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Yes, You Can Write in a Statistics Class: An Instructional Tool to

Reduce Anxiety and Improve Statistics Performance

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### Overview

The acquisition of good written communication skills is recognized as a high priority for colleges and universities. Many acknowledge that the teaching of writing skills is not the sole responsibility of the English instructor. Indeed, writing across the curriculum is both a tool and a goal for improving students' writing proficiency. Although English, history, and sociology seem obvious choices for writing-intensive courses, an opportunity also exists to incorporate writing into the teaching of an introductory statistics course. Benefits to the student include a means for reducing statistics anxiety (Sgoutas-Emch & Johnson, 1998), improved writing skills, as well as a greater comprehension of the subject matter. Specifically, writing is an innovative strategy for reducing students' statistics anxiety, enhancing conceptual understanding (Beins, 1993), and promoting statistical thinking skills (Townsend, 2003).

Discipline specific writing can facilitate conceptual learning by encouraging students to think through ideas and provide explicit, detailed arguments. Writing also allows students to restructure ideas into their own words, which requires higher order reasoning as well as deeper level processing of the course material.

Incorporating writing into an introduction to statistics course also benefits the instructor. In particular, writing provides instructors with valuable information regarding their students' level of anxiety and conceptual understanding and with the opportunity to modify their teaching methodology if necessary.

This resource outlines 32 low-stakes writing assignments in three key areas: (a) writing to reduce statistics anxiety, (b) writing to improve conceptual knowledge, and (c) writing to enhance statistical thinking skills. Many of the writing assignments can stand alone, whereas

others are specific to a particular statistics topic. For each writing assignment we provide a summary of its purpose and the estimated class time needed to complete the assignment.

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## WRITING TO REDUCE STATISTICS ANXIETY

**Writing Assignment 1. Perceptions, Attitudes, and Feelings**Summary:

This writing assignment requires students to give an honest assessment of their perceptions, attitudes, and feelings about statistics. This assignment should be given during the first class meeting and again at the end of the course. The information obtained can be used to address students' perceptions and concerns about taking statistics.

Class Time Involved:

15 minutes

Writing Assignment:

1. Discuss your attitudes and feelings about taking statistics.
2. What are your major concerns about taking a course in statistics?
3. Discuss your personal objectives for this course and then outline the steps you will take to achieve these objectives.

**Writing Assignment 2. What Do You Know About Statistics?**Summary:

This collaborative writing assignment encourages students to brainstorm and freely write their experiences with statistics. The idea is to get students thinking about the many everyday uses of statistics in hopes that a course in statistics will not seem so threatening.

Class Time Involved:

30 minutes

Writing Assignment:

1. Get into small groups of three or four.
2. Take 10 minutes to brainstorm and 5 minutes to free write about the many ways statistics are used every day.
3. Be prepared to discuss your written responses with the class.

**Writing Assignment 3. Journaling**Summary:

For this assignment students keep a journal in which they periodically discuss their anxiety level through the progression of the course, including before and after each exam. With this information, instructors can gauge student mastery of the concepts.

Class Time Involved:

5 minutes

Writing Assignment:

1. How do you feel before taking this exam?
2. How do you feel after taking this exam?
3. Now that we have reached (the first week, the first month, midterm), discuss your feelings about taking a statistics course and compare these feelings with your initial reaction on the first day.

**Writing Assignment 4. Take a Letter**Summary:

This writing assignment requires students to write a letter, e-mail, or posting to their Face book page to a hypothetical statistics student describing their initial anxiety about taking a statistics course and offering suggestions and recommendations for how they managed their anxiety. This assignment is best given at the conclusion of the course, as either an in-class or an out-of-class assignment. Instructors can pass out copies of the letters to future statistics students; or post responses to the course website for in-coming students to read.

Class Time Involved:

30 minutes

Writing Assignment:

Taking a statistics course can be anxiety provoking for many students. Think about how you felt when you learned you had to enroll in a statistics course. Then write a letter to a future statistics student discussing your attitudes, perceptions, and feelings about taking statistics and how they changed as the term progressed. Your letter should also include a discussion of your initial level of anxiety and suggestions for how you managed it (e.g., tutoring).

**Writing Assignment 5. Statistics is...**Summary:

This writing assignment encourages students to think about and then discuss their perceptions about taking a course in statistics. This assignment should be given at the beginning of the term.

Class Time Involved:

10 minutes

Writing Assignment:

Use the following frame to write a sentence discussing your perceptions of statistics.

1. Statistics is...
2. Taking a statistics class makes me feel...
3. In order to reduce my anxiety about taking statistics I will...

**Writing Assignment 6. Ode to Statistics**Summary:

This writing assignment encourages students to write an ode of praise to statistics portraying it as significant and relevant to their lives. Students should not worry about the verse rhyming.

Alternatively, instructors can have students compose a rap song or poem.

Class Time Involved:

None; this assignment is best used as an out-of-class assignment.

Writing Assignment:

An ode is usually a lyrical verse written in praise or dedication to someone or something that inspires the author. Think about how statistics inspires you (o.k., you may have to fake it); then write an ode of praise, poem, or rap song portraying statistics as significant and inspiring for you.

**Writing Assignment 7. Dear John**Summary:

This writing assignment requires students to write a good-bye letter to “statistics anxiety.”

Alternatively, instructors can have students post a hypothetical goodbye letter to statistics on their Face book page.

Class Time Involved:

30 minutes or out of class.

Writing Assignment:

A "Dear John/Jane letter" is a letter written to a relationship partner informing him or her of the end of their relationship. Write a “Dear John” or “Dear Jane” letter to statistics anxiety bidding “him/her” goodbye.

**Writing Assignment 8. Flip It**Summary:

This writing assignment requires students to generate a list of adjectives that represent an honest assessment of their feelings and perceptions regarding taking a statistics course. Students then generate a second list of more positive adjectives to take the place of the original list.

Class Time Involved:

10 minutes

Writing Assignment:

1. Take 5 minutes to write a list of words that describe your feelings about taking statistics. This should be done in column format. Next, think about and list more positive adjectives to replace the original words. For example:

Hard	Challenging
Fearful	Fearless
Irrelevant	Important

2. After you have compiled your list, write out some strategies that you can implement to bring about these changes.

## Writing Assignment 9. Rate Your Anxiety

Summary:

This writing assignment requires students to rate their level of statistics anxiety at the beginning and end of the course.

Class Time Involved:

15 minutes

Writing Assignment:

1. At the beginning of the course, rate your level of anxiety on an 11-point scale from 0 (*no anxiety*) to 10 (*high anxiety*).
2. Next discuss ways that you can minimize your anxiety.
3. At the end of the course, use the same rating scale, 0-10.
4. Discuss how and why your level of anxiety has changed since the beginning of the course.

## Writing Assignment 10. It Just Takes Confidence

Summary:

This writing assignment encourages students to brainstorm ways to reduce statistics anxiety.

Class Time Involved:

5 minutes

Writing Assignment:

Brainstorming involves writing down everything that comes to mind about a particular topic.

For the next 5 minutes, brainstorm strategies that you can undertake to reduce anxiety and increase your confidence about taking a statistics class. Share these strategies with your classmates.

## WRITING TO IMPROVE CONCEPTUAL KNOWLEDGE

## Writing Assignment 11: Music and Memory

Summary:

This writing assignment is designed to help students understand descriptive statistics concepts.

Class Time involved:

40 minutes

Writing Assignment:

To test the hypothesis that students who listen to classical music will recall more words on a memory task than students who listen to country music, an experimental psychologist randomly assigned 20 students to either a classical music group or a country music group. The experimenter read a list of 10 words to members of both groups. Then, students listened to either 2 minutes of a classical song or 2 minutes of a country song. Finally they wrote down as many words as they could remember from the list of 10 words. The data are as follows:

Classical Music

7  
8  
8  
7  
6  
9  
6  
8  
8  
7

Country Music

6  
5  
6  
7  
5  
6  
8  
9  
6  
5

Music and Memory Worksheet

1. State the hypothesis.
2. Why is random sampling important in an experiment?
3. What is the independent variable in this study?
4. What is the dependent variable in this study?
5. Is the independent variable in this study discrete or continuous? Explain.
6. Is the dependent variable in this study discrete or continuous? Explain.
7. On what scale of measurement is the independent variable measured? Explain.
8. On what scale of measurement is the dependent variable measured? Explain.
9. Compute the mean for the classical music group and the country music group. In a few sentences discuss what these values tell you about the data.
10. Compute the standard deviation for the classical music group and the country music group. In a few sentences discuss what these values tell you about the consistency of the data.

Alternative Writing Assignment:

Instructors can have students discuss the appropriate research design and hypothesis test for this research scenario.

## Writing Assignment 12: Link the Words

Summary:

Elaine Backus created a writing assignment called a meaningful paragraph, which is a piece of writing that uses all of the major concepts from a given topic to develop a complete and coherent sentence. The goal of this writing assignment is to demonstrate understanding of the relationship between each of a set of terms. For example, below is a meaningful paragraph using the terms *population*, *sample*, *data*, and *variable*.

Recently, psychologists have discovered a link between heart disease and depression. Researchers studied a **sample** of 100 adults, drawn from a **population** of 6,000. Each participant contributed two pieces of **data**: presence of heart disease and level of depression. Researchers also assessed additional **variables** such as race, gender, and age. Findings indicated that people with heart disease were more likely to suffer from depression.

Class Time Involved:

40 minutes

Sample Terms:

1. Independent variable, dependent variable, population, random sample
2. Probability, alpha, Type 1 error, null hypothesis
3. Mean, skewed, standard deviation, median, data

Writing Assignment:

Using the statistical concepts provided, develop a complete and coherent paragraph that demonstrates your understanding of the relationship between the terms.

## Writing Assignment 13: It's in the Cards

Summary:

This assignment encourages students to think about and summarize statistical concepts individually and in groups.

Class Time involved:

30 minutes

Instruct Instructions:

1. Prior to the day of the writing assignment, select various statistical concepts (e.g., standard deviation) from a given chapter. Write each of these concepts on at least three index cards, one concept per card, with the repetition depending on the size of the class and the number of concepts selected from the chapter.
2. On the day of the writing assignment, have each student randomly select an index card.
3. Allow students 10 minutes to write 5-10 concepts on a sheet of paper.
4. Next, invite students to locate the other students in the class who have their same concept to compare and reconcile answers.
5. Have each group read their reconciled answers to the class.

## Writing Assignment 14: Compare and Contrast

Summary:

This assignment encourages students to discuss the similarities and differences between two related statistics concepts.

Class Time involved:

15 minutes

Sample terms:

1. Population, Sample
2. Independent Samples t-test, One-Way ANOVA
3. Nominal, Ordinal
4. Type I error, Type II error
5. Descriptive Statistics; Inferential Statistics

Writing Assignment:

1. Using the two related terms provided, discuss the similarities between the terms (e.g., the mean and median are both measures of central tendency).
2. Discuss the differences between the terms (e.g., the mean is used most often with interval and ratio data and the median is used most often with ordinal level data).

## Writing Assignment 15: The Beginning and the End

Summary:

This assignment encourages students to briefly summarize statistics concepts. This assignment can be used at the beginning or end of the class session to assess students' comprehension of the course material.

Class Time involved:

5 minutes

Writing Assignment:

Take 5 minutes and write about a statistical concept that you found challenging. Explain why this concept was challenging for you.

## Writing Assignment 16: The Open-Ended Question

Summary:

This assignment requires students, alone or in pairs, to respond in writing to open-ended discussion questions related to the class material. This assignment works well after a brief lecture on a given topic or at the end of class. Answers should be discussed as a class.

Class Time involved:

10 minutes

Writing Assignment:

## Sample Questions

1. What is a sampling distribution of means?
2. When is it inappropriate to use the mean as a measure of central tendency?
3. List and discuss the four scales of measurement.
4. What is the purpose of the  $z$  score?

## Writing Assignment 17: Explain it to Me

Summary:

This assignment requires students to work in pairs to describe a concept to a person who has never taken a statistics course. This assignment helps students to explain the concept in their own words and facilitates organization of ideas.

Class Time involved:

10 minutes

Writing Assignment:

1. Get into pairs. Write one or two sentences explaining a concept, for example  $z$ -scores, to an individual who has never taken statistics.
2. Be prepared to discuss your answers with the class.

## Writing Assignment 18. It's Procedural

Summary:

This assignment requires students to write out the procedural steps of their computations. This assignment facilitates organization of ideas.

Class Time Involved:

15 minutes. Alternatively, instructors can have students complete this assignment out of class.

Applicable Procedures:

1. Mean
2. Median
3. Sum of Square, Variance, Standard Deviation
4. Z-Score

Writing Assignment:

Write out and discuss the procedural steps involved in statistical computations.

Sample Problem:

1. Compute the mean for the following population of scores: 5, 4, 3, 2, 1
2. List and discuss the procedural steps involved in this computation.

Step 1: Take the sum of the population of scores. The sum of the scores is 15.

Step 2: Next, divide the sum of the scores, in this case 15, by the total number of scores in the population. The total number of scores in the population is  $N = 5$ .

Step 3: Fifteen divided by 5 equals 3. The mean of the population of scores is  $\mu = 3$ .

## Writing Assignment 19. Entrance Slips and Exit Slips

Summary:

Arnold Stromberg and Subathra Ramanathan (1996) developed this short writing assignment that consists of students writing—on index cards—short answers to questions asked at the beginning or end of the class session. The goals of this writing assignment are (a) to get students accustomed to justify their answers in writing, (b) to encourage students to write in clear and concise sentences, and (c) to provide faculty with information regarding the current skill level of their students.

Class Time Involved:

5 minutes

Writing Assignment:

Take 5 minutes at the beginning or end of the class period to provide short answers for questions such as:

- a. Briefly discuss a topic from the previous class period that you would like the professor to re-explain.
- b. Clearly and concisely explain the difference between a nominal and ordinal scale of measurement. Give an example.
- c. Be prepared to share what you have written to the class.

## WRITING TO ENHANCE STATISTICAL THINKING

## Writing Assignment 20. Research Article

Summary:

This assignment encourages students to summarize and interpret statistical analyses presented in empirical research articles. Instructors should provide students with several articles from which to choose.

Class Time Involved:

40 minutes. Alternatively, instructors can make this an out-of-class assignment.

Writing Assignment:

1. After discussing a particular statistical topic, have students identify and select an empirical article detailing a study that used the research design and statistical analysis discussed in class (e.g., between subjects design and independent samples  $t$  test).
2. Students should provide answers to prompts such as:
  - a) State the hypothesis of the study.
  - b) Identify and discuss the independent and dependent variables.
  - c) In three or four sentences, discuss the statistical analyses presented in the results section.
  - d) Write a summary of the study findings.
  - e) Did the authors choose the appropriate statistical test? Explain.
  - f) Did the researcher draw appropriate conclusions based upon the data? Explain.

## Writing Assignment 21. Reaction Time

Summary:

This assignment requires students to draw appropriate inferences relying on assumptions about hypothesis testing using  $z$ -scores.

Class Time Involved:

20 minutes. Alternatively, instructors can make this an out-of-class assignment.

Writing Assignment:

A researcher would like to evaluate the effectiveness of a new cold medication on reaction time. The distribution of reaction times from a national sample forms a positively skewed distribution with  $M = 200$  seconds. The sample size is 4 participants. Each person takes the cold medicine, and one hour later reaction time is measured. The sample obtained an average reaction time of  $M = 215$  seconds with  $SD = 8.67$ . Based on this information, can the researcher conclude that the cold medication has an effect on reaction time? Explain your answer.

## Writing Assignment 22. Research Scenario

Summary:

This assignment requires students to apply various research and statistical concepts to a research scenario.

Class Time Involved:

20 minutes. Alternatively, instructors can make this an out-of-class assignment.

Writing Assignment:

For the following research design, identify the following: (a) the independent and dependent variables, (b) the appropriate scale of measurement for each variable, and (c) the appropriate statistical test. Justify your answers.

## Research Design 1

A researcher is interested in examining the relationship between assertiveness and level of stress in college students. She believes that college students who are more assertive experience less stress than students who are less assertive. She surveys a random sample of college students and asks them to complete a questionnaire in which they rate their level of assertiveness and level of stress on a 5-point scale. How would the researcher determine if there is a relationship between assertiveness and stress?

### Research Design 2

A researcher is interested in gender differences in attitudes toward dating. Specifically, she wants to test the hypothesis that women are more accepting than men are of the idea that men should always pay on the first date, and thus women should have a more traditional view of dating than men do. Data are collected from 10 women and 10 men using a scale that measures dating behaviors and attitudes. Higher scores mean more traditional dating attitudes. How would the researcher determine if there is a gender difference in dating attitudes?

### Research Design 3

A statistics professor is looking for the best way to encourage her students to improve their exam performance. She believes that requiring students to work in collaborative groups will result in students making fewer errors on their final exams. To test this hypothesis, the instructor's two introduction to statistics classes were randomly assigned to one of two instructional conditions: a traditional lecture condition, where the instructor spends 50 minutes of each class period presenting the day's material to the class from the blackboard; and a collaborative instruction condition, where students spend at least 20 minutes per class period working together to learn the day's material. Every other aspect of the professor's course design and teaching were the same for each condition. At the end of the course students in both conditions were given a 50-question, multiple-choice final exam. How would the statistics professor determine if working in a collaborative group results in fewer errors on the final exam?

## Writing Assignment 23. Interpret It: Frequency Distribution

Summary:

This assignment requires students to interpret frequency distribution data.

Class Time Involved:

20 minutes.

Writing Assignment:

McKee and Ptacek (2001) asked 90 college students about a time they had “delivered bad news” to someone. The table below shows the results for the type of bad news given. Using the data that follow, answer the questions listed after the table.

Descriptive Statistics for the Type of News Given		
Category	Frequency	Percentage
1. Relationship with family	19	21.1
2. School	1	1.1
3. Job/work	6	6.7
4. Relationship with girlfriend or boyfriend	17	18.9
5. Personal health	1	1.1
6. Finance	1	1.1
7. Relationship with friends	21	23.3
8. Health of family member or friend	23	25.6
9. Other	1	1.1
Totals	90	100%

- a. Explain the idea of a frequency table to a person who has never had a course in statistics.
- b. Explain the general meaning of the pattern of results.

## Writing Assignment 24. Interpret it: Histogram

Summary:

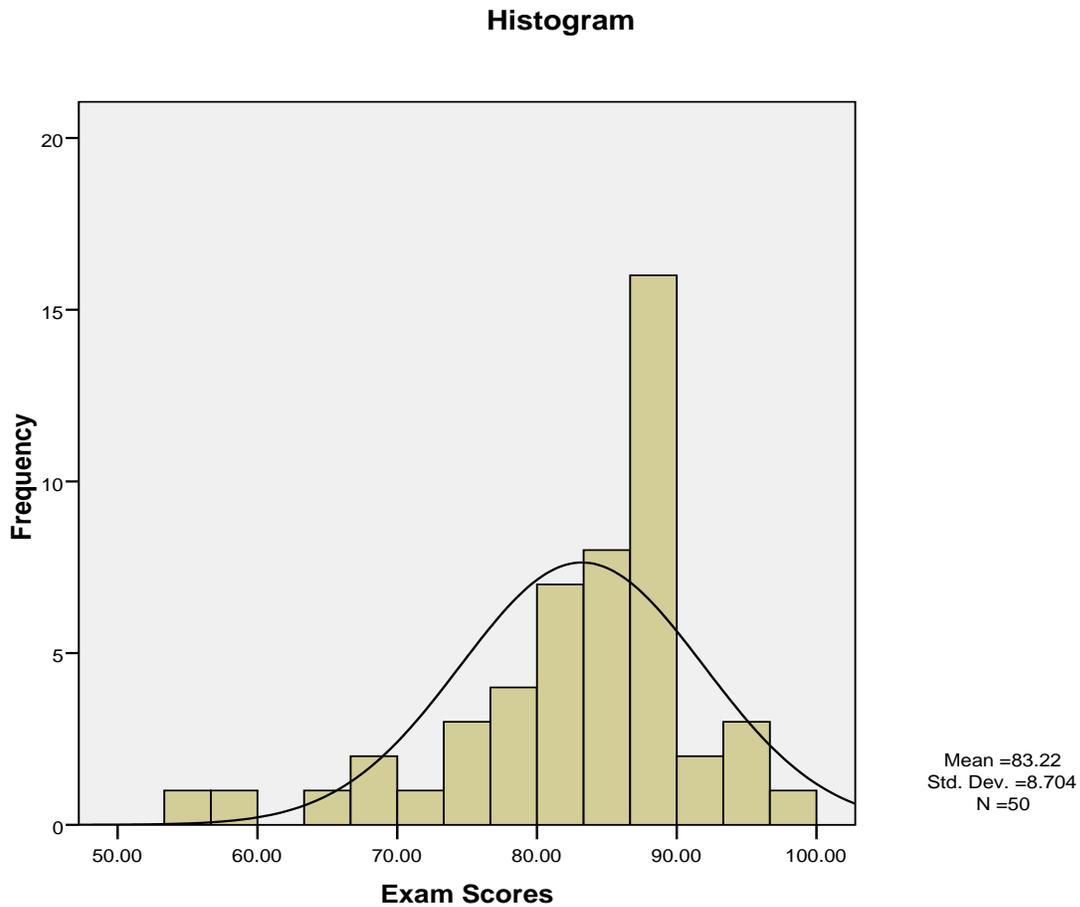
This assignment requires students to interpret findings presented in a histogram.

Class Time Involved:

10 minutes.

Writing Assignment:

Dr. Peabody gave a statistics exam to students in his Introduction to Statistics course. The following is a graphic display of the exam distribution



- Identify the approximate shape of the exam distribution. Explain.
- With the shape of the distribution in mind, discuss the level of difficulty of this exam.
- Why is a histogram appropriate to display these data?

## Writing Assignment 25. Standard Deviation

Summary:

This assignment requires students to interpret the meaning of measures of variability, specifically standard deviation.

Class Time Involved:

20 minutes.

Writing Assignment:

Provide a 2-3 sentence response for each case below.

1. A researcher studied the level of depression experienced over a 3-week period by 30 people taking an antidepressant. In an article describing the results of the study, the researcher reports, "The mean level of depression was 8.46 ( $SD = 1.18$ )." Interpret these findings.
2. Prior to the start of the academic year, Dr. Hill reviewed the placement test results of the students in her statistics class. She found that the standard deviation of the students' scores on the statistics pretest was exactly 0.00. What does this tell you? Explain.



Writing Assignment 27. Interpret it: Independent Samples  $t$  TestSummary:

This assignment requires students to interpret an independent samples  $t$  test.

Class Time Involved:

20 minutes.

Writing Assignments:

In a study examining the effect of room temperature on academic performance, researchers tested knowledge of basic statistical concepts for two groups of Introduction to Statistics students who took their exams in rooms with different temperatures. One group took their exam in a room heated to 70 degrees Fahrenheit and the second group in a room heated to 90 degrees Fahrenheit.

With an alpha level of .05 and a two-tailed  $t$  test, the mean number of items students correctly answered in the 70 degree room ( $M = 7.9$  out of 10,  $SD = 1.1$ ) was significantly greater than the mean number of items students correctly answered in the 90 degree room ( $M = 6.6$ ,  $SD = 1.3$ ),  $t(22) = 2.44$ ,  $p < .05$ ,  $\eta^2 = .21$ .

1. Identify the independent and dependent variables for this study.
2. What is the significance level for this test? What does this value indicate?
3. What does  $t(22)$  indicate? How many participants are in this study?
4. What does 2.44 indicate?
5. What does  $p < .05$  indicate?
6. What does  $\eta^2 = .21$  indicate?
7. Can the researchers conclude that room temperature had a significant effect on academic performance? Explain.

## Writing Assignment 28. I've Got the Power

Summary:

This assignment requires students to examine the difference between statistical significance and practical significance and the role of power in this distinction.

Class Time Involved:

20 minutes.

Writing Assignment:

A statistics professor was interested in determining if working collaboratively helped students to identify the appropriate statistics test. To find out, she had 1,000 statistics students complete a pretest that included six scenarios for which students had to identify the appropriate statistics test. After the pretest, the instructor had students work in collaborative groups using a statistics decision aid. One week later, she gave the same students a posttest that was similar to the pretest. Test scores were used to measure performance. The results of the paired samples  $t$  test were significant at the .001 level with an effect size of .04. Can the statistics professor conclude that working collaboratively is effective? Explain.

To assist you with answering the above questions, consider the following:

- a. What is the role of significance and sample size in interpreting these results?
- b. What is the role of power when a result is not statistically significant?
- c. What is the role of power when a result is statistically significant?
- d. What factors will increase power?
- e. What are the disadvantages of increasing power by (a) using a more lenient significance level or (b) using a one-tailed rather than a two-tailed test?
- f. What is the problem with the research design used for this study? How would you improve upon this research design?

## Writing Assignment 29. Interpret It: Pearson Correlation

Summary:

This assignment requires students to interpret statistical output for the Pearson correlation.

Class Time Involved:

20 minutes. Alternatively, instructors can make this an out-of-class assignment.

Writing Assignment:

A statistics instructor is interested in examining the relationship between students' level of statistics anxiety and their academic self-efficacy and statistics performance. A class of  $N = 10$  students was asked to respond to a self-efficacy scale and an anxiety scale. Each student's average statistics exam score was also recorded. The results are as follows:

		EFFICACY	ANXIETY	STATS EXAM
EFFICACY	Pearson Correlation	1.00	-.617	.888**
	Sig. (2-tailed)	.000	.057	.001
	<i>N</i>	10	10	10
ANXIETY	Pearson Correlation	-.617	1.00	-.661*
	Sig. (2-tailed)	.057	.000	.0380
	<i>N</i>	10	10	10
STATS EXAM	Pearson Correlation	.888**	-.661*	1.00
	Sig. (2-tailed)	.001	.038	.000
	<i>N</i>	10	10	10

- Explain what is meant by a correlation coefficient using one of the correlations as an example.
- Study the table and comment on the patterns of results in terms of which variables are relatively strongly correlated and which are not very strongly correlated.
- Comment on the limitations of making conclusions about direction of causality based on these data. In other words, discuss the issue of making cause-effect statements using correlations.

Writing Assignment 30 Interpret it: Paired Samples  $t$ -TestSummary:

This assignment requires students to interpret statistical output for the Paired Samples  $t$  test

Class Time Involved:

20 minutes. Alternatively, instructors can make this an out-of-class assignment.

Writing Assignment:

A clinical psychologist is interested in examining attitudes toward the mentally ill. She believes that contact with a person who is mentally ill will improve individuals' attitudes. To test her hypothesis, she measured attitudes toward the mentally ill before and after contact with an individual diagnosed as clinically depressed. The results are as follows:

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Before	11.7143	7	1.97605	.74688
	After	16.2857	7	2.81154	1.06266

Paired Samples Test

	Paired Differences					$t$	$df$	Sig. (2-tailed)
	Mean	Std. Dev	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 Before - After	-4.57143	2.57275	.97241	-6.95083	-2.19203	-4.701	6	.003

- Why is the paired samples  $t$  test appropriate for this study?
- Study the table and comment on whether or not there is a significant treatment effect. In other words, did exposure to an individual diagnosed with mental illness improve attitudes toward the mentally ill? Explain.
- Using the information in the tables above, write an APA style results section.

Writing Assignment 31: Interpret it: ANOVA

Summary:

This assignment requires students to interpret statistical output for the one-way Analysis of Variance.

Class Time Involved:

20 minutes. Alternatively, instructors can make this an out-of-class assignment.

Writing Assignment:

An Industrial Organizational psychologist is interested in examining the relative effectiveness of three leadership styles on worker productivity. A sample of  $N = 15$  assembly line workers is obtained. These individuals are randomly assignment to each of the three leadership conditions: Authoritarian, Democratic, and Delegative. The number of units workers produced in a 10-hour shift is recorded. The data are as follows:

**ANOVA**

Productivity

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	329.200	2	164.600	159.290	.000
Within Groups	12.400	12	1.033		
Total	341.600	14			

**Multiple Comparisons**

Productivity

Tukey HSD

(I) leadership	(J) leadership	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
authoritative	democratic	-10.40000*	.64291	.000	-12.1152	-8.6848
	delegative	-9.40000*	.64291	.000	-11.1152	-7.6848
democratic	authoritative	10.40000*	.64291	.000	8.6848	12.1152
	delegative	1.00000	.64291	.301	-.7152	2.7152
delegative	authoritative	9.40000*	.64291	.000	7.6848	11.1152
	democratic	-1.00000	.64291	.301	-2.7152	.7152

\*The mean difference is significant at the 0.05 level.

- a. Why is the one-way ANOVA, rather than the independent samples  $t$  test, appropriate for this study?
- b. Study the table and comment on whether the means for the three leadership styles differ significantly. In other words, does leadership style influence worker productivity? Explain.
- c. In terms of these data, discuss why it is appropriate to conduct post hoc tests after the initial analysis of variance? Under what circumstances would it be inappropriate to conduct post hoc tests after performing a one-way ANOVA?
- d. Discuss what these post hoc tests tell you that you could not determine from the initial analysis of variance.
- e. Using the information in the tables above, write an APA style results section.

## Writing Assignment 32: Interpret it: Chi-Square Goodness-of-Fit

Summary:

This assignment requires students to interpret statistical output for the Chi-Square Goodness of Fit test.

Class Time Involved:

20 minutes. Alternatively, instructors can make this an out-of-class assignment.

Writing Assignment:

A child psychologist observed that in a random sample of 60 toddlers, 27 preferred to play with masculine toys, 19 preferred to play with feminine toys and 14 preferred to play with gender neutral toys. A chi-square test of the null hypothesis is provided below:

## CATEGORY

	Observed <i>N</i>	Expected <i>N</i>	Residual
Masculine toys	27	20.0	7.0
Feminine toys	19	20.0	-1.0
Neutral toys	14	20.0	-6.0
Total	60		

## Test Statistics

	CATEGORY
Chi-Square	4.300
df	2
Asymp. Sig.	.116

- Why is the chi-square goodness-of-fit the appropriate test? Explain.
- Is there a significant preference for these three types of toys? Explain.
- Using the information in the tables above, write an APA style results section.