

Tips for Incorporating Writing Into An Introductory Statistics Course

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Statistics educators know all too well that teaching statistics can be a challenge, even for the most experienced instructors. Students often bring with them anxieties and misperceptions that can lead to a tense and frustrating learning environment, compelling many students to delay taking a statistics course or in some cases, avoid pursuing a major that has the completion of a statistics course as a requirement (Sgoutas-Emch & Johnson, 1998). In light of these challenges, what is a statistics instructor to do? One strategy I've found to be effective is incorporating writing into the introductory statistics course. Encouraging students to write can minimize statistics anxiety and enhance statistics performance (Sgoutas-Emch & Johnson, 1998). I use a multi-level writing approach that engages students in three areas:

- Writing to minimize anxiety
- Writing to deepen conceptual understanding
- Writing to develop statistical thinking and reasoning skills

Level 1: Writing to Reduce Statistics Anxiety

In my class, I use low-stakes writing activities that provide students an opportunity to discuss their anxiety in a non-threatening manner while forming a positive, non-judgmental learning environment (Firmin & Proemmel, 2008). When instructing students to write for the purpose of reducing anxiety, the most important thing is simply the process of writing rather than the grading of the activity. So instructors should periodically assign a writing activity as a way to assess students' anxiety level throughout the term.

Statistics Journal: Requiring students to write about their concerns, fears, and anxieties in a journal is an effective tool for reducing statistics anxiety (Sgoutas-Emch & Johnson, 1998). This activity requires students to keep a journal in which they periodically write about their anxiety level throughout the duration of the term, especially before and after each exam. Additionally, students should discuss their feelings about the course at various intervals, such as after the first week of the course, the end of the first month, and at midterm. At these times, instructors should encourage students to compare their present feelings with their initial feelings from the beginning of the course. Periodically collecting and skimming the journals represents a good opportunity to assess students' anxiety levels throughout the term and also provides opportunities for students to discuss their feelings and anxieties about statistics in a non-threatening outlet (Firmin & Proemmel, 2008).

Flip It: For this writing activity, divide students into small groups and task them with generating a list of

five to ten adjectives that describe their feelings and perceptions about taking a statistics course. Next, have them generate a second list of more positive adjectives to replace the original list. For example, a group may create an initial list describing statistics as “hard,” “fear inducing,” and “irrelevant.” A second, more positive list of descriptors may include adjectives such as “challenging,” “fearless,” and “significant.” After the groups have compiled their lists, have them provide recommendations and suggestions for how they will realize the second list. After giving the groups 15 minutes to work on this activity, have each group report back to the class. It is important to note that in the event a group generates an initial list that is overwhelmingly positive, the second list should be omitted and the group should provide the class with insight into their positive attitude about taking a statistics course.

Statistics Simile: Mark J. Sciutto (1995) offers this quick and easy writing activity; all students have to do is complete the stem, “A class in statistics is like _____.” After five minutes, collect the papers and share the responses with the class. The benefits of this activity are enormous. Students are reassured that they are not alone in their anxiety and it serves as an icebreaker for a course that is inherently anxiety provoking (Hulsizer & Woolf, 2009).

Take a Letter: To get students to reflect on their experiences and growth in statistics, have them write a letter to a future statistics student or post a message to their Facebook page describing their initial anxiety about taking a statistics course. In addition, students should offer insight into how they managed their anxiety. To expand the benefits of this assignment, distribute copies of the letters to future students or post select letters to the course Web page for incoming students to read.

Level 2: Writing to Deepen Conceptual Understanding of Statistics Concepts

These discipline-specific writing activities facilitate conceptual understanding of statistics by encouraging students to think through ideas and provide explicit, detailed answers to questions. These assignments can be used as non-graded activities, or they could be collected and students could be awarded points depending on the accuracy and thoroughness of their answers.

Concept Check: This activity is based upon the popular minute paper. This assignment encourages students to provide responses to questions posed after a class discussion of a specific statistics topic. For example, students may be asked to discuss the three measures of central tendency and the appropriateness of their use, or discuss the concept of variability for a person who has never taken a statistics course. After giving students a minute or two to write their answers, discuss the responses as a class. This writing activity can serve as a review of previously learned concepts and can provide valuable information to instructors concerning their students’ level of conceptual understanding.

A Meaningful Paragraph: One of my favorite writing activities is Elaine Backus’s (as cited in Jordan, 2008) meaningful paragraph. This assignment requires students to develop a paragraph 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. After students complete their paragraphs, have them share what they have written with the class. Below is a meaningful paragraph for 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.

Entrance and Exit Slips: Arnold Stromberg and Subathra Ramanathan (1996) developed this interesting writing activity, which consists of students writing — on three-by-five index cards — short answers to prompts such as, “briefly discuss a topic from the previous class period that you would like the instructor to re-explain,” “discuss a concept from last class period that you found difficult,” or “briefly summarize the main idea of the assigned readings.” These assignments can be collected as an “entrance slip” to class as a way to increase attendance and to verify student understanding of the assigned reading. Conversely, these assignments can be used as an “exit slip” from the class. Before ending class, encourage students to summarize in two to three sentences what they learned during the class period. This activity provides valuable information regarding students’ comprehension of the material.

Compare and Contrast: To get students thinking about the relationship between concepts, have students write about the similarities and differences between two related statistics concepts. For example, for the concepts of “mean” and “median,” an important similarity between these two terms is that they are both measures of central tendency, and a difference is that the mean is used most often with interval/ratio data while the median is used most often with ordinal data. Students can compare and contrast terms such as “population and sample,” “independent variable and dependent variable,” “Type I error” and “Type II error,” “nominal and ordinal scales of measurement” and “descriptive statistics” and “inferential statistics.” After 5 to 10 minutes, have students share their answers with the rest of the class.

Level 3: Writing to Develop Statistical Thinking and Reasoning Skills

These writing activities encourage students to be reflective in their thinking, and to engage in higher-order cognitive processing of the course material, namely application, evaluation, interpretation, and synthesis. These activities can also be used as non-graded assignments or can be collected and graded based upon the accuracy and thoroughness of the answer. Additionally, multiple assignments of this type should be given throughout the term to facilitate the development of students’ statistical thinking and reasoning skills.

The Research Scenario: This activity requires students to apply various research and statistical concepts to a research scenario. For the following research design, students should be asked to identify (a) the independent and dependent variables, (b) the appropriate scale of measurement for each variable, and (c) the appropriate statistical test with a one sentence justification of their choice.

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?

Allow students approximately 10 minutes to complete this activity, and then have a few students share their answers with the class. To reinforce learning, I typically assign this type of writing activity after the introduction of each new hypothesis test.

The Article Critique: One of the most effective ways to foster students' statistical thinking and statistical reasoning skills is by introducing the article critique. To begin, provide students with several articles that detail the statistical test discussed in class and ask them to choose one. Next, have students provide answers to prompts such as:

State the hypothesis of the study.

Identify and discuss the independent and dependent variables.

In two to three sentences, discuss the appropriateness of the statistical analyses presented in the article. Did the researcher draw appropriate conclusions based upon the data? Explain.

Instructors can collect this assignment to check it for accuracy. I typically assign three points for each correct answer and provide feedback for incorrect responses. The idea is not to provide the students with the correct answers but to provide them with sufficient prompts to get them thinking. For example, if a student incorrectly identifies the independent variable in their article as the dependent variable, I may write, "Go back to your text and review the definitions for independent variable and dependent variable," or "Was this variable measured or manipulated?"

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

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.

Did I Make the Right

Decision? An important aspect of statistical thinking and reasoning is being able to analyze the data analysis strategy for accuracy. A writing activity that I developed involves a research scenario that contains inaccurate or inappropriate details, such as:

A researcher conducts tests among three experimental drugs — Xylefal, Zykal, and Tanocal — being tested for use with Alzheimer’s patients. He wants to determine if differences exist in their effects on mental ability. He decides to use the t-test for independent groups to test all pairwise comparisons.

After allowing students time to review the scenario, have them briefly discuss in two to three sentences why they believe the statistical technique is inappropriate as well as what would be a more appropriate technique and why. After giving students 10 minutes to complete their answers, have students share their responses with the class. Again, this type of activity should be assigned multiple times during the term to facilitate the development of statistical thinking and reasoning skills.

Interpret It: Requiring students to interpret printouts is another effective way of developing students’ statistical thinking and reasoning skills. For this activity, provide students with a research scenario and an accompanying PASW (SPSS)-generated printout of instructor-created data. Have the students answer a series of questions that assess their evaluation and interpretation of the scenario and the printout. Here is an example of a scenario, the accompanying data, and a series of questions for the students:

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:

Why is the one-way ANOVA, rather than the independent samples t test, appropriate for this study?

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.

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?

Discuss what these post hoc tests tell you that you could not determine from the initial analysis of variance.

Use the information in the tables above to write an APA-style results section.

This activity is typically completed outside of class, and graded in the same way as the “Article Critique” assignment. I assign three points for each correct answer and provide written feedback in the form of reflective prompts for the incorrect answers. Once again, this type of writing activity should be assigned multiple times throughout the term to facilitate the development of students’ statistical thinking and reasoning skills.

Summary

Incorporating writing into an introductory statistics course can be an effective teaching tool. These assignments encourage students to take responsibility for their learning by acknowledging and dealing with anxiety that can interfere with their performance. This multilevel approach to writing moves students through several stages of statistical development — from basic comprehension to application and interpretation to synthesis and evaluation. I hope you find these ideas helpful, and that you will consider incorporating writing into your introductory statistics course.