



Written Communication to Achieve Data Literacy Goals in a Probability and Statistics Course

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Elizabeth Frances Vicario (University of South Florida)

I am a PhD student at the University of South Florida in Environmental Engineering. My research interests are in climate resilience, community education, and decentralized water supply and sanitation. I currently work as a teaching assistant for USF's Probability and Statistics for Engineers course, where I have helped my supervisor develop a transdisciplinary curriculum designed to integrate information and data literacy into the course. This summer I will participate in an NSF IRES grant in Ghana, where science education students from USF and the University of Cape Coast will implement an environmental science and engineering curriculum to high school students. I hope to incorporate education and capacity building into my research and future career in water and sanitation development.

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making recommendations. In their *Guidelines for Assessment and Instruction in Statistics Education*, the American Statistical Association [9]

critically engage with the material they are learning. Skills these assignment types develop include reflecting, applying, and analyzing

us to modify the course assignments, teaching approaches, grading, and assessment to complement and advance the learning outcomes for the primary course material, as well as to fully meet the specific information and data literacy course learning outcomes.

Table 1: Initial Assignments

#	Problem	Audience and Document type	Specific Extraneous Technical Knowledge Required to Address the Problem
1	Using soldier fatality data to determine intervention strategy	Your Government, Memorandum	Historic perspective on military fatalities, interventions required for each fatality, speaking to culturally diverse government officials
2	Exploring ongoing -g zr g t k o g p w o " c t q w p f " you	None (faculty) Question/answer	for which Bayesørule assist addressing
3	Selecting a major vendor through comparative analysis	None (faculty) Question/answer	Understanding of production accuracy and knowledge of what a steel shaft for a gearbox is and how it works
4	Report to the Mayor requesting expanding ambulance services	Mayor Report	Identify standards on ambulance response time
5	Objectively verify liability for a claimed catastrophic machine failure	Expert witness report	Knowledge of internal combustion engines, with copper lead bearing material on shafts, class action lawsuits, and the US legal system
6	R ² value of a regression equation: Why is it drawing g x g t { q p g a " c w g p k q p	None (faculty) Question/answer	Knowledge of how regression equations are used in engineering decision making

Assignment and Instruction Challenges

As we implemented the new assignments, we recognized several challenges that required us to modify or change the assignments over time: 1) students complained that writing elements of assignments offered them no opportunity to improve their work. 2) The data literacy writing goals were not clearly identified or scaffolded. 3) Each assignment required that students have specific technical knowledge in one or another engineering subfield to write clear responses. 4) The assignment rubrics did not provide students with meaningful feedback on their work.

- **Learning progression through the semester.** Students did not like working on writing assignments when they felt they had no opportunity to improve their work. While the initial assignments were scaffolded to progress in the quantitative part of the course, they did not effectively scaffold for learning in the data literacy. Ultimately, tying data literacy assignments into student efforts to learn specific quantitative concepts in the course both distracted them from the writing and limited their ability work on data literacy skills. These challenges suggested the need for phased assignments and scaffolding across assignments.

practice with these skills within assignments, as well as to advance these skills over the course of the semester.

We reduced the information and data literacy component to three distinct assignments, each with a preliminary low-stakes phase to the assignments where students work on reading and then interpreting data, and on developing a component of the

deciding what quantitative tools can be used to address the problem. We use Pón[çø'[18]
How To Solve It

significance of what they did and found to a jury (a naïve audience) in an abbreviated legal memorandum. Because this is an engineering problem, we spend time on making sure students understand the specifics of the problem, and how to read problems to identify a statistical approach to answering them, using techniques from Pólya [18] as part of the preliminary deliverable.

The assignments we developed to address the identified challenges are summarized on Table 3. The preliminary and final deliverable assignments for the IDL 2 are included in Appendix B.

Grading and Feedback

Efficient grading and effective feedback are always in opposition. This is especially true for large classes with students across multiple sections, in multiple modalities, as we have. The initial grading rubrics, which related directly to AAC&U Value Rubric categories, did not provide students with actionable feedback (see Appendix A for assignment rubric examples). With the volume of assignments to be graded each semester, the rubric became the primary tool for student feedback. Providing that feedback was the goal of our rubric revision.

Table 4: Initial Rubric Items

content issues may require personalized feedback. However, less time is spent re-reading assignments for overall professionalism, tone, and content.

Assessment

Our assessment instrument includes modifications of the AAC&U Value Rubrics for Information Literacy, and Written Communication developed by the University of South Florida General Education Council. For this course, we evaluate these relative to data literacy proficiency. Each semester 10% of two final deliverables from the data literacy assignments are assessed using these benchmarks. At least two different raters conduct the reviews. Review of the data from the first several years of the course are ongoing.

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Appendix A: Initial Assignment Example

Assignment 2: Exploring ongoing Experiments around you

Question and Answer Problem

Answer each of the following questions in 50 words or less

1. Describe an experiment (e.g., the weather, the traffic, 911 calls) that is ongoing in your surroundings, and state possible outcomes of the experiment.
2. Using the above outcomes, describe two possible events (namely, A and B) and discuss if A and B are 1) mutually exclusive, and 2) independent.
3. Equate the two events to a question.

Assignment 2 Rubric

- Ability to write
- Critical and analytical thinking
- Problem solving approach

Appendix B: New Assignment Example with rubric

Assignment 2 Preliminary Description

Answering the questions below is intended to provide you with an understanding of the data in the provided document and space to think about how it can be used to support the argument you are required to make with it for the final phase of this assignment. You will share what you found in small teams during the workshop, where you will help each other hone your thinking on what this data is, tells you, and its utility for making the argument you will make for the final phase of this work. For answers that require more than one or two words or numbers, you must use your own words. Your answers will be presented to your classmates during the workshop (or for those who are asynchronous, on your own time.)

Answer the following questions about *Analytics and AI-driven enterprises thrive in the age of with: The culture catalyst*

1. What do you know about the data that is used to develop the findings and inferences that are being presented in this document?
2. What is the size of the sample?
3. Who were the participants sampled? (What types of organizational roles did they have?)
4. What do you know about the organizations the participants came from?
5. How were the data collected?
6. What is the margin of error for these data?
7. What is the confidence level?

Using the answers from above

8. How would you identify the population the sample these data are intended to represent?
9. How do the sample and population described relate to the hypothetical company you work for?

Go through the document and highlight any place that the data is presented in the text. Then identify the three to five points that are most important to the argument you will have to make and briefly describe how they can be used in your argument.

There are 6 figures in the document, identify briefly what each one tells you. Then identify the two you think are most important to supporting the argument you will be making in the memorandum.

Preliminary Assignment Rubric

This assignment is graded on completion. Students earn full points for a completed assignment, partial credit if the assignment is incomplete and no credit if it was not completed on time. The more detailed review of the assignment is completed in the workshop.

Assignment 2 Final Description

[qw'ctg'y qtnkpi 'hqt'Tg-kgn'k'vgtpc'kqpcn'c"36.222-person consulting organization. You work in c"fk'kukqp"qh'yj g"qti cpl'cv'qp'y cv'r tqxkf gu'er'k'p'v'ugt'x'k'egu'k'p"{'qw'h'gnf'0Tg-k'gn'o'ctng'u"{'qw" field's full range of professional work services to its clients. Your manager has asked you to write a memorandum to your division leaders. This memorandum will make a case that increasing the number of employees in the division proficient in statistics and probability will improve provided services and increase profitability.

He has asked you to address the memorandum to Fiya Basak, Vice President of [your field]; Anozie Nwaike, senior manager of [your field]; and Elizabeth Rice, senior manager of [your field], with a copy to you

- Uses of probability/statistics in the field - This section discusses the purpose of using statistics in your field. How is it beneficial to the field? What kinds of problems can it address?
 - *There are 2-3 specific examples of probability/statistics uses within your field (department)*
 - *The examples are well-explained and the purpose of using probability/statistics is clear*
 - *(Technical) language use is appropriate for the audience*
- Data Literacy Data from the required Deloitte report is included and discussed in the text. After reading this section, the audience understands the potential financial benefits of promoting data literacy in the company.
 - *meaningful statistics/data from the Deloitte report are identified*
 - *The data is used effectively to enhance the argument*
 - *Fit of the data from the Deloitte report is presented in the description of the data*
- Conclusion - In this section, you summarize what you discussed about the use of probability and statistics in your field and how promoting data literacy will improve the company's bottom line.
 - *A brief summary of the document is given, including both components*
 - *A concluding statement is given that restates the thesis/argument*
- Professionalism - The correct template was used, formatting is consistent, and the writing of the document is professional and appropriate.
 - *The handout is well organized with headings and has good flow in every section of the paper*
 - *The tone is professional and well suited for the audience in every section of the paper.*
 - *the paper has been revised for clarity; spelling, and grammatical errors have been eliminated*
 - *The tone is professional and well suited for the audience in every section of the paper.*
- References - References for 4 sources are in APA format. In-text citations are used for each reference.
 - *The required Deloitte report is included and cited*
 - *3 other trustworthy sources are used and cited*
 - *Sources are in APA format*
 - *Sources are in alphabetical order*
 - *In-text citations are used in the format (Author's last name, year) anywhere you have used someone else's ideas or data*
 - *Each source corresponds to at least one in-text citation*