

Pecking Order in Chickens Investigation

A note to teachers:

This is an interesting yet rather atypical data investigation. Students investigating this dataset require a reasonable level of competence with the graphic calculator and the ability to 'thinking outside the box'.

For this reason it is suggested:

- Students need to have the graphic calculator competence to generate and interpret statistics, box and whisker plots, scatter plots, lines of best fit and correlating coefficients.
- Students spend a few minutes carefully understanding the problem to decide what it is they are actually looking for.
- The activity be run in an open-ended manner.
- Students work in pairs or small groups.

It is very interesting to observe the strategies employed by students as they investigate this activity given the chance to think through their ideas and strategies without too much teacher intervention. However, a bit of careful 'prodding' (questioning) is always beneficial for students who become 'stuck'. It is therefore important that before running this activity, teachers familiarize themselves with the variety of strategies available to help them formulate the best questions.

NOTE: If you are new to STAT mode you may find it beneficial to first work through the worksheet 'Self-Guided_9860_STAT'.

NOTE: If you desire to modify this activity (for example to make it assessable) and therefore desire the original word document you may request it by emailing casio.edusupport@shriro.com.au.

Pecking Order in Chickens Investigation

'Pecking order' refers to the relative ranking that often occurs between animals of the same species when they live in close proximity. A researcher on animal behavior wants to study the relationship between pecking order and weight. He places four chickens in each of seven pens and observes the pecking order that emerges in each pen.

The dataset below contains the weights (in grams) of the chickens, arranged by pecking order. That is the first row (pecking order 1) gives the weight of the dominant chicken in each pen, the second row (pecking order 2) gives the weight of the second most dominant chicken in each pen, and so on.

Instructions:

Work in pairs or threes. Read and discuss the information carefully.

You are to investigate the data. Use your graphic calculator to assist your investigation. There may be more than one way to enter the data.

You may also may use strategies to investigate this activity without technology.

You are to write a summary of your findings. (Refer to your teacher's guidelines).

Justify all your conclusions.

Pecking Order	Pen1	Pen2	Pen3	Pen4	Pen5	Pen6	Pen7
1	1880	1300	1600	1380	1800	1000	1680
2	1920	1700	1830	1520	1780	1740	1460
3	1600	1500	1520	1520	1360	1520	1760
4	1830	1880	1820	1380	2000	2000	1800

Source: Data collected by D. L. Cunningham, Cornell University

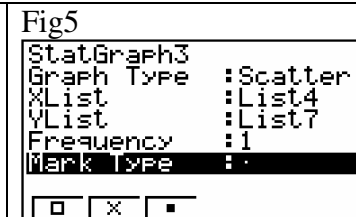
Weight in grams



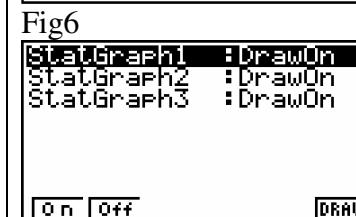
Examples of Investigative Strategies: Pecking Order in Chickens

Instructions	Screenshots																																																												
<p>A class of engaged students who are competent with STAT mode of the Casio 9860 will employ some interesting and varied strategies when tackling this investigation. Some of these strategies are outlined below.</p> <p><u>Finding the 'Pen Statistics'</u></p> <p>The most common data entry students first execute is to enter the data as it appears in the investigation. One of the first skills many students employ is to find the statistics, specifically the mean, on each pen. This of course does not help in the quest to determine if any relationship exists between chicken weight and pecking order. It is beneficial to be on the lookout for students embarking on this course of action. Allow them time to explore and conclude that another strategy is required. A good question to ask students who become 'stuck' is "How does the mean of each pen help you to investigate the relationship between pecking order and weight?"</p> <p><u>Pecking order Scatter Plots</u></p> <p>If we include the pecking orders in a list alongside the lists of data for each pen (Fig1) then we could generate a scatter plot for each pen and check the correlating coefficient for each. If students have already entered the data for each pen BUT NOT THE PECKING ORDER, they can enter the pecking order after the pen-7 data. As long as the list containing the pecking order is set as the X List of the scatter plot it does not matter into which list the pecking order numbers 1, 2, 3 and 4 are entered.</p> <p>The software emulator which generated the screen shots on this page has the pecking orders in List 4 and the Pen Data in lists 5 through 11 (Figs1&2)</p> <p>Because each scatter plot will contain few points (4 each) we could generate 3 scatter plots at a time, using a different mark for each plot.</p> <p><u>Set up StatGraph1 for Pen1 scatter plot using the F1 Mark Type</u> (Fig3) (Your list numbers do not need to match the examples in Figs 3, 4 and 5)</p> <p><u>Set up StatGraph2 for Pen2 scatter plot using the F2 Mark Type</u> (Fig4)</p>	<div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> <p style="text-align: center;">Fig1</p> <table border="1" style="width: 100%; border-collapse: collapse; font-family: monospace;"> <thead> <tr> <th></th> <th>List 4</th> <th>List 5</th> <th>List 6</th> <th>List 7</th> </tr> </thead> <tbody> <tr> <td>SUB</td> <td>PECKG</td> <td>P1</td> <td>P2</td> <td>P3</td> </tr> <tr> <td>1</td> <td>1</td> <td>1880</td> <td>1300</td> <td>1600</td> </tr> <tr> <td>2</td> <td>2</td> <td>1920</td> <td>1700</td> <td>1830</td> </tr> <tr> <td>3</td> <td>3</td> <td>1600</td> <td>1500</td> <td>1520</td> </tr> <tr> <td>4</td> <td>4</td> <td>1830</td> <td>1880</td> <td>1820</td> </tr> </tbody> </table> <p style="text-align: right; font-size: small;">1</p> </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> <p style="text-align: center;">Fig2</p> <table border="1" style="width: 100%; border-collapse: collapse; font-family: monospace;"> <thead> <tr> <th></th> <th>List 8</th> <th>List 9</th> <th>List 10</th> <th>List 11</th> </tr> </thead> <tbody> <tr> <td>SUB</td> <td>P4</td> <td>P5</td> <td>P6</td> <td>P7</td> </tr> <tr> <td>1</td> <td>1330</td> <td>1800</td> <td>1000</td> <td>1680</td> </tr> <tr> <td>2</td> <td>1520</td> <td>1780</td> <td>1740</td> <td>1460</td> </tr> <tr> <td>3</td> <td>1520</td> <td>1360</td> <td>1520</td> <td>1760</td> </tr> <tr> <td>4</td> <td>1380</td> <td>2000</td> <td>2000</td> <td>1800</td> </tr> </tbody> </table> <p style="text-align: right; font-size: small;">1380</p> </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"> <p style="text-align: center;">Fig3</p> <pre style="font-family: monospace; font-size: small;"> StatGraph1 Graph Type : Scatter XList : List4 YList : List5 Frequency : 1 Mark Type : □ </pre> </div> <div style="border: 1px solid black; padding: 5px;"> <p style="text-align: center;">Fig4</p> <pre style="font-family: monospace; font-size: small;"> StatGraph2 Graph Type : Scatter XList : List4 YList : List6 Frequency : 1 Mark Type : * </pre> </div>		List 4	List 5	List 6	List 7	SUB	PECKG	P1	P2	P3	1	1	1880	1300	1600	2	2	1920	1700	1830	3	3	1600	1500	1520	4	4	1830	1880	1820		List 8	List 9	List 10	List 11	SUB	P4	P5	P6	P7	1	1330	1800	1000	1680	2	1520	1780	1740	1460	3	1520	1360	1520	1760	4	1380	2000	2000	1800
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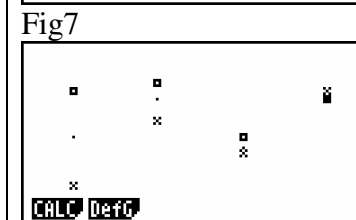
Set up StatGraph3 for Pen3 scatter plot using the F3 Mark Type (Fig5)



Press EXIT and SEL (F4) to turn all three graphs on (use cursor and F1 to turn 'Draw On' in each case) (Fig6)

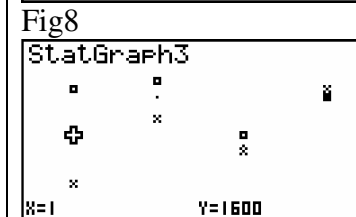


Press Draw (F6) (Fig7) Remember the 'box' mark is Pen1, the 'x' mark is Pen2 and the 'dot' mark is Pen3.

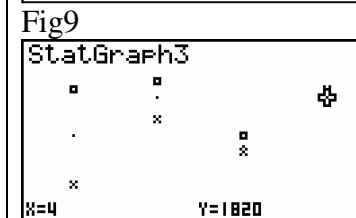


We need to interpret the shape of each graph. Notice that only 2 of the 4 points for Pen3 ('dot' mark) are showing. This is because the last 2 points of Graph3 are common with points of Graphs 1 and 2. This is not a problem if we trace the graphs.

Press Trace (SHIFT F1) and use the down arrow to move the cursor onto StatGraph3 (Pen3) (Fig8)



Now use the right arrow to **scroll and see the two 'hidden' points** (Fig9 shows the second 'hidden' point)



Trace along each graph and discuss what is indicated about the chickens in each pen by the graphs.

There seems little conclusive evidence of a relationship between pecking order and chicken weight from these graphs. But let's check the lines of best fit and correlating coefficients.

To generate a line of best fit from a scatter plot the trace must be turned OFF

Turn the trace off by **pressing SHIFT F1.**

Press CALC (F1) then X (F2) (Fig10)

The screen indicates that StatGraph1 is being displayed. (By scrolling up or down the other graphs are selected)

To generate the line of best fit for StatGraph1 (Pen1), select StatGraph1 using the arrows. Then **press EXE.**

The first screen will give the equation of the line of best fit (Fig11). Note the correlating coefficient is -0.4

Press Draw (F6) (Fig12)

To generate the line of best fit for Pen2, **press EXIT EXIT SEL (F4) DRAW (F6) CALC (F1) X (F2)**

Then press down arrow to select StatGraph2 (Fig13)

Press EXE then DRAW (F6) (Fig14)

Fig10

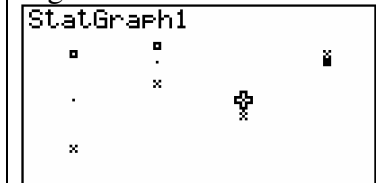


Fig11

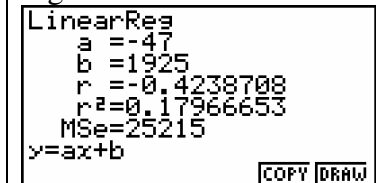


Fig12

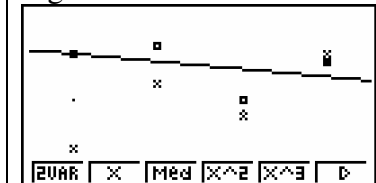


Fig13

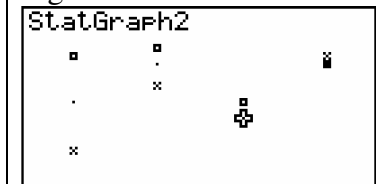
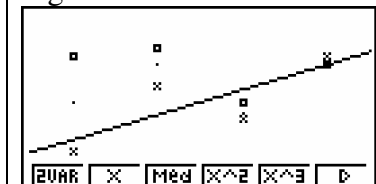


Fig14



Performing the corresponding set of key strokes will generate the line of best fit for Pen3 (Fig15)

The only Pen so far to display a strong relationship between chicken weight and pecking order is Pen2 with a correlating coefficient of 0.79

By returning to StatGraph Setup and resetting the YLists to the respective lists for pens 4, 5, 6 and 7 the remaining lines of best fit can be generated. These are displayed below.

Line of best fit for Pen4 (Fig16)

Line of best fit for Pen5 (Fig17)

Line of best fit for Pen6 (Fig18)

Line of best fit for Pen7 (Fig19)

NOTE: Some groups of students cleverly utilize their 3 calculators so that all 7 graphs are displayed simultaneously.

Fig15

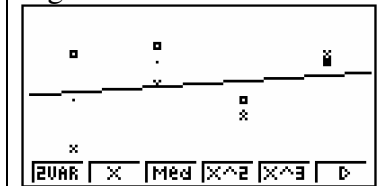


Fig16

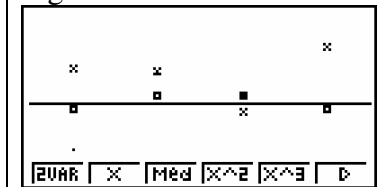


Fig17

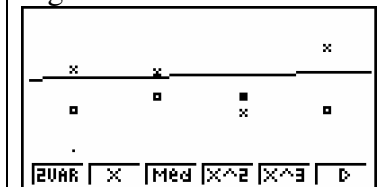


Fig18

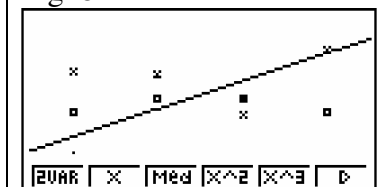
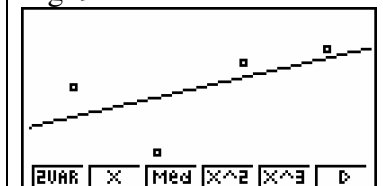


Fig19



A summary table of Pen number and Correlating Coefficients appears below.

Pen No.	r
1	-0.42
2	0.79
3	0.29
4	0
5	0.09
6	0.85
7	0.56

From these results it appears that two out of the 7 pens (Pens 2 and 6) indicate a strong correlation between pecking order and chicken weight and one pen (7) could be argued as having some kind of correlation. HOWEVER, realize that this is not the correlation that we might expect. The positive correlations mean that the higher the pecking order number (ie the lower the pecking order) the heavier the chicken. In lay terms it appears the lighter the chickens in Pens 2, 6 and 7 the 'bossier'/more assertive they are!

Investigating the data according to Pecking Order (rather than Pen Number)

Another valid strategy requires the data to be entered into 4 lists ie Pecking Orders 1, 2, 3 and 4 (Figs20&21)
This allows for a comparison between chickens of each pecking order.

Comparing the Box Plots of the weights of the 7 chickens of each Pecking Order

We can only display three box plots on the screen simultaneously so we will display Pecking Orders 1, 2 and 3 on one screen (Fig22 – Pecking Order is on top) and then Pecking Orders 1, 2 and 4 on another (Fig23 – Pecking Order 4 is on the bottom).
NOTE: Some groups of students will cleverly utilize 2 calculators so that all 4 graphs are displayed simultaneously.

A table of Pecking Order and Median Chicken Weights, gained from the Box Plots, appears below.

Peck Order	Median Weight
1	1600
2	1740
3	1520
4	1830

Again, although not conclusive it appears there could be a mild trend that the lighter chickens tended to have a higher Pecking Order, ie lower Pecking Order Number (ie lighter chickens in this study tended to be the most assertive).

Fig20

SUB	List12 PECK1	List13 PECK2	List14 PECK3	List15 PECK4
1	1830	1920	1600	1830
2	1300	1700	1500	1880
3	1600	1830	1520	1820
4	1300	1520	1520	1380
				1830

GFPH1 GFPH2 GFPH3 SEL SET

Fig21

SUB	List12 PECK1	List13 PECK2	List14 PECK3	List15 PECK4
4	1380	1520	1520	1380
5	1800	1780	1360	2000
6	1000	1740	1520	2000
7	1320	1460	1760	1800
				1630

GFPH1 GFPH2 GFPH3 SEL SET

Fig22

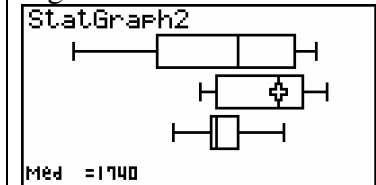
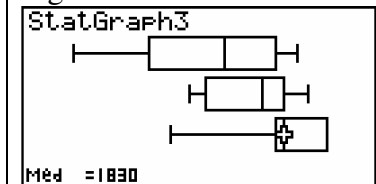


Fig23



A 'crude', yet effective, 'no-technology' method:

This is an interesting activity 'closer' which does not require technology. To see at a glance whether the heaviest chickens tend to have the highest pecking order (ie are the most assertive - we know this is not the case), simply colour in the heaviest chicken weight in each pen.

An example of this 'graph' appears below. We can see at a glance the heaviest chickens tend to be at the lower end of the pecking order.

Peck	Pen1	Pen2	Pen3	Pen4	Pen5	Pen6	Pen7	Tally	
1	1880	1300	1600	1380	1800	1000	1680	0	
2	1920	1700	1830	1520	1780	1740	1460	6	
3	1600	1500	1520	1520	1360	1520	1760	3	
4	1830	1880	1820	1380	2000	2000	1800	16	
								Total	25

Continuing this method we can investigate the remaining weight rankings'.

Below is a 'graph' of the second-heaviest chickens.

Peck	Pen1	Pen2	Pen3	Pen4	Pen5	Pen6	Pen7	Tally	
1	1880	1300	1600	1380	1800	1000	1680	2	
2	1920	1700	1830	1520	1780	1740	1460	6	
3	1600	1500	1520	1520	1360	1520	1760	6	
4	1830	1880	1820	1380	2000	2000	1800	4	
								Total	18

The 'graph' of the second-lightest chickens:

Peck	Pen1	Pen2	Pen3	Pen4	Pen5	Pen6	Pen7	Tally	
1	1880	1300	1600	1380	1800	1000	1680	3	
2	1920	1700	1830	1520	1780	1740	1460	2	
3	1600	1500	1520	1520	1360	1520	1760	6	
4	1830	1880	1820	1380	2000	2000	1800	8	
								Total	19

The 'graph' of the lightest chickens:

Peck	Pen1	Pen2	Pen3	Pen4	Pen5	Pen6	Pen7	Tally	
1	1880	1300	1600	1380	1800	1000	1680	3	
2	1920	1700	1830	1520	1780	1740	1460	2	
3	1600	1500	1520	1520	1360	1520	1760	9	
4	1830	1880	1820	1380	2000	2000	1800	4	
								Total	18

Note that a tally row has been included (a highlighted chicken is allocated points equal to its Pecking Order number)
 The higher the Tally Total, the larger the Pecking Order numbers, therefore the less assertive the chickens. We can see the heaviest chickens in this study were definitely the least assertive (Tally Total = 25). However, the remaining three categories of chicken weights are virtually identical (tally totals of 18, 19 and 18). We could therefore conclude that although the heaviest chickens tended to be the least assertive, there is little to suggest that, of the remaining chickens, the lighter the chicken the more assertive they were.