

Activity Overview

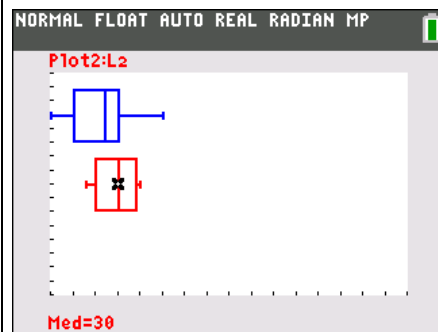
In this activity, students will gather data by recording estimates of how long they think they can hold their breath and the actual amount of time. Then, they will create scatter plots and box plots to analyze the data.

Topic: Geometry & Measurements

- Ordered pairs, graphing ordered pairs
- Scatter plots, box plots

Teacher Preparation and Notes

- Prior to this activity, students should have had some experience with graphing scatter plots and box plots.
- **To download the student worksheet, go to education.ti.com/exchange/bsp**



This activity utilizes MathPrint™ functionality and includes screen captures taken from the TI-84 Plus C Silver Edition. It is also appropriate for use with the TI-83 Plus, TI-84 Plus, and TI-84 Plus Silver Edition but slight variances may be found within the directions.

Compatible Devices:

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

Associated Materials:

- Breathtaking_Scatter_Plots_Student.pdf
- Breathtaking_Scatter_Plots_Student.doc

Tech Tips:

- 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.

Part 1 – Estimate Vs. Actual Time

The scenario given for this problem is that Brian has dropped his watch into 20 feet of water. He needs to dive down nearly 20 feet, locate the watch, grab it, and swim back to the surface. Students will gather their own data about how long they can hold their breaths and then plot that data to analyze it.

Questions 1–3

First have students estimate how long they think they can hold their breaths. Then, perform 3 timed trials for each student. Students will sometimes want to average the three trials but it is appropriate to simply use the longest trial in each case.

Question 4

After students have gathered their data, they will need to enter the estimated values (x-values) into **L1** and the actual times (y-values) into **L2**.

Press **[STAT]** and select **1:Edit...** If there are already values in the lists, move to the top of each list and press **[CLEAR]** **[ENTER]**.

Then, have students enter the class' values, pressing **[ENTER]** after each data point. Sample data is shown at the right.

Students will then set up a scatter plot of L1 (estimated) versus L2 (actual). Press **[2nd]** **[STAT PLOT]** to access the stat plots. Set up **Plot1** as shown.

Spend time helping students find an appropriate window in which to graph their data. A sample window is shown but it may need to be adjusted based on your class data. Change the **Xmin** and **Xmax** and this will automatically adjust **ΔX** . Do not change **ΔX** .

Questions 5–6

Have students explore the scatter plot using the **[TRACE]** key. Lead students to see that if the estimate and the actual were exactly the same that the x-value and y-value would be exactly the same.

L1	L2	L3	L4	L5	1
20	23	-----	-----	-----	
30	25				
27	27				
40	30				
15	30				
25	34				
30	35				
-----	-----				

L1(1)=20

Plot1	Plot2	Plot3
On	Off	Off
Type:	[Scatter] [Line] [Bar] [Dot] [Box] [Cross]	
Xlist:	L1	
Ylist:	L2	
Mark:	[Box] [Cross] [Dot] [Triangle] [Square]	
Color:	BLUE	

WINDOW
Xmin=15
Xmax=95
Xscl=5
Ymin=15
Ymax=95
Yscl=5
Xres=1
$\Delta X = .303030303030303$
TraceStep = .606060606060606

Part 2 – X-Y Line

After students have concluded that if the actual and estimate were exactly the same that the x-value and y-value would be exactly the same, they will then graph the X-Y line.

Questions 7–8

Students will now need to copy **L2** into **L3** to replicate the estimate being exactly the same as the actual. To do this, move to the top of L3 and press **[2nd] [L2] [ENTER]**. This will duplicate the numbers in L2 into L3.

Now, set up **Plot2** exactly like **Plot1** except select L2 and L3. Have students turn Plot1 off *before* graphing Plot2. Press **[2nd] [STAT PLOT] [ENTER] ► [ENTER]** to turn the plot off.

When students graph L2 versus L3, they will get the X-Y line. A few sample data points are shown at the right.

Questions 9–10

Now, turn Plot1 back on to view both at the same time. Use the **[TRACE]** key to explore Plot1 compared to Plot2. Use the **▲** or **▼** to move between plots (Plot1 and Plot2) and use the **◀** and **▶** to move along the scatter plot. Make sure students understand that the **Plot1** in the top left corner indicates Plot1 and shows which lists are graphed.

They should quickly begin to realize that there are Plot1 values above and below Plot2 values. Guide students to conclude that the values above Plot2 are points where the actual value is greater than the estimated value. (The student could hold their breath longer than they thought they could.) The points below Plot2 show where the estimate was greater than the actual value. (The student did not hold their breath as long as they thought they could).

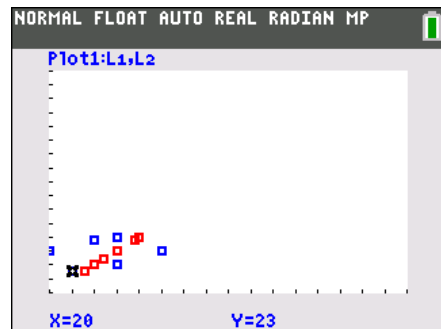
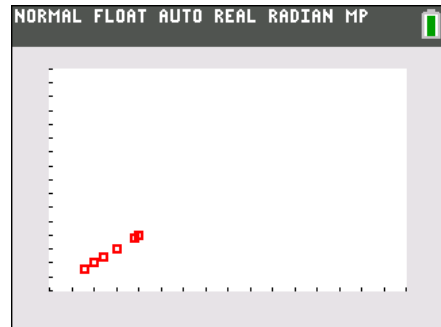
Questions 11–12

As students explore the data, they will likely see that more points are above the X-Y line than below. Almost always, middle school students underestimate the length of time they can hold their breath.

Lead students to see that the person best to help would be the student with the data point highest along the y-axis, regardless of where this point falls along the x-axis. Help students see that the x-axis location is the *estimated* time only, not the actual time.

L1	L2	L3	L4	L5	3
20	23	-----	-----	-----	
30	25				
27	27				
40	30				
15	30				
25	34				
30	35				

L3=L 2



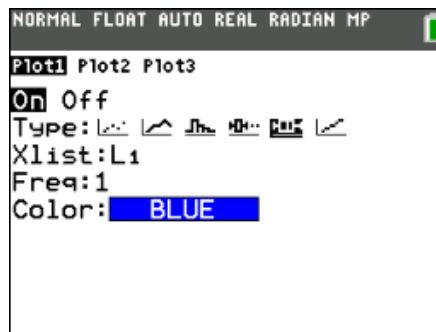
Part 3 – Box Plots

Finally, students will create a box plot of both the estimated times and the actual times. Looking at these on the same screen should help students even more clearly see that the estimated times are generally lower than the actual data values.

Question 13

If students have had little experience with box plots, you may want to have them go through the steps of creating a box plot on the board before the TI-84 Plus creates the box plot for them (sort the list, find the quartiles, etc).

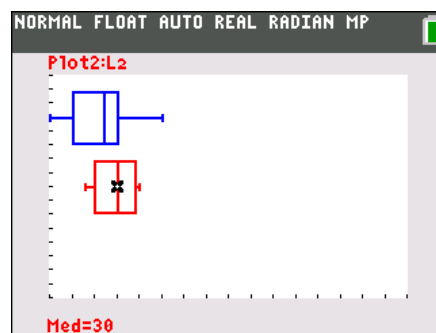
To change **Plot1**, press 2nd [STAT PLOT] and select Plot1. Adjust the settings as show at the right. Change **Plot2** to use an Xlist of L2. After the plots are set up, press [GRAPH].



A sample screen is shown below at the right.

Questions 14–17

Have students explore the values associated with the box plot. Press [TRACE] and they will see **Plot1: L1** appear in the top left corner and **Med=** appear along the bottom of the screen. Clarify that they know which plot they are tracing (estimate or actual) and that they know which statistic the point represents. Use the \blacktriangle or \blacktriangledown to move between plots (Plot1 and Plot2) and use the \blacktriangleleft and \blacktriangleright to move along the box plot. Plot2 is shown at the right.



Just like students noticed in the XY-line plot, the box plot of L1 will show that the estimated times are regularly below the actual times.

In this representation of the data, students should conclude that the person best suited to help Brian retrieve his watch is the person with the greatest actual time. (maxX).

Solutions – student worksheet

Part 1

- How long do you think Brian would need to retrieve the watch?

Answer: Answers will vary. Accept reasonable answers.

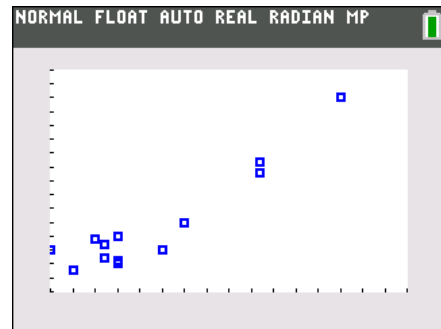
- How long do you think you could hold your breath in seconds?

Answer: Answers will vary. Accept reasonable answers.

- What are your actual three trials? **Answer: See students' work.**

- Create a scatter plot of the estimates (Question 2) as the x -coordinate and the *longest* actual trial (Question 3) as the y -coordinate. The plot should have one point per student.

Answer: Answer will vary. Scatter plot could look similar to the screenshot at the right. Students should add a scale to the graph and label the axes.



- With your partner, determine what the scatter plot tells you about the estimates made and the actual times people could hold their breaths. Summarize your observations.

Answer: Students should conclude that the actual times for holding their breaths were generally greater than their estimates.

- What do you think the graph would look like if each person estimated the time they could hold their breath *exactly*?

Answer: If the actual and estimate matched, the data would create a straight line where $y = x$.

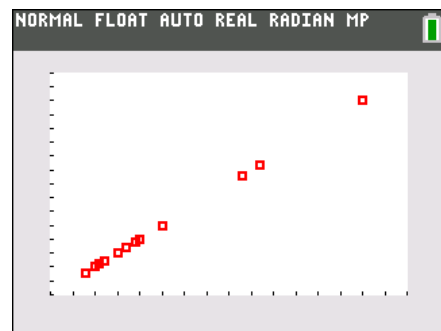
Part 2

- Copy L2 into L3. Go to the top of L3 and press $\boxed{2nd}$ $\boxed{[L2]}$. Then, set up **Plot2** as you did in Question 4 but graph L2 versus L3. When you press \boxed{GRAPH} , what do you notice?

Answer: Students should see that a straight line has been created where $y = x$.

- Draw your new scatter plot at the right.

Answer: A sample screen could look like the screenshot at the right. Students should add a scale to the graph and label the axes.



- Turn Plot1 back on. Press \boxed{TRACE} and move to one of the points in Plot1 above the points in Plot2. What does this point above Plot2 tell you?

Answer: The point above Plot 2 tells me that the actual was greater than the estimate.

10. Now, press **TRACE** and move to one of the points in Plot1 below the points in Plot2. What does this point below Plot2 tell you?

Answer: The point below Plot 2 tells me that the actual was less than the estimate.



11. Overall, is there a trend in the data?

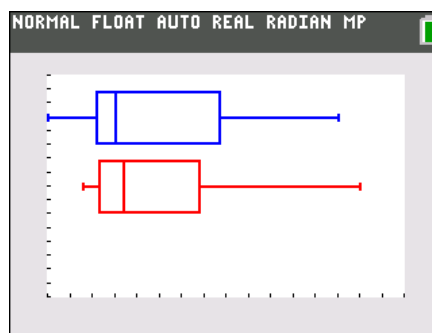
Answer: Students should see that students more often underestimate how long they can hold their breaths. This may vary based on your class data.

12. In Brian's watch situation, which student would be best to help and why?

Answer: Answers will vary. This should be the student that has the greatest actual trial time.

Part 3

13. Now, create a box plot of the estimated data and the actual data. Change Plot1 to select the  symbol for the plot type and L1 (estimated data). Change Plot2 to select the  symbol for the plot type and L2 (actual data). Draw your box plots at the right.



Answer: Graphs will depend on class data. A screen could resemble the screenshot at the right. Students should add a scale to the graph and label the axes. In a box plot the y-axis needs no scale.

14. What does the box plot for the estimates tell you? Press **TRACE** to explore the graph.

Answer: Students should comment on the maximum, minimum, median, and other summary statistics. References to actual numbers will be based on class data.

15. What does the box plot for the actual data tell you?

Answer: Students should comment on the maximum, minimum, median, and other summary statistics. References to actual numbers will be based on class data.

16. What do the box plots show about how the estimates compare to the actual data?

Answer: Again, students should see that the estimates are less than the actual data. This may vary by classroom however.

17. Thinking about Brian's watch situation again, which data show(s) the student(s) in your class that would be best to attempt the rescue? Why?

Answer: In this representation, the student with the maximum value for their time trial should help retrieve the watch.