Graphics Calculator Resources for Years 9 and 10

Activity	*Reaction Times and Statistics*
Year Group	8 – 10
Level	1, 2
Strand	Chance and Data
Sub-Strand	Statistics
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Calculators	TI-83 family
Description	Programs are used to measure reaction times in various scenarios. The data are displayed as box-and-whisker plots for subsequent analysis.

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Activities and associated programs can be downloaded from *www.canberramaths.org.au* under *Resources* or from *www.ma.adfa.edu.au* under *High School and College Activities.*

Reaction Times and Statistics

Introduction

There are three activities here, based around a common theme of reaction times. In each activity, a calculator program is used to measure and record reaction times under different conditions.

1. Use the REACTHND program to measure reaction times using first one hand, then the other. Analyse the resulting box-and-whisker plots, one for each hand, to draw conclusions from your data. Based on a presentation by Jamie Alford of the University of Queensland.

2. Use the REACT program to measure reaction times under three different conditions:

   (a) intense concentration and complete silence;

   (b) relaxed in relative quiet;

   (c) distracted in a noisy environment.

   These conditions pertain to a person's reaction time, and therefore time to apply the brakes and stopping distances, when driving a car. The data are plotted as box-and-whisker plots and are also available in lists for further analysis. Originally cast as a Statistics Mini Assignment by Dan Graeme of the University of Queensland.

3. Use the CARSTOP program to simulate driving behind a car whose brake lights suddenly flash on. The speed of your car and the distance behind the car in front can be varied. Scenarios such as those in Activity 2 can be used. The reaction times are plotted as a box-and-whisker plot and the data are available in a list for further analysis.

   This activity is designed to appeal to, and maybe even instruct, students approaching driving age. The outcomes, crashing or stopping safely, reflect what would actually happen, assuming both cars stop in the same distance after the brakes are applied.

Real-World Statistics #1

Introduction

You are a statistician employed by Microsoft. You have been commissioned to assist in the design of a new control pad for the XBOX® II. The data you are tasked to compile are the reaction times of the 'better' and 'worse' hands of users. You are required to measure and analyse the reaction times, and to comment on the differences between the two hands. To help with your research, you are provided with a graphics-calculator program to measure reaction times and a set of steps to work through.

Method

Use the REACTHND program to measure your reaction times using *at least* 15 trials on each hand. Sketch your boxplots and complete the quartile analysis below — use the arrow keys to find the numbers from the boxplots.

	Left Hand	Right Hand
Mean		
minX		
Q1		
Median		
Q3		
maxX		

Analysis

Compare your results with those of others in your group. Detail any differences in the data obtained from different individuals.

From the data, describe the differences between your 'better' hand and your 'worse' hand. How accurate are these terms?

Further Activities

1. What, from your findings, should Microsoft consider when designing the control pad?

2. Present a rough design of the new control pad. This should be light on artistic focus, but high on thinking. Microsoft has paid designers. You are the statistician. Your job is to give a rough outline of the control pad **with a high level of justification**. Your design should be a one-third-page diagram, with the other two-thirds of the page used for justification and conclusion.

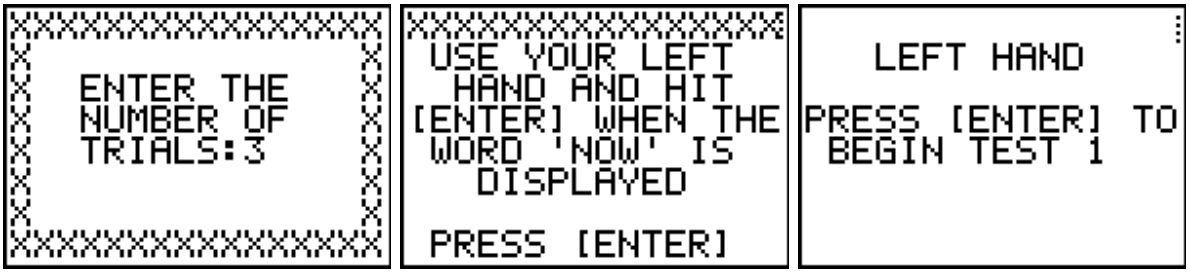
3. Reflect on the activity. Explain your work as a statistician, including formal descriptions of the types of tasks you performed and why you believe they were relevant. You should also address what you think the purpose behind statistical work is.

Teacher's Notes

This activity uses a calculator program REACTHND to create box plots using reaction-time data collected from the students.

Before you begin this activity, have the students clear all lists in their calculators: press [2nd] [+] (MEM), then [4] to select ClrAllLists and [ENTER] to carry out the process.

To run the REACTHND program, press [PRGM], then the number against the program name and [ENTER] to start it. Below are some of the screens that students will see in collecting the data.



'DEFAULTS' in the last screen refers to the DEFAULTS program. If you do not have this program, turn off the StatPlots in [Y=].

Note: Students should rest their finger below the full-stop key instead of having it hover over the [ENTER] key.

The means are displayed on the screen. Using the arrow keys when the box plots are graphed will give students the following information for each hand.

- minX: minimum — smallest value in the data
- Q1: lower quartile — cutoff point for the bottom 25% of the data
- Median: cutoff point for the bottom 50% of the data
- Q3: upper quartile — cutoff point for the top 25% of the data
- maxX: maximum — largest value in the data

Real-World Statistics #2

Introduction

You are a statistician employed by a car company **ROLLER**. In their current advertising campaign, they claim that their cars have the least road noise of any current car on the market and that therefore their cars are the safest, as drivers are not distracted as they are in other noisier makes of car.

You have been commissioned to compile data to measure the effect of noise on the reaction times of drivers. The data are required to be collected under each of the following conditions.

Scenario 1: Total concentration and complete silence.

Scenario 2: Relaxed in relative quiet.

Scenario 3: Distracted in a noisy environment.

Method

Use the graphics-calculator program REACT to measure reaction times for each of the three scenarios. The program leads you through the steps. Note that the reaction time just pressing a calculator key is likely to be significantly shorter than when you move your foot onto the brake pedal and push it. The simulation will be more realistic if you rest your finger on the [Y=] key while waiting for *NOW* to be displayed.

Do *at least* 15 trials for each scenario. After you have done all the trials, the program will present the results as boxplots, one for each scenario.

Use the arrow keys to move around the boxplots.

Results

Sketch your boxplots and complete the quartile analysis below — use the arrow keys to find all the numbers (except the means) from the boxplots.

Press [ENTER] to obtain the means.

	Scenario 1	Scenario 2	Scenario 3
minX			
Q1			
Median			
Q3			
maxX			
Mean			

Press [ENTER] to finish the program. As the final screen tells you, the data are available in lists L_1 – L_3 for further analysis.[1]

Analysis

From your results, describe the differences between your reaction times in the three scenarios. Explain what these mean in plain English — don't just say the means are different, or something similar.

From your findings, should ROLLER continue with their current advertising campaign? Why or why not?

Compare your results and conclusions with those of other 'drivers'. Summarise any similarities and differences.

[1] Press [STAT] [1] to see the data. You can replot the boxplots by pressing [Y=] and using the cursor and [ENTER] to highlight Plot1, Plot2 and Plot3 at the top of the screen. Press [TRACE] to replot. If you have changed the WINDOW since the boxplots were plotted by the program, press [ZOOM] [9] to set an appropriate window.

Further analysis

On one calculator, enter the *median* from each participant for Scenario 1 into L_1, for Scenario 2 into L_2 and for Scenario 3 into L_3. Turn on Plot1, Plot2 and Plot3 in [Y=] and press [ZOOM] [9] to plot the boxplots of these medians.

Sketch the boxplots of the class medians and fill in the quartile analysis below.

	Scenario 1	Scenario 2	Scenario 3
minX			
Q1			
Median			
Q3			
maxX			
Mean			

Now do the same for the *means*. Sketch the boxplots of the class means and fill in the quartile analysis below.

	Scenario 1	Scenario 2	Scenario 3
minX			
Q1			
Median			
Q3			
maxX			
Mean			

What is the difference between the boxplots of the median and the boxplots of the mean of the group data?

Which of these would ROLLER use to support their ads? Why?

Real-World Statistics #3

Introduction

You have just begun to drive a car. One of the important and basic things you have to learn is how far behind the car in front should you drive so that you can stop safely if it brakes.

The calculator program CARSTOP simulates this situation. You select a speed to travel at and the distance behind the car in front. After a random interval, the brake lights of the car in front will come on, indicating that it is braking hard to stop in minimum distance. Will you stop in time or will you crash into the car in front?

When you see the brake lights come on, you have to move your finger from the [Y=] key (top left) to the [ENTER] key (bottom right) and press it. This simulates taking your foot off the accelerator pedal, moving it to the brake pedal and pushing it hard.[2] Each time you do this, the calculator records your reaction time, as well as indicating the outcome. The program assumes that both cars stop in the same distance once the brakes are applied.

Method

Run the CARSTOP program. Select CHOOSE CALC and select your calculator type from the menu. Read the instructions if you wish ('when all else fails').

Choose a speed in kilometres per hour (city 60 km/h, main road 80 km/h, highway 100 km/h). Choose a distance behind — specified in metres and car lengths. To set speed or distance, move the cursor (highlight) to either S (speed) or D (distance) with the left/right arrow keys. Use the up/down arrow keys to increase/decrease the value.

When you have set the values, press [Y=] to start driving. Press [ENTER] to apply your brakes when the brake lights come on. There is a short time interval (as in real life) before the outcome is known.

The instructions at the top right of the screen tell you which keys are operative at each step.

Run 15 trials at each speed, changing the distance behind if necessary, for each of the three scenarios below (you will have to re-run the program for each scenario). These scenarios simulate different driving conditions.

Scenario 1: Total concentration and complete silence.

Scenario 2: Relaxed in relative quiet, e.g. radio or CD playing.

Scenario 3: Distracted in a noisy environment, e.g. people talking to you.

When you have completed your trials for a scenario, press the [Q] key ([ALPHA] not necessary), select QUIT and PLOT BOXPLOT.

[2] The real-life situation is still likely to take longer than the calculator simulation.

Results

Sketch the boxplot for each scenario and complete the quartile analysis below — use the arrow keys to find all the numbers (except the mean) from each boxplot.

	Scenario 1	Scenario 2	Scenario 3
minX			
Q1			
Median			
Q3			
maxX			
Mean			

Press [ENTER] to finish the program. As the final screen tells you, the data for the scenario are available in list L_1 for further analysis.[3]

Analysis

From your results, describe the differences between your reaction times in the three scenarios. Explain what these mean in plain English — don't just say the means are different, or something similar.

What do these results suggest regarding the distance you should drive behind the car in front in each of the scenarios?

[3]Press [STAT] [1] to see the data. You can replot the boxplot by pressing [Y=] and using the cursor and [ENTER] to highlight Plot1 at the top of the screen. Press [TRACE] to replot. If you have changed the WINDOW since the boxplot was plotted by the program, press [ZOOM] [9] to set an appropriate window.

Given that a safe distance is one at which you can stop before running into the car in front 100% of the time, fill in the table below. You may need to do some more trials for this.

	Safe distance (m)			
Speed	Scenario 1	Scenario 2	Scenario 3	Two-second criterion
60				
80				
100				

Can you come up with a rule of thumb that relates a safe distance in metres or car lengths to speed in km/h? Check using the program that your rule of thumb makes sense for higher and lower speeds.

A time rule of thumb often taught is that there should be a two-second gap between cars. Calculate corresponding distance values to add to your table. Compare with the other values and comment. What distance rule of thumb (car lengths) corresponds to the two-second time rule of thumb?

How would your reaction time using the program compare, do you think, to your reaction time in taking your foot off the accelerator pedal and pressing the brake pedal down hard. How would this change your rule of thumb?