



### Math Objectives

- Students will interpret comparative boxplots.
- Students will reason abstractly and quantitatively (CCSS Mathematical Practice).
- Students will use appropriate tools strategically (CCSS Mathematical Practice).

### Vocabulary

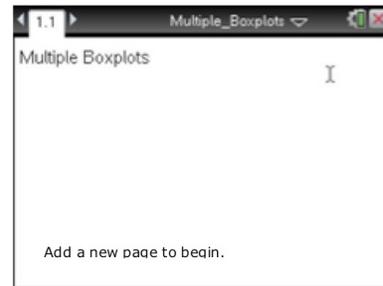
- boxplot
- five-number summary
- interquartile range
- maximum
- mean
- median
- minimum
- outlier
- $Q_1$  (lower quartile) and  $Q_3$  (upper quartile)

### About the Lesson

- This lesson involves analyzing three parallel boxplots.
- As a result, students will:
  - Make conjectures about the distribution of grades for three students.
  - Compare the distribution of grades for the three students using information obtained from the boxplots.

### TI-Nspire™ Navigator™ System

- Transfer a File.
- Use Screen Capture to examine patterns that emerge.
- Use Live Presenter to demonstrate.
- Use Teacher Edition computer software to review student documents.



### TI-Nspire™ Technology Skills:

- Download a TI-Nspire document
- Open a document
- Move between pages
- Grab and drag a point

### Tech Tips:

- Make sure the font size on your TI-Nspire handhelds is set to Medium.
- You can hide the function entry line by pressing **ctrl** **G**.

### Lesson Files:

*Student Activity*

Multiple\_Boxplots\_Student.pdf

Multiple\_Boxplots\_Student.doc

*TI-Nspire document*

Multiple\_Boxplots.tns

*Teacher Create File*

Multiple\_Boxplots\_Create.doc

Visit [www.mathnspired.com](http://www.mathnspired.com) for lesson updates and tech tip videos.



**Discussion Points and Possible Answers**

**Tech Tip:** Moving the cursor over the plot will show important values such as the Median, the  $Q_1$ , and the maximum value.

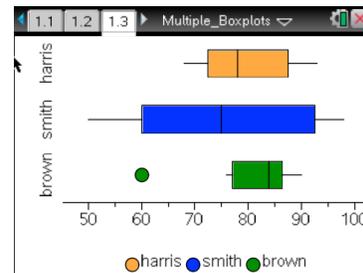
**Teacher Tip:** Students have the option of either using the create document which contains instructions for creating three parallel boxplots for the distribution of grades of three students or using an existing .tns file.

**Teacher Tip:** The sample answers in this document are more explanatory than many possible student responses. Push the students to give thorough explanations for their reasoning, being careful to use appropriate words.

**Move to page 1.3.**

1. Which student seems to have the best grades? Explain your reasoning.

**Sample Answers:** Answers will vary. Some students might suggest that Smith has the best grades because he has the highest scores and one fourth of them are at or above 92.5. Other students might suggest that Brown's scores were the best because half of his scores were 84 or above.



2. a. Which student is most consistent in his grades? Explain your reasoning.

**Sample Answers:** Answers will vary, but students should reason either Harris or Brown. Brown has the smallest interquartile range, half of his scores are between 77 and 86.5, and the smallest range excluding the outlier. However, the outlier might indicate that Brown's scores are inconsistent. Overall, Harris has the smallest range, 25 points, compared to 30 for Brown and 48 for Smith.

- b. If the boxplot whiskers had been extended so you were unaware that Brown's minimum score, 60, was an outlier, would your answer to part a. change? Explain your reasoning.

**Sample Answers:** Yes, Smith's distribution has the largest range, 48, followed by Brown's scores with a range of 30. Thus, Harris is the most consistent in his grades because all of his grades are closer to each other than Smith's or Brown's.



3. Write a paragraph comparing the grades for each of the three students using the information you can obtain about their scores from the boxplots.

**Sample Answers:** Smith had the biggest range in scores, with the best score of everyone, 98, and the worst one, 50. One-fourth of his scores were higher than any of Brown's, but three-fourths of Brown's scores were above 77 while only half of Harris's scores were greater than 78 and half of Smith's were greater than 75. Smith generally has lower scores than either Harris or Brown with a little more than 50% of his scores falling below Brown's scores (excluding the outlier) and over 25% of his scores falling below Harris's scores. Neither Harris, Brown, nor Smith have really better scores than either of the other two.

4. a. Make an estimate of the mean as compared to the median for each of the three students. Explain your reasoning based on the boxplots.

**Sample Answers:** The mean score for Harris should be slightly above the median of 78 because the distribution appears to be skewed right. The mean for Smith will be close to the median, 75, because the distribution seems to be fairly symmetric. The mean for Brown will be below the median because the distribution appears to be skewed left and has an outlier.

- b. To find the actual values of the means to test your estimates in part 4a, select **MENU > Analyze > Plot Value**. The screen will display **v1:=**. Use the alphabet keys to type **mean(harris)**, and then press .

- The value of the mean of the scores for Harris will be displayed, and the vertical line indicates the location of the mean in the boxplot.
- How did the mean compare to the median? How well did your estimate in 4a match the actual value of the mean?

**Sample Answers:** The mean for Harris is about 79.5, above the median of 78. My estimate was near the actual mean.

- c. Repeat the steps to find the mean for Smith and Brown. How did the mean compare to the median? How well did your estimate in 4a match the actual value of the mean?

**Sample Answers:** My estimates for both were close. The mean for Smith is 75.4 and the median is 75. The mean for Brown is about 80.5, lower than the median of 84.



5. a. Record the 5-number summary from the boxplots for each of the three students into the columns labeled original in the table below.

**Sample Answers:**

	Original					New				
	Min	1 <sup>st</sup> Quartile	Med	3 <sup>rd</sup> Quartile	Max	Min	1 <sup>st</sup> Quartile	Med	3 <sup>rd</sup> Quartile	Max
Harris	68	72.5	78	87.5	93					
Smith	50	60	75	92.5	98					
Brown	60	77	84	86.5	90					

- b. Suppose all three students got 100 on the next test. Press ctrl ◀ to return to the spreadsheet on Page 1.2. Scroll down, and add 100 in the tenth row for all three students. Record the new values in the table above. How did adding 100 change the distributions of the scores for the three students? Explain.

**Sample Answers:** Adding 100 raised the quartiles for all three students. Overall, the change seemed to have the biggest affect on Smith (see the table). Harris and Smith now have the same median at 79, but the top one-fourth of Smith's scores are 95 or above as compared to 90 for Harris and 88 for Brown. Half of Brown's scores are higher than 84. All of the minimums remained the same.

	Original					New				
	Min	1 <sup>st</sup> Quartile	Med	3 <sup>rd</sup> Quartile	Max	Min	1 <sup>st</sup> Quartile	Med	3 <sup>rd</sup> Quartile	Max
Harris						68	75	79	90	100
Smith						50	65	79	95	100
Brown						60	78	84	88	100

- c. In part b, Brown's median score did not change. What does this tell you about Brown's test scores that fall near the middle? Explain your reasoning.

**Sample Answers:** More than one of Brown's test scores must be 84. If Brown had an odd number of test scores, then the median would be the middle test score, 84. If Brown had an even number of test scores, then the median would be the average of the two middle scores. Once the 100 was added, if the median was a test score of 84, then it now has to be averaged since we added a data value. The only way it could be averaged and still equal 84 is if both test scores were an 84.



**Teacher Tip:** You might want to ask students to consider other questions such as: If Brown's outlier were removed, what would be the effect on the mean and median? Suppose after the 100 were added, how would dropping the lowest score affect Brown's grade?

**TI-Nspire Navigator Opportunity: Quick Poll**

**See Note 1 at the end of this lesson.**

### Wrap Up

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

- How to interpret comparative boxplots using their important characteristics.

### Assessment

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

1. Boxplots show individual data points.
2. A data set with an IQR of 50 has more data values than a data set with an IQR of 25.
3. A boxplot splits a data set into four sections, each having approximately the same number of data points.
4. If the distribution is skewed to the right, then the median is larger than the mean.

**Answers:** 1. Never 2. Sometimes 3. Always 4. Never

### TI-Nspire Navigator

#### Note 1

#### Name of Feature: Quick Poll

A Quick Poll can be given at the conclusion of the lesson. You can save the results and show a Class Analysis at the start of the next class to discuss possible misunderstandings students might have.

The assessment questions above are sample questions you might use.



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