivalents of the percents. You can also find the answer by adding the area of each bin.

### Move to page 1.5.

5. Page 1.5 is a split screen displaying two frequency histograms that were created from the same data set. The bin width is 5 for both histograms, but the bin alignment has changed. The bin alignment changes the starting point of the bins, and thus it changes the bin intervals.
- a. Compare and contrast the histograms.



**Sample Answers:** The histograms appear to be displaying different data sets even though they are displaying the same data. The top histogram is skewed right; the bottom histogram



is only slightly skewed right with the exception of the bins containing the high numbers of shoes. The bottom histogram also has fewer gaps in the data. The bin intervals have changed—the top histogram begins [3,8) whereas the bottom histogram begins [1,6). Both histograms contain all of the data (23 girls are represented in each histogram).

- b. Using either histogram, can you tell if any girl owned 54 pairs of shoes? Explain how you know.

**Sample Answers:** The bottom histogram has a bin that could contain 54 pairs of shoes because the bin interval is [51, 56) and one data value is contained in the class. However, the last bin in the top histogram covers the interval [48, 53), and there is no bin into which 54 would fall. Therefore, there was no girl who owned 54 pairs of shoes.

- c. Which display would you use if you were a girl arguing that you had to have more shoes because most other girls had a lot of shoes? Which display would you use if you were arguing that most girls did not have that many pairs of shoes? Explain your reasoning in both cases.

**Sample Answers:** The bottom histogram might be used to argue for more shoes as the distribution seems to be centered higher and it has a mode interval [11,16), which makes it look like most girls have 11 to 15 pairs of shoes. In addition, there are two bins that contain girls with a large number of shoes [46, 51) and [51, 56). The top histogram seems to be skewed right with most girls having fewer pairs of shoes and the mode interval is [8,13), which would seem to indicate that most girls have 8 to 12 pairs of shoes.

6. What are some of the advantages and disadvantages of using a histogram to display data?

**Sample Answers:** It is easy to see the shape of a distribution when it is graphically summarized using a histogram; however, the shape can change based on bin width and alignment. A histogram can be constructed to use frequency, relative frequency, and density associated with each bin. However, individual data points are not typically shown in a histogram.

## Wrap Up

Upon completion of the discussion, the teacher should ensure that students are able to understand:

- How to use histograms to describe the shape, center, and spread of a distribution.
- How class width and class alignment could affect the shape, center, and spread.

## Assessment

The following three statements are prepared for use in the *Histograms\_QP.tns* file. Teachers can use this file for students to ‘Self Check’ their understanding or teachers with TI-Navigator can send the each statement as a Quick Poll.



Label each of the following as always, sometimes, or never. Be prepared to defend your answers.

1. Histograms show individual data points.

**Sample Answer:** Sometimes; if the data are whole numbers and the bin width is one.

2. For a given data set, a histogram with larger bin widths will not show all of the characteristics of a distribution.

**Sample Answer:** Sometimes; it is more difficult to determine shape, gaps, and variability of data when the bin widths are large.

3. Histograms created from the same data set with different classes and/or class widths can suggest different distribution shapes.

**Sample Answer:** Always, if you allow the extreme case of a bin per data value and the other extreme of only one bin.

A follow-up activity and possible assessment is to collect class data such as shoe size, number of pairs of shoes, or minutes to travel to school to create and compare histograms. The distributions of boys' and girls' shoe data can lead to interesting comparisons and discussions.



## TI-Nspire Navigator

### Quick Poll

A *Quick Poll* can be given at the conclusion of the lesson. It is recommended to use the *Histograms\_QP* file. You can save the results and show students' responses at the start of the next class to discuss possible misunderstandings students might have.

The assessment questions above are sample questions you might use.