

Box and Whiskers

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GRADE LEVELS 6-8th grade

TIME ALLOTMENT One class period - 55 minutes

OVERVIEW - This lesson shows the students how to relate collected data with a box and whiskers graph in a number of formats. The students will collect, organize, create, and interpret a box and whiskers graph. Students interpret the difference between sets of data using two different types of technology.

SUBJECT MATTER - Middle School Mathematics, data analysis and graphing.

Learning Objectives

The participants will be able to predict the factors that affect a box and whiskers graph. They will be able to construct a box and whiskers graph using a graphing calculator.

STANDARDS

The objectives will in part meet the following State Standards.

Virginia 6th Grade Math Standards of Learning

- 6.18 The student, given a problem situation, will collect, analyze, display, and interpret data in a variety of graphical methods, including
- a) line, bar, and circle graphs;
 - b) stem-and-leaf plots; and
 - c) **box-and-whisker plots.**
- 6.10 The student will estimate and then determine length, weight/mass, area, and liquid volume/capacity, using standard and nonstandard units of measure.

Standards can be found at

<http://www.pen.k12.va.us/VDOE/Superintendent/Sols/home.shtml>

MEDIA COMPONENTS

Video:

3-2-1 Contact, Episode #27, "Collect the Data" (available from BRPTV.)

MATERIALS

For the teacher:

- ✓ TV/VCR
- ✓ Computer with projection capacity
- ✓ TI interactive computer program from Texas Instruments
- ✓ TI-83 overhead calculator or Smart View program
- ✓ Signs made for participants to wear to indicate the five main locations on box and whiskers graph. Signs can be made on 8x11 sheets of paper and worn around the neck by attaching string to the corners. The five signs should be: median, lower extreme, upper extreme, lower quartile, upper quartile.
- ✓ Yarn
- ✓ Boxandwhiskers.ti (a computer file for TI Interactive, provided with this lesson)

For the students:

- ✓ TI-83 calculators (one per student)
- ✓ One small bag of Scooby snacks per student
- ✓ One ruler per student
- ✓ One index card per student

PREP FOR TEACHERS

- Put the video, *3-2-1 Contact*, into the VCR. Fast forward to beginning of the first clip that will be used, approximately 07:51
- Load the computer file, boxandwhiskers.ti in the computer.
- Test out each of the TI-83 calculators to make sure that the batteries are working.

- Place the following on the students' desk ahead of time: index card, ruler, small bag of candy, calculators.

INTRODUCTORY ACTIVITY: SETTING THE STAGE

Say: “Today we are going to make a human box and whiskers graph like the ones that we have studied in class. On your desk you will find an index card and a ruler. Take the ruler and measure your hand span (distance from the tip of your smallest finger to the tip of your thumb with your hand spread) to the nearest centimeter. Then record your results on your index cards in large numbers.” Students will measure their hand span in centimeters and record their score on 3x5 index cards.

(*Note: This activity works best with an odd number of students. If you use an even number, you will have to deal with the averaging of numbers, so you should do an uneven number.)

Say: “Now I want you to line up facing me in the front of the room, in order from smallest to largest hand span with the smallest score on your right. Hold the card in front of you so that everyone can see what your number is.”

Students form a line at the front of the room facing the instructor with the smallest score on the instructor’s left and the largest at the other end of the line.

(Look at the pictures below to see how this activity works. The seven persons are standing in a row holding a card. In this picture, I am showing you the activity with seven students, but this is just an example. It can be any uneven number.)

Ask: “Who can tell me the five points on a box and whiskers graph?” (Answer – median, lower extreme, upper extreme, lower quartile, upper quartile)

Say: “Now we are going to find those five points. I want the persons at the ends of the line to raise their hands.

The persons with numbers 1 and 7 will raise their hands.



Say: “Now, moving towards the center of the line, the next two persons will raise their hands.” (In the picture, persons holding two and six will raise their hands)



Say: “Moving again towards the center, the next pair of persons will raise their hands.” (In the picture, persons three and five will raise their hands.)



Say: “The person in the center is the median.”
(In this picture the median is the person holding the four card)

Place the card with the word *median* on it around that person’s neck.

Say: “Now we are going to find the lower extreme. The lower extreme is the lowest score in our list.” **Ask:** “Which person has the lowest score in our line?”
(Answer – the person at the end of the line with the smallest value)

Place the card with the word *lower extreme* on it around that person’s neck.



Say: “Now we are going to find the upper extreme. The upper extreme is the highest score in our list.” **Ask:** “Which person has the highest score in our line?” (Answer – the person at the end of the line to the right)

Place the card with the word *upper extreme* on it around that person’s neck.



(The picture shows the location of the median, upper extreme and lower extreme.

Say “Now we are going to find the lower quartile. Using the hand raising method that we used to find the median, let’s find the middle person between the median and the lower extreme.”

Place the card labeled *lower quartile* around the neck of the person who is in the middle.

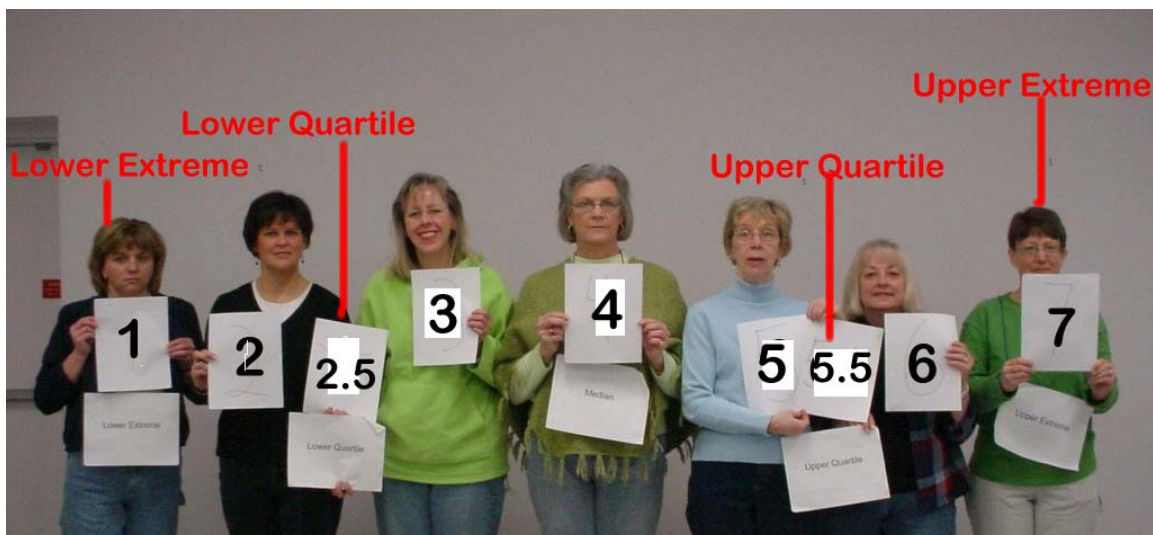
(In the picture the lower quartile would be the average of 2 and 3 or 2.5. Have those persons hold the card labeled 2.5)



Say “Now we are going to find the upper quartile. Using the hand raising method that we used to find the median, let’s find the middle person between the median and the upper extreme.”

Place the card labeled *upper quartile* around the neck of the person who is in the middle.

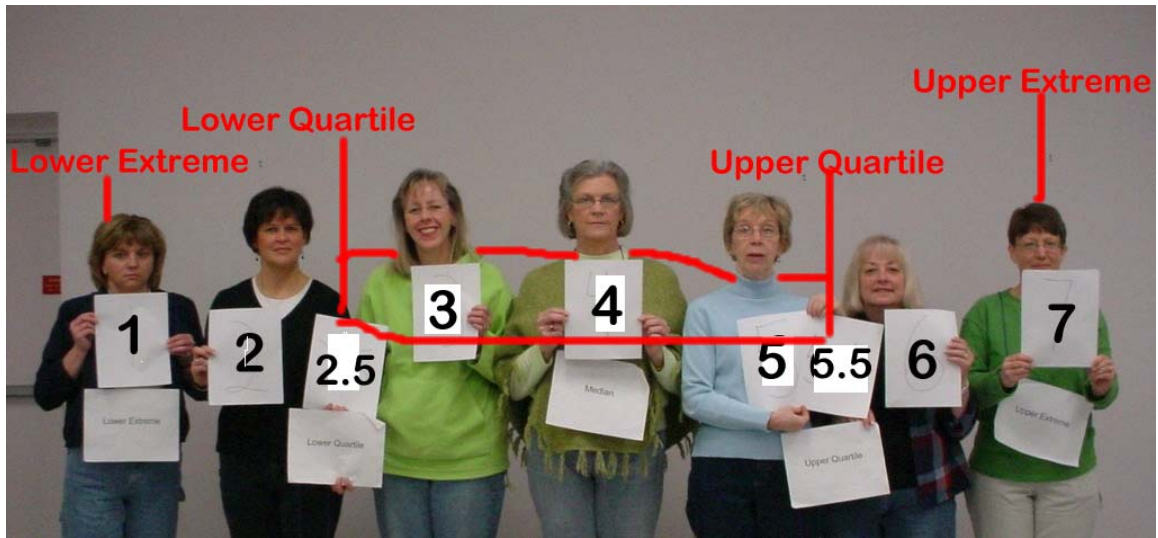
(In the picture the lower quartile would be the average of 5 and 6 or 5.5. Have those persons hold the card labeled 5.5)



Say “Now we need to form our box.” **Ask:** “Which people should be inside of our box?” (Answer – everyone from the lower quartile to the upper quartile.)

Hand the end of the yarn to the person who has the sign that says lower quartile. String it down the line to the person who has the sign that says upper quartile. Then run the yarn behind the line until you reach the lower quartile again. That person will hold the ball of yarn.

(See picture)



Say “Now we have completed our human box and whiskers graph.” **Ask:** “What percent of our data is inside the box?” (Answer – 50 percent) **Ask:** “What percent of our data is part of the lower whisker?” (Answer – 25 percent) **Ask:** “What percent of our data is part of the upper whisker?” (Answer – 25 percent)

Collect the cards from the participants as they return to their seats.

LEARNING ACTIVITIES

Activity One.

Open the file Boxandwhiskers.ti on the computer which is connected to the overhead projector.

Say “Now we are going to enter the data we just collected into this spreadsheet and observe the box and whiskers graph that it generates.”

Using the data collected in the Introductory Activity, input this data into the Exercise One spreadsheet of the TI Interactive worksheet.

Ask: “Where are each of the five points in this graph?” (Answer – point to the lower and upper extremes, median, upper and lower quartiles)

Ask: “What are some general observations you can make about this graph?” (Let participants respond orally)

Ask: “What is different about the human graph and the computer version?” (Let participants respond orally)

Activity Two

Scroll up the screen until you are showing the box and whiskers graph in Exercise Two of the document.

Say: “Now we are going to look at another box and whiskers graph and answer some questions about it.” **Ask:** “What is the median of the graph?” (Answer – 42) **Ask:** “What are the upper and lower quartiles of this graph?” (Answer – 14 and 53) **Ask:** “What are the upper and lower extremes of this graph?” (Answer – 10 and 65) **Ask:** “What do you predict will occur if I change the upper extreme to 75?” (Let the participants respond with their opinions)

Move the upper extreme to 75.

Ask: “Did the graph change as you thought it would?” (Let the participants respond)

Activity Three

Scroll up so that the graph in activity three on the document is at the top of the screen.

Say “Now we are going to look at two box and whiskers graphs side by side. These graphs are of two different math classes on a recent test.”

Ask: “Which graph belongs with the data in L1? How do you know?” (Answer – the graph in L1 belongs with the red box and whiskers because it is the graph with that particular upper extreme)

Ask: “What is the median of each class? The upper and lower extreme?” (Answer – medians are 42 and 48, upper extremes are 72 and 60, lower extremes are 2 and 15)

Say “Now, look at the two graphs and decide which class performed better on the math test. Be prepared to defend your answer.”

(Let participants respond orally)

Activity Four

Open up your internet browser to
<http://weather.unisys.com/hurricane/atlantic/2005/index.html>

Say “Now we are going to look at how to collect real data from the internet. I have opened up the official website for U.S. hurricane data.”

Highlight the two columns for season 2004 and 2005. Copy this data to the spreadsheet on TI interactive. Delete all columns except wind speeds and names.

Say “These two columns show the wind speeds for hurricane seasons 2004 and 2005. Compare the two graphs and make some general observations.”

Ask: “What did you notice? Did anything surprise you? “ (Possible answers might include the only very slight difference in the top speeds, similar box and whiskers graphs, impressions that the 2005 season was significantly worse than the 2004 season.)

(Let participants respond)

Ask: “What other factors may have had an impact on the graph?” (Answer – hurricanes in 2005 landed near major cities; more hurricanes in 2005)

(Optional activity) Use this web site to instruct students on how to import data into TI interactive using the import feature.

Activity Five

In this part of the lesson, students will count the number of Scooby Snacks found in their bag. Scooby Snacks tend to have close to the exact same number of snacks in each bag. The box and whiskers graph may indeed be a straight line if all of the bags have the same number of candies. This leads nicely into a discussion of quality control in a factory and why it is important to both the company and to the consumer.

Say “On your desk is a small bag of Scooby Snacks. Please open the bag and count how many Scooby Snacks are in the bag. Do not eat them at this time. When you are finished counting them, raise your hand and I will record your answer in this graph.”

As people finish, record their answers in Exercise Five list. When the last person has given their answer, double click on the list to create the graph.

Ask: “How is this graph different from the other graphs?” (Answer - this graph shows very little variability, and may even show a straight line.)

Ask: “What might cause this graph to be different from the other graphs?” (Answer – the number of Scooby Snacks is almost the same in every single bag so there is a lack of variability)

Ask: “ Who in real life might be concerned about the consistency of number of items in a product sold?” (Answer – possible answers include a quality control person in a factory, consumer)

Activity Six

Set the VCR to beginning of the *3-2-1 Contact*, Episode #27 clip on collecting data on fish. (Visual clue - tropical fish swimming in the ocean and a change from the preceding clip which is on bears; approximately at 07:51)

Say: "Mathematicians and scientists are both involved with collecting and analyzing data. In this video clip that you are going to watch a group of scientists is collecting data about tropical fish in the ocean. Collecting data is the first step in studying relationships between data."

Focus for Media Interaction, Say: "After watching this clip be able to tell what method the scientists used to differentiate between the fish."

Watch clip. Stop at 10:14 (Visual clue – two men finish showing the scales on the fish)

Ask: "What method did the scientists use to differentiate between the fish?" (Answer - each fish has individual markings on the right side of the rear fin which enables the scientists to identify them)

Focus for Media Interaction, Say: " After watching this next clip, be able to state how the scientists recorded information about the movements of fish while in the water."

Watch clip. Stop at 10:58 (Visual clue – man stops putting down markers in the ocean)

Ask: “How did scientists record information about the movements of fish while in the water?” (Answer - As they trail a particular fish, they drop a marker each time the fish changes direction. From that, they can plot where that fish has been.)

Say: "The scientists want to study how often the fish engage in certain activities. We call this idea of 'how often', frequency."

Focus for Media Interaction "After watching this next clip, be able to describe how the scientists collected the frequency of events while under the ocean."

Begin clip. Stop at 12:14 (Visual clue – scientist finishes showing the adapted underwater computer)

Ask: "How did the scientists collect the frequency of events while under the ocean?" (Answer - the scientists had an underwater computer and set it up so that each different behavior that the fish exhibited could be tabulated.)

CULMINATING ACTIVITY

In this activity you will instruct the participants in the use of the TI-83's to construct a box and whiskers graph. Be sure to familiarize yourself thoroughly before trying this in class. I have put in screenshots to help you work through the instruction.

Turn on your overhead calculator or SmartView. Teachers without overhead calculators may find it useful to make a transparency of a calculator keypad so that the students can see the buttons as well as hear the instructions.

Say “ Today we are going to use TI-83's to construct box and whiskers graph. I will go through the steps with you slowly. Here is the data that we will use.”

Given the data set
(3, 15, 24, 25, 27, 30, 45, 55, 56, 70)
create a box and whisker plot to represent this data.

Say: “ Turn the calculator on. Press the Y= button. Clear out any information left over in the calculator.”

(this is what should be on your calculator)

```
2nd Plot1 Plot2 Plot3
\Y1=
\Y2=
\Y3=
\Y4=
\Y5=
\Y6=
\Y7=
```

Say: “ Press STAT key. You will see a list of choices. The words Edit and number 1 should be highlighted.”

(this is what should be on your calculator)

```
2nd CALC TESTS
1:Edit...
2:SortA(
3:SortD(
4:ClrList
5:SetUpEditor
```

Say: “Press the ENTER key.”

Say: “ Look in the column under L1. Use the DEL key to remove any left- over data.”

Say: “Enter each piece of data in the L1 column. Press enter after each entry.”

(this is what should be on your calculator)

L1	L2	L3	1
8	-----	-----	
15			
24			
25			
27			
30			
45			

L1(1)=3

Say: “Press the 2nd Key”

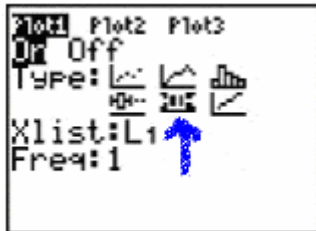
Say: “Press the Stat Plot Key (y=key)”

Say: “Plot 1 should be highlighted. Press the enter key.”

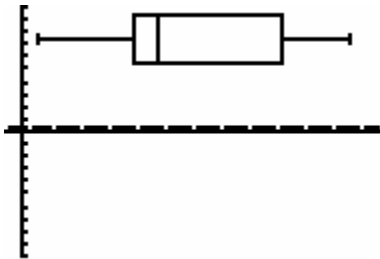
(this is what should be on your calculator)

```
5: [2nd] [F1] [F2] [F3] [F4]
1: Plot1...On
   [2nd] [F1] 1
2: Plot2...Off
   [2nd] [F1] L2
3: Plot3...Off
   [2nd] [F1] L2
4: [2nd] [F1] PlotsOff
```

Say: "Using the arrow keys, move over until the SECOND box plot graphic is highlighted. See the figure on the screen."



Say: "Press the zoom button followed by the number 9. You should now be able to view the box and whiskers graph."



Say: "Press the trace button. Locate the value of the median, lower and upper quartile, lower and upper extreme by moving the cursor over each of the points"
(answer - median = 28.5 upper quartile=55 lower quartile=24 lower extreme=3, upper extreme=70)

Extension Activities

Name the 5 points on a box and whiskers graph

Explain why and how one graph might be different from another.

Demonstrate that you can create a box and whiskers graph on your calculator.



CROSS-CURRICULAR EXTENSIONS

Social Studies

- Students can investigate the roll of surveys and polls in American history and government.

English

- Students can develop presentations based on a chosen research topic for which a presentation might include a box and whiskers graph.

Science

- Students can explore the internet to locate sources of real life data in the scientific areas.

COMMUNITY CONNECTIONS

Invite a pollster to speak to the class about what polls are, how they are collected and how they are used for a variety of purposes.