

Examples of Quantitative Reasoning

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Abstract

Quantitative Reasoning (QR) skills play an important role in enhancing a student's ability to analyze and communicate results of a quantitative analysis in real-world settings. The University of Texas at San Antonio (UTSA) has developed the Quantitative Literacy Program (QLP) to integrate quantitative reasoning skills across various disciplines in the general education curriculum. UTSA's QLP has a team of specialists that assist faculty during the course redesign process to integrate data intensive real world problems into their current course. Even the courses that are naturally quantitative intensive, but tend to focus mostly on data analysis and not on communicating the results of the data, require careful redesign to incorporate quantitative literacy. Incorporating QR poses a significant challenge for courses that aren't naturally data intensive. These courses may show a visual representation of data, but never actually explore, analyze, or write about data. This paper describes an example of integrating QR skills in two courses—one is an inherently quantitative intensive course and the other a not inherently quantitative-intensive course—over a two-year period.

Keywords: Anthropology, biology, Core curriculum, Quantitative Literacy, Quantitative Reasoning Examples, Quantitative Writing Examples

1. Introduction

“Quantitative Literacy (QL) – also known as Numeracy or Quantitative Reasoning (QR) – is a “habit of mind,” competency, and comfort in working with numerical data. Individuals with strong QL skills possess the ability to reason and solve quantitative problems from a wide array of authentic contexts and everyday life situations.” [1]

Quantitative literacy has always been considered important, but until recently, the challenges of teaching the same have been underestimated. Educationalists are realizing that being able to teach the ideas of quantitative literacy starts at a young age. It is not sufficient that students be exposed to quantitative content only in the context of courses that are quantitative intensive; rather, it is crucial that these ideas are presented in multiple contexts. As Bok [2] states, *“numeracy is not something mastered in a single course. The ability to apply quantitative methods to real-world problems requires a faculty and an insight and intuition that can be developed only through repeated practice. Thus quantitative material needs to permeate the curriculum.”*

The University of Texas at San Antonio (UTSA) has started the Quantitative Literacy Program (QLP) to integrate systematically quantitative reasoning across the curriculum. As a result of these efforts, the students at UTSA have the opportunity to see

quantitative methods applied in many different domains including English composition, mathematics, and social and natural sciences. The purpose of incorporating QL into a diverse group of courses is to ensure that the students are exposed to the understanding and evaluation of data that are inherent and natural in any discipline, not just those that are naturally quantitative intensive. Students need to understand [3] that *“today, quantitative reasoning is required in virtually all academic fields, is used in most every profession, and is necessary for decision making in everyday life.”* Therefore, if students see quantitative literacy in a variety of contexts, they are more willing to apply it in their own field and find it interesting. By incorporating skills used to effectively analyze and communicate the results of a quantitative analysis in various disciplines, students see data in a variety of different contexts throughout their college career. UTSA’s Quantitative Literacy Program (QLP) is designed to expose undergraduate students to basic QL skills and to help them understand and communicate quantitative analyses effectively [4].

The rest of the paper is organized as follows. Section 2 introduces the background information on UTSA’s QLP. Section 3 presents an example of incorporating quantitative literacy into a course that is naturally quantitative intensive. Section 4 presents an example of integrating quantitative literacy into a course that is not naturally quantitative. Section 5 concludes the paper.

2. UTSA’s Quantitative Literacy Program

The Quantitative Literacy Program is currently in its third year of implementation. Faculty members that are interested in incorporating quantitative literacy into their course go through an extensive course redesign process. This process begins with eager faculty members submitting a proposal for course redesign. Faculty members whose courses are chosen for course redesign receive a stipend and go through a three part workshop with the QLP Team. This QLP Team consists of members from the University including two Program Coordinators from the Department of Management Science and Statistics, one Faculty Specialist from the Department of Mathematics, the Director of the Writing Program, and a Course Redesign Specialist from the Teaching and Learning Center. After attending the summer-long workshop, faculty members are in charge of implementation and sustainability of the enhanced course. During its first year of implementation, ten courses were selected for course redesign.

- Introduction to Physical Anthropology
- Introduction to Archaeology
- Introduction to Astronomy (Q)
- Contemporary Biology (Q)
- Biosciences I (Q)
- Economic Principles and Issues(Q)
- Introductory Microeconomics(Q)
- Introductory macroeconomics (Q)
- Geology: The Third Planet
- Introduction to Sociology

In the second year of the program, six additional courses were chosen for course redesign.

- Algebra for Scientists and Engineers (Q)

- Introduction to American Politics
- Basic Chemistry (Q)
- English Composition I and II
- Basic Statistics (Q)
- Introduction to World Civilizations to the 15th Century

Currently in its third year, four courses were chosen for course redesign.

- Introduction to World Civilizations since the 15th Century
- Technical Writing
- Introduction to Mathematics (Q)
- Critical Thinking

These courses are from various disciplines across the University, all part of the general education curriculum. Many of these courses are already quantitative intensive (marked with a “Q”), and have integrated communicating quantitative reasoning as part of their course redesign. However, some of these courses are integrating the ideas of data analysis for the first time. This poses a significant challenge in these courses. In the past, they may have shown their students graphs and charts, but never fully discussed the data or the results of the analysis. Therefore students may have never been introduced to the ideas of visualizing, analyzing, and effectively communicating data.

3. Incorporating Quantitative Literacy into a Quantitative Intensive Course

Biology is naturally a quantitative intensive course. Courses in this discipline tend to focus on quantitative research and many times incorporate labs to collect data, create visual representations, and analyze the results. Therefore, the biology survey course already had many of the quantitative components integrated, and the faculty worked diligently on incorporating the use of data to communicate results effectively. Students are now asked to collect data, create visual representations, analyze the results, and then write and conclude the data analysis process. An example from Contemporary Biology is presented below to demonstrate how quantitative writing is incorporated.

6. The table below contains data for the incidence of lung cancer by gender and race.

- Create separate graphs for the incidence of lung cancer by gender and incidence of lung cancer by race. Make sure that you include the appropriate graph labels to make your graph informative.
- Summarize the results of each graph in 3-4 sentences.

Age-adjusted Incidence of Lung Cancer in the United States (per 100,000)

Gender	All Races	White	Black	Asian/Pacific Islander	American Indian/Alaska Native	Hispanic
Male and Female	65.5	66.1	68.2	35.5	41.7	33.4
Male	80.5	79.9	95.1	47.1	49.3	43.4
Female	54.5	55.9	50.3	26.9	35.8	26

(Source: Center for Disease Control and Prevention, National Program for Cancer Registries)

Figure 1. Example of introducing quantitative data representation and quantitative writing in a biology course.

The faculty members from Contemporary Biology have incorporated a scaffolding process. Their semester long quantitative literacy project begins with simple data collection. The students then have to analyze the data by creating graphical representations, and finally summarize the results. At the end of the semester, students have to use all information gathered from previous assignments to create a written argument. Students immediately see the usefulness of this type of project, as this particular project was related to a city wide movement to ban smoking in public places.

4. Incorporating Quantitative Literacy into a Non-quantitative Intensive Course

Physical Anthropology discusses many topics during lecture where quantitative literacy can be integrated, one such topic is primate behavior. Faculty members from this discipline have created a project that takes students through an entire data analysis from beginning to end.

A. Data Collection: Using the datasheets provided, collect 30 instantaneous time samples (1 sample/min) per group. Using the ethogram below, indicate the number of animals engaged in each behavioral category during each sample. If there are animals you cannot see because they have moved to the inside enclosure, mark these animals as “out of view” (OV).

- Rest** Stationary posture, including lying, sitting or standing.
- Move** Any manner of progression around the enclosure (e.g., walk, run, jump, swing).
- Feed** Ingest or chew food or water
- Social** Any form of physical contact with another animal, including grooming or sitting together. Also includes social play such as chasing that does not include contact.
- Aggression** Hitting, chasing or biting another individual in a hostile manner (as opposed to play).
- Other** Any behaviors not included in the categories above.

Once the observations are completed, the students need to total the data and calculate percentages for each behavior as indicated on the following data sheet.

ANT 2033 (Q)
Primate Activity Profile

DATASHEET

Date: _____ Weather (check all that apply): Sun Wind Cloud Rain
 Species: _____ # Animals in Cage: Male _____ Female _____ Juvs _____
 Observer: _____ Time Begin: _____

Scan Number	Rest	Move	Feed	Social	Aggressive	Other	Total	Out of View
1								
2								
...								
29								
30								
TOTAL								

I

Rest%	Move%	Feed%	Social%	Aggress%	Other%	Total
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B. Presentation of Results: Provide a graph or graphs summarizing the data you collected. An example would be a pie (e.g. Fig. 1) or bar chart that indicates the percentage of time each group spent in each of the different behaviors. Make sure to include a graph title and data labels as appropriate.

C. Brief Report: Provide a short report that includes the following elements:

i. Introduction: A description of the two species you have selected, including an overview of their behavior and ecology in the wild (i.e. taxonomy, geographic distribution, habitat, diet, and social organization);

ii. Methods: A description of the specific zoo groups you observed, including the number of animals present, age/sex class composition (if known), and a physical description of the enclosure. Also provide brief overview of the data collection methods you used;

iii. Results: A detailed description of the way the animals divided their time during your observation (be sure to reference your graphs in your report); and

iv. Discussion: Finally, discuss which factor or factors accounts for the similarities or differences you found in the activity budgets of the two species. In your write up you want to be sure to reference the context of your observations. For example it may be relevant to consider the number of animals in each cage, the time of day you conducted your observations, whether there was food present or if zoo visitors interacting with the animals during your observations. Make sure you reference information provided in accompanying graph(s) in support of your conclusions.

Students in Anthropology are required to visit the city zoo, collect and record data based on a prescribed observational protocol, and then analyze the results with visual representations and basic calculations. At the end, each student must effectively communicate the results of the study in a detailed discussion.

5. Conclusions

This paper describes the introduction of quantitative reasoning and writing in two different courses: an introductory biology course, which is naturally quantitative intensive, and an introductory anthropology course, which is not normally taught as a quantitative intensive course. In each case, the quantitative data are taken from the examples that are relevant to the discipline of the course. The assignments are designed to motivate students to learn more about the subject while they also learn quantitative data analysis, representation and writing. For the biology course, asking the students to write a short paragraph interpreting the data provided emphasized quantitative writing. For the anthropology course, the collection and presentation of data introduced the concepts of data gathering and graphical presentation of the same, in addition to quantitative writing. We are currently working with faculty who teach English composition to incorporate graphical presentation of data as part of the visual literacy required to be addressed by these courses, in addition to writing short essays with quantitative justification.

UTSA is currently in the third year of its Quantitative Literacy Program implementation. Courses from the general education curriculum will continue to submit proposals and go through the course redesign process to integrate quantitative reasoning. Courses that have already gone through the course redesign process, are currently working on sustaining the integration of quantitative literacy into all sections across the course. In the future, the QLP plans to extend proposal submissions to upper level courses that are interested in integrating quantitative literacy. Students graduating from UTSA will leave the University with a better understanding of communicating the results of a data analysis and will be better prepared for the workforce.

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