Graphing and Statistical Analysis Packet

For this activity you will read through this packet and watch a series of videos to complete a series of questions. You can find the videos at: http://www.bozemanscience.com/statistics-graphing/

Variables and Graphing:

In many of the experimental laboratory exercises you will complete, observations result in data that can be recorded. In most cases, the data recorded are not all the same-measurements vary. Characteristics that show variability are called ***variables.***

Discrete variables *include those in which observations fall into one of several mutually exclusive categories (for example, red, yellow, or white flowers) or in which observations are not observed on a continuous scale (for example, the number of eggs in a bird's nest or the number of legs on an insect) these variables can take on only a limited number of values - a bird's nest cannot contain 1.23 eggs.*

Continuous variables *are derived from quantitative observations in which the data can assume any value in a continuous interval of measurement. Thus, one of the eggs in a bird's nest may weigh 1.20 or 1.23 or 1.25 grams-all values within a given range are possible. Continuous variables are often distributed within their possible range according to a frequency distribution-more observations tend to fall toward the middle of the range than toward the limits of that range.*

Familiarity with the number and types of variables as well as attention to the number of data points to be reported allows us to make appropriate decisions about the way in which experimental data are to be presented. Data are usually reported in the form of tables or graphs. To learn more about graphing watch: ***Beginners Guide to Graphing.***

1. Define:
    - Discrete Variable
    - Continuous Variable

2. List the 5 types of graphs. For each graph record when it is appropriate to use it and which type of variable (discrete or continuous) would be recorded on it.

3. On which axis should the independent variable and dependent variable be placed?

4. List some of the components of a successful graph.

5. Define the following terms in relation to graphs: (use the internet to answer)
   - Extrapolation
   - Interpolation

Once data is taken, several measures (statistics) are of interest. To learn more about statistics watch the video: ***Statistics in Science***

6. N =
7. n =
8. $\overline{x}$ =
9. M =
10. Range =
11. Degrees of freedom =

Watch the video: Standard Deviation

12. What is standard deviation?

13. What is the equation for standard deviation?

14. Calculate the standard deviation for the following data set: 0, 2, 4, 5, 7 (try this shortcut)

Calculation Shortcut

- *Copy observation data*
- *Find the deviation (how much observation differs from mean)*
- *square each deviation*
- *add up it all up*
- *divide that number by sample size - 1*
- *take the square root of that number*

Observation	Deviation	Deviation Squared
0		
2		
4		
5		
7		
Sum of deviations squared=		
Divided by 5 – 1 =		
Take the square root=		

Watch the video: Standard Error

15. What is standard error?

16. What is the equation for standard error?

17. Calculate the standard error for the following data set: 9, 15 Show your work.

Watch the video: Chi Square Test

18. What is the equation for the Chi Square Test?

19. Define: O_i E_i

20. What is a null hypothesis?

21. At what point do we accept or reject the null hypothesis?

The following practice sets are similar to data you may record during our first laboratory experience. In that lab you will be recording reaction rates.

Practice Problem Set 1 (show all of your work)

Table 1: Reaction Measurements for Male and Females in cm

Males (cm)	Females (cm)
84	35
55	34
63	46
52	26
61	63
49	76
75	48
29	33
50	62
76	40
82	26
46	81

1. Calculate the median for the males.

2. Calculate the mean for the males.

3. Calculate the standard deviation for the males.

4. Calculate the standard error for the males.

5. Calculate the median for the females.

6. Calculate the mean for the females.

7. Calculate the standard deviation for the females.

8. Calculate the standard error for the females.

9. Order the data into one set from shortest (fastest) to longest (slowest). This will be one data set that combines both the male and female information. If the data comes from the males, mark it M; if it comes from the females, mark it F. *(I did the first few for you)*

Shortest																					Longest
26	26	29	33																		
F	F	M	F																		

10. Put an arrow where the median is.

11. In the following chart record your observed and expected data for the problem set. To do this look at #9. How many F's do you have below the median and above the median? How many M's do you have below the median and above the median? These are your observed data. What would you expect to happen? That is your expected.

	Observed	Expected
F Below Median		
F Above Median		
M Below Median		
M Above Median		

**Think about what you would expect!*

12. Calculate X^2 (Chi Square) – show your work.

13. How many degrees of freedom are there in this example?

14. Looking at **Table AI-2 – Critical Values of X^2** (at the end of this packet), what is the value for a 5% probability for this degree of freedom?

15. Do we accept or reject the null hypothesis?

16. Accorded to this data and our chi square test, does gender have an affect on reaction rate?

The Chi Square Test can be used to analyze both unpaired and paired data sets.

An unpaired test compares all observations in treatment group 1 with all observations in treatment group 2. An unpaired test is appropriate when there is no reason to link particular observations in treatment group 1 with particular observations in treatment group 2. An example would be a men-verses-woman experiment like the practice set you just completed.

On the other hand, a paired test compares the first observation in treatment group 1 with the first observation in treatment group 2, the second observation in treatment group 1 with the second observation in treatment group 2, and so forth. It greatly increases the power of the test in "before-and -after" experiments where the effect of treatments on the same individuals are being examined. The following rules will work in most cases:

- For treatment groups of different individuals use an unpaired test.
- For treatment groups of the same individuals use a paired test.

Problem Set 2

Table 2. Reaction Measurements (in cm) of Individuals for Dominant and Non-dominant hands.

Individual	Dominant Hand (cm)	Non Dominant Hand (cm)
1	24	84
2	37	79
3	58	56
4	42	71
5	31	55
6	75	64
7	61	60
8	48	87
9	59	74
10	71	78

17. Is this a paired or unpaired test?

18. In the following chart, if the dominant hand had a faster reaction than the non-dominant hand, put a -. If the non-dominant hand is faster, put a +.

Individual	- / +
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

*If hand dominance made no difference, we would **expect** 5 + signs and 5 – signs.*

19. Write the equation for chi-square:

20. Complete the chart.

	Observed	Expected
+		
-		

21. Calculate X^2 (chi square) – show your work:

22. How many degrees of freedom are there in this example?

23. Looking at **Table AI-2 – Critical Values of X^2**, what is the value for a 5% probability for this degree of freedom?

24. When the X^2 value we got from our calculations is HIGHER than the value in the table, do we reject or accept the null hypothesis?

25. So in this example, do we reject or accept the null hypothesis? Does hand dominance make a difference in reaction times?

Table AI-2 Critical Values of χ^2

Degrees of freedom	$p = 0.9$* (9 in 10)	$p = 0.5$ (1 in 2)	$p = 0.2$ (1 in 5)	$p = 0.05$ (1 in 20)	$p = 0.01$ (1 in 100)	$p = 0.001$ (1 in 1,000)
1	.016	.46	1.64	3.84	6.64	10.83
2	.21	1.39	3.22	5.99	9.21	13.82
3	.58	2.37	4.64	7.82	11.35	16.27
4	1.06	3.37	5.99	9.49	13.28	18.47
5	1.61	4.35	7.29	11.07	15.09	20.52
6	2.20	5.35	8.56	12.59	16.81	22.46
7	2.83	6.35	9.80	14.07	18.48	24.32
8	3.49	7.34	11.30	15.51	20.09	26.13
9	4.17	8.34	12.24	16.92	21.67	24.88
10	4.87	9.34	13.44	18.31	23.21	29.59

*p is the probability that results could be due to chance alone. The numbers in parentheses below each value of p restate p in terms of chance: 9 chances in 10 that results could be due to chance alone, and so on.