Lab Framework

Text: Applied Mathematics

Unit number and title: 2--Estimating Answers

Short Description: Use neck and wrist circumference measurements to see how men's shirt sizes are created.

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Lab Title

Finding the right size shirt is a pain in the neck!

LAB PLAN

TEACHER: Teacher Prep/ Lesson Plan

- **Lab Objective**
  To collect data, organize it into a table, perform required calculations, and observe correlations between neck size and wrist size.
- **Statement of pre-requisite skills needed**
  Ability to measure, sort data into a list, plot points on a scatterplot.
- **Vocabulary**
  Estimate -- to make an appropriate guess; to round, to approximate
  Residual -- the difference between the actual value and the predicted value in a set of data
- **Materials List**

- **GLEs (State Standards) addressed**
  Math:
  EALR 1: The student understands and applies the concepts and procedures of mathematics.
  COMPONENT 1.1: Understand and apply the concepts and procedures of number sense
  1.1.7 Apply strategies and uses tools to complete tasks involving the computation of real numbers. W
  EALR 2: The student uses mathematics to define and solve problems.
  COMPONENT 2.2: Construct solutions
  2.2.2 Apply mathematical concepts and procedures from number sense, measurement, geometric sense, probability and statistics, and/or algebraic sense to construct solutions. W
  EALR 4: The student communicates knowledge and understanding in both everyday and mathematical language.
  COMPONENT 4.2: Organize, represent, and share information
  4.2.2 Represent mathematical information in graphs or other appropriate forms. W

Writing:
EALR 2: The student writes in a variety of forms for different audiences and purposed.
COMPONENT 2.2: Writes for different purposes.
2.2.1 Demonstrates understanding of different purposes of understanding. W
EALR 3: The student writes clearly and effectively.
COMPONENT 3.3: Knows and applies writing conventions appropriate for the grade level. W
3.3.7 Applies paragraph conventions

- **Leadership Skills**

- **SCAN Skills/Workplace Skills**

  Writing
  A. Communicates thoughts, ideas, information and messages in writing.
  B. Records information completely and accurately.

  Math
  A. Performs basic computations.
  B. Uses basic numerical concepts such as whole numbers and percentages in practical situations
- **Set-up information**

  Lab organization –
    - The students will pick up a piece of string or a tape measure and begin by measuring their neck circumference and wrist circumference.
    - The students will need to look for a relationship between neck circumference and wrist circumference.
    - The students will plot the data on a scatter plot, with neck circumference on one axis and wrist circumference on another.
    - ***Optional:*** If using Excel or the list function of a graphing calculator, calculate the linear regression line. If not, use $y = (x - 1)/2$ as the regression equation for predicting the wrist size.
    - ***Optional:*** Calculate the residuals of the wrist measurement--the difference between the predicted value and the actual value.
- **Teacher Assessment of student learning**

  Students will be assessed, on a percentage basis, on the accuracy of their calculations and their persuasive conclusion that must include a minimum of two statements of supporting data and meets the WASL standard for writing.
- **Summary of learning**
    - Each team will share their conclusion and supporting data with the class.
    - The teachers should ask for possible career applications and discuss them. Examples are given below.

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Students with learning disabilities may be paired with an existing team of two students. Students would then be assigned the roles of counter/recorder, calculator and grapher.

- **Career Applications**
  - Men’s shirt design companies compare the wrist and neck sizes.
  - Businesses may be concerned with residuals because they will want to know whether their model is an accurate model.
  - Companies may develop trend lines to model behavior of two (or more) variables.

Lab Title: **Finding the right size shirt is a pain in the neck!**
Student Instructions

- **Statement of problem addressed by lab**
  Why do certain men's shirts only use the neck circumference as a sizing tool? Analyze the correlation between neck circumference and wrist circumference.

- **Grouping instructions and roles**
  The students will gather information as a class and then organize information individually.

- **Procedures –** steps to follow/instructions

1. Measure your neck and wrist and record your findings on the board. (Measure in centimeters).
2. Organize the information (neck circumference and wrist circumference) into a table. You will need the following columns (make sure you leave room for every student in the class). Leave the third and fourth column empty as we will fill them in later

Neck Circumference	**Wrist circumference**	**Predicted Wrist circumference**	**Residuals -- difference between actual wrist circumference and predicted wrist circumference**

3. On the grid below, plot the information collected from the data collection. Place the neck circumference on the x-axis and the wrist circumference on the y-axis.

4. Describe any trends that you notice.

5. Using a ruler, draw a "line of best fit."

6. Suppose you measure a person's neck and the measurement is 37 centimeters. Use you best fit line to estimate the wrist size of this person. Explain how you determined your estimate.

7.   We will now fill in the predicted wrist circumference. The find the value, take one (1) away from the neck circumference and then divide by two. The result is a prediction of the measurement of the person wrist.

Ex. If you measure a person wrist to be 34 cm, do the following:

$$\frac{(34cm - 1)}{2} = 16.5cm$$

so the persons wrist is predicted to be 16.5 cm.

Fill in the third column of the table in item #2 above.

8.   The fourth column of the table is titled residuals. To calculate the residuals, do the following:

$$(\text{actual value}) - (\text{predicted value}) = \text{residual value}$$

9. Be prepared to present your findings to the class.

- **Assessment instructions** (peer-teacher)

  Students will be assessed on the accuracy of their calculations and their conclusion to the lab. The conclusion should include supporting data from their lab as well as a persuasive answer.

Week 2 Jan 20-22

Math Modeling (College Algebra, COMAP, Inc 2002)

Modeling processĊ**/b>**making mathematical sense of this crazy world.

Math modeling starts with a question, whose answer we want to find out. We make initial assumptions, what and how many variables could be influencing the process? We gather data, draw graphs, make a table of relevant values or try to find an equation to answer the original question.

Then we test the math model to check its accuracy.

There are two kinds of modeling process.

→ → 1) Theory Model Data (this outline is used, when we want to test any theory)

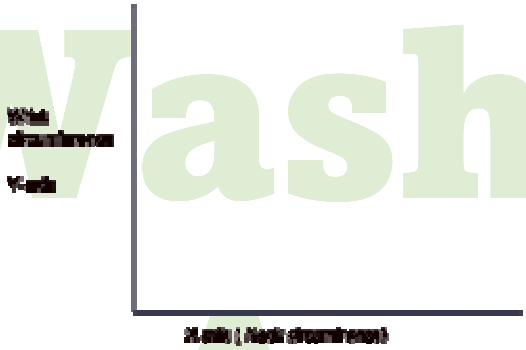
→ → 2) Data Model Theory (we use data to construct a math model to predict or find an answer)

Question: Is their any relationship between neck sizes of a man to his wrist size?

1) Collect the data from a group of men

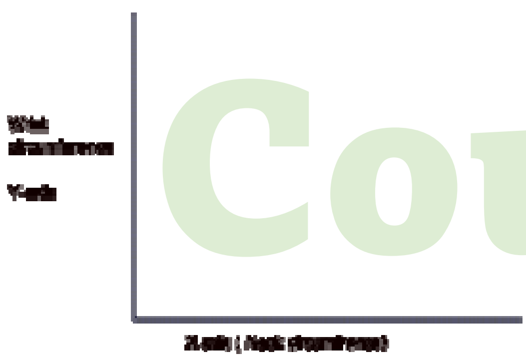
Students	Neck circumference in cm	Wrist circumference in cm
#1		
#2		
#3		
#4		
#5		
#6		
#7		
#8		
#9		

2) Prepare a scatter plot by hand.



3) What pattern do you see? (Linear, non-linear, direct, indirect variation etc)
(Look at the different graphs drawn last week in the class)

4) Draw a best fit line on the graph.



4) If you knew Wayne neck size can you predict his wrist size? (Use your best fit line to predict)

5) Evaluate your model against the unknown values?

Residuals to judge the model

Residual is the error between an actual value and the value predicted by a model.

Error = (actual value Ppredicted value from the graph) .If there was no error there should not be any error. Best line has relatively small residue.

Neck size	Wrist size (actual)	Predicated value from the graph	Residue

Theory behind above linear model (assuming it is linear) (functions modeling change, Hughes - hallet)

Direct proportionality:

***Q* = *k* * *t* (*Q* is a quantity directly proportional to *t*, where *k* is constant)**

Example: Circumference, *C*, of a circle is proportional to its diameter; *d* .What is the constant proportionality?

C* = *k d

Tin Can	D(inches)	C(inches)
Tomato Paste	2.1	6.6
Beef Broth	2.6	8.2
Condensed milk	2.9	9.1
Chunk light tuna	3.4	10.7
Crushed tomatoes	4.0	12.6

Calculate *k* (constant of proportionality) ___________________________

Other proportionality concepts

1) Directly proportional to a power of *x* if

2) Y is inversely proportional to if

Rate of change

Average rate of change or rate of change, of Q with respect to t over an interval is

$$\text{Average rate of change} = \frac{\text{change in Q}}{\text{Change in t}}$$

Example

Annual sales of CDs and LPs (in millions) for selected years

Year	1982	1984	1986	1988	1990	1992	1994
CD sales	0	5.8	53	150	287	408	662
LP sales	244	205	125	72	12	2.3	1.9

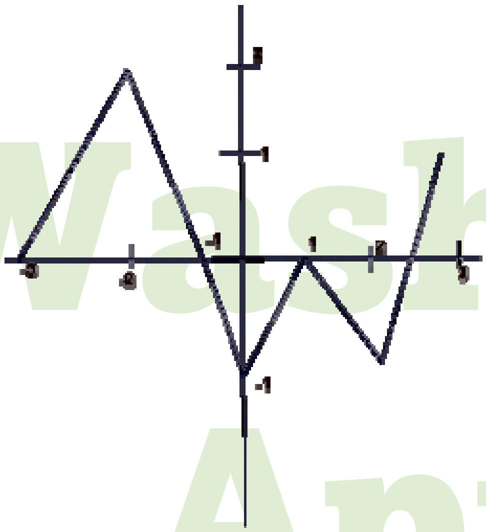
1) Calculate rate of change (CDs) from 1982 to 1994

2) Calculate rate of change (LPs) from 1982 to 1994

Increasing and decreasing functions

1) If f is an increasing function, then the average rate of change is positive on every interval

2) If f is a decreasing function, then the average rate of change is negative on every interval.



Write the intervals where the function is increasing ______________________

Write the intervals where the function is decreasing ________________________

What makes a function linear?

Answer
Linear function has constant rate of change.

The graph of any linear function is a straight line.

Example: A small business spends $ 20,000 on new computer equipment and, for tax purpose, chooses to depreciate it to $ 0 at a constant rate over a five year period. Make a table and a graph showing the value of the equipment over the five year period.

t, year	V, value ($)
0	20,000
1	16,000
2	12,000
3	8,000
4	4,000
5	0

Average rate of change of value from t = 0 to t = 5

Change in value / change in time = $\frac{\Delta V}{\Delta t} = \frac{-\$20,000}{5} = -\$4,000 \text{ per year}$

General formula for the family of linear functions

Output(y) = Initial value (b) + Rate of change (m)   Input (x)

Y = mx + b

b---- Represent y-intercept, where the line is crossing the y-axis.

How can we transform the above data into an equation form?

1) We have calculated the rate of change (slope) ---- $ -4000.00 --- (m)

2) Initial value ---- $ 20,000.00 --- (b)

As we substitute in the above equation, we will get y = -4000x + 20000

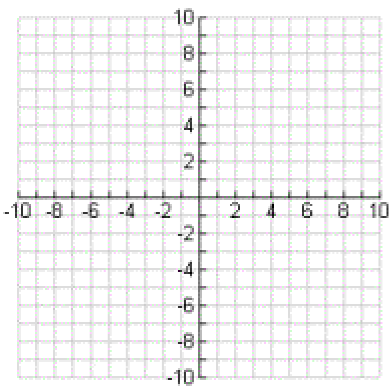
We need rate of change and **initial value** to find the equation of a straight line.

Problem The former republic of Yugoslavia began exporting cars called Yugos in 1985. Information is given in the following table.

Year	Price in $, p	Number sold, Q
1985	3990	49,000
1986	4110	43,000
1987	4200	38,500
1988	4330	32,000

a) **Based on the data in the table, show that Q could be a linear function of p.**
(calculate slope)

b) **(draw the graph)**



Key Word: Slope of a line

1) **Slope of a line, rate of change, $\frac{y_2 - y_1}{x_2 - x_1} = m$ (where (x_1, y_1) & (x_2, y_2) are any two points given on the line.)**

(Advanced algebra key curriculum)

Problems (find the slope of the line containing each pair of points)

1) **(3, -4) and (7, 2)**

2) **(5,3) and (2,5)**

3) **(-0.02,3.2) and (0.08,-2.3)**

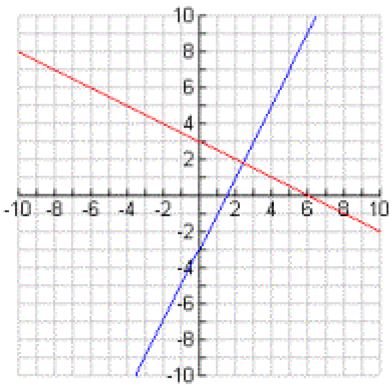
Find the slope of each line

1) $y = 5(3x - 9) + 2$

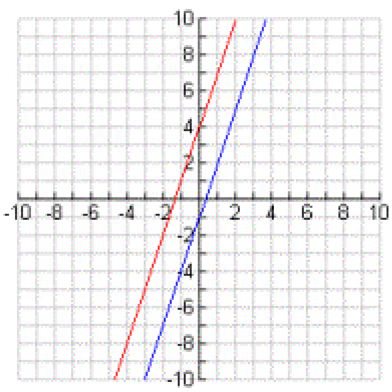
2) $\frac{2}{3}y = \frac{2}{3}x + \frac{1}{2}$

3) Find the equations of both lines in each graph. (y = mx + b)

a)



b)



4) Looking at the previous equations (problem # 3) what do the equations in 3a have in common? What do you notice about their graphs?

5) What do the equations in (problem # 3) have in common? What do you notice about their graphs?

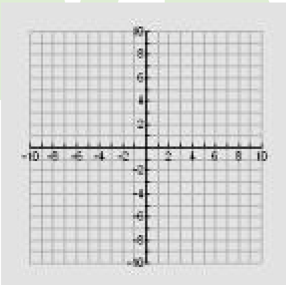
Graphing calculator problem (how to draw the graph of a recursive function)

(Look at the hand out)

6) Layton measure the voltage across different numbers of batteries placed end to end. He records his data in a table.

Number of batteries	1	2	3	4	5	6	7	8
Voltage (volts)	1.43	2.94	4.32	5.88	7.39	8.82	10.27	11.70

a) Draw the graph of above data. (X batteries, y voltage)



b) Let x represent the number of batteries and let y represent the voltage. Find the slope of a line approximating these data. Be sure to include units with your answer.

c) Which points did you use and why? What is the real world meaning of this slope?

d) Does it make sense that the y-intercept of the line is 0? Explain why or why not.