Teaching Statistical Literacy as a Quantitative Rhetoric Course

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Abstract
To be understood and retained, knowledge of statistics needs to be situated in clear and relevant contexts. Statistical information must ultimately be interpreted, and so students need to develop the skills to derive specific meaning from statistics. For this reason, the inclusion of statistical literacy in general education curricula is crucial. Traditional introductory courses in statistics, while they may include real-world examples, are not typically designed around this need. For students in the social and natural sciences, such contexts are an integral part of their major course of study where the meaning of statistics most frequently comes from disciplinary applications—the production of statistics as scientific evidence. Students in the humanities and fine arts, on the other hand, still build their beliefs about authority – the bases for making claims and the expertise that such practices entail – mainly on philosophical premises. In the world of policy decisions, however, statistical evidence matters. To be without the tools of statistical inquiry and analysis is to be excluded from contemporary public policy debates. To serve this need, Augsburg College's GST 200 Quantitative Reasoning/Statistical Literacy, focuses on statistical literacy rather than the production of statistical information. This paper includes a description of the design and the necessary preparation for a general-studies quantitative-reasoning course focused on quantitative rhetoric and the course content and the pedagogies by which it is delivered. It also includes a summary of course assessment practices and conclusions that might be made from them.

Key Words: critical thinking, statistical literacy, quantitative rhetoric

1. Purpose and Substance of GST 200

Much of the statistical information that people encounter day to day is found in news media or in other forums of public discourse. To be responsible participants in this discourse—an expectation certainly held for all college-educated people—everyone needs some familiarity with statistics and its applications. Within a typical college curriculum, quantitative methods are included, along with specific disciplinary examples, in the major course sequences of the social and natural sciences. In the humanities and fine arts, quantitative courses are typically lacking. Augsburg's GST 200 has been developed to prepare all college graduates to participate in debates of national and community issues. This particular iteration of GST 200 focused on quantitative rhetoric, strategies for the use of numerical information in argument and persuasion.

The need for statistical literacy extends beyond simple mathematical reasoning. While math education is to be highly valued, statistical literacy involves a much broader array of skills: critical thinking, analysis of argumentation and persuasion, and an ability to interpret statistics in context. Toward that end, one offering of GST 200 was developed around rhetorical uses of statistical information: quantitative rhetoric. The central

purposes of the course are the critique of public argument and the analysis of the numeric information upon which those arguments are based.

Other schools in our region have reconsidered the ways by which they approach quantitative reasoning, and with positive results. Carleton College's QuIRK initiative (Quantitative Inquiry, Reasoning, and Knowledge) for example, integrates quantitative reasoning with the college's writing program. As a financial and organizational sponsor of the National Numeracy Network, Carleton subscribes to the NNN's vision:

> *The National Numeracy Network envisions a society in which all citizens possess the power and habit of mind to search out quantitative information, critique it, reflect upon it, and apply it in their public, personal and professional lives.*
> (See http://serc.carleton.edu/nnn/about/index.html.)

In support of Carleton's initiative, Lutsky (2007) makes two important points about quantitative literacy: first, that the enhancement of quantitative skills is essential to general education, and second, that argumentation provides an ideal context for the development of these skills. Lutsky makes the distinction between the *interpretation* of quantitative information and using quantitative information *in support of an argument.* Grawe and Rutz (2009) argue both the need for and the value of this integration of statistical literacy with students' development of expository writing skills as a means for developing numeracy skills across disciplines and skills area within the Carleton curriculum. Grawe, Lutsky, and Tassara (2010) also describe a rubric developed at Carleton for the assessment of quantitative literacy. Augsburg College's expectations for quantitative application skills in student projects closely resemble the initiative underway at Carleton.

The central focus of Augsburg's GST 200 is the interpretation of statistical information: the creation of meaning through the use of numbers. GST 200 addresses these skills as a form of literacy, one that achieves meaning primarily through the use of natural language. Ultimately, numbers are meaningless without context and application, and this location of numbers typically happens in natural language rather than numerical notation. For this reason, linguistic concerns also figure prominently in the teaching of GST 200. Statistical literacy, as it is taught at Augsburg, goes beyond standard definitions of numeracy. Consider, for example, this definition of numeracy used in the UK:

> *Numeracy is a proficiency which is developed mainly in mathematics, but also in other subjects. It is more than an ability to do basic arithmetic. It involves developing confidence and competence with numbers and measures. It requires understanding of the number system, a repertoire of mathematical techniques, and an inclination and ability to solve quantitative or spatial problems in a range of contexts. Numeracy also demands understanding of the ways in which data are gathered by counting and measuring, and presented in graphs, diagrams, charts and tables.*
> – Department for Education and Skills (UK)

Beyond these concerns, Augsburg's conception of statistical literacy also includes a set of explicit goals and objectives for the understanding of numerical information. Most importantly, it examines the connection between statistical measures and the narratives that frame our day-to-day realities. The subtitle of Milo Schield's Statistical Literacy text

(Schield 2009), for example, is "Seeing the story behind the statistics." In many ways, this is the story that the statistics create. In GST 200, we use the following definition:

> *Statistical literacy is the ability to read and interpret summary statistics in the everyday media: in graphs, tables, statements, surveys and studies. Statistical literacy is needed by data consumers – students in non-quantitative majors: majors with no quantitative requirement such as political science, history, English, primary education, communications, music, art and philosophy.*
> --Schield (2010)

For students in non-quantitative majors, the particular challenge in meeting this requirement involves contextualized statistical information. In other words, students need to learn about statistics in familiar contexts that have relevance and application within the larger educational concerns that our students have defined for themselves. One could simply include a statistics course within the general education requirements for graduation (the course of action my colleagues in the mathematics department recommend) but the content and skills learned within such a course are certain to be forgotten—and quickly. To make the learning stick, we need to begin with a meaningful context.

2. Preparation to Teach Statistical Literacy

We should also note that statistical literacy is a non-disciplinary skill set. One observable phenomenon in many college curricula is the separation of quantitative courses by discipline. Individual major course sequences, in other words, include their own quantitative methods course tailored to a specific set of disciplinary needs or concerns. While these courses serve the particular needs of students within an academic major, they may fall short of the goal when applications of statistics span disciplines or evade traditional disciplinary boundaries. Rhetoric, for example, is applied across a variety of disciplines, and thus an understanding of quantitative rhetoric can serve a broader variety of needs than can a discipline-based statistical methods course.

Given this broader approach to quantitative reasoning, faculty from non-quantitative disciplines may require professional development in both statistics and statistical literacy prior to teaching statistical literacy. The writer of this paper, for example, benefited greatly from an opportunity to observe a full iteration of GST 200 prior to teaching it for the first time. This opportunity provided a foundation for both the course and the statistical concepts included within it. While my undergraduate major in economics and business included a complement of quantitative coursework, it had been years since I had used this knowledge base, and calculus does not provide background for statistical literacy. Observation of the course proved highly valuable for shaping my presentation of quantitative information to the students I would eventually teach. Interestingly, though, faculty from mathematics and statistics may also benefit from an orientation to *statistical literacy*, since this is not within the typical scope of traditional math and statistics coursework.

A variety of web-based and print resources exist to assist anyone teaching statistical literacy. The statistical literacy website, statlit.org, includes links to articles, student activities, resources for numeracy and quantitative literacy, and lists of current and past events organized around these concerns. The National Numeracy Network website likewise includes teaching resources, articles on quantitative literacy and reasoning, and a

collection of projects designed to promote and support these activities. These two resources are not affiliated with disciplinary concerns and exist to promote statistical literacy among all students.

3. Course Goals and objectives for Augsburg's GST 200

GST 200 is a general studies course (hence the course number prefix: GST) offered at the sophomore level. It has no departmental or disciplinary affiliation. The structure of the course is interdisciplinary, incorporating ideas and methods from statistics, critical thinking, rhetoric, and linguistics. Students in this course are expected to develop five central skills:

- Learn fundamental concepts and methods of statistics
- Understand the appropriate uses of statistics as evidence within arguments
- Recognize inconsistent, inappropriate, or inaccurate use of statistics in quantitative reasoning
- Understand rhetorical applications of statistics
- Accurately decode representations of quantitative information in natural language

Similarly, the course has five primary outcomes. By the end of the course, students will use these skills in the following ways:

- Students will understand the uses of and be able to calculate common statistical measures
- Students will understand appropriate uses for various statistical measures
- Students will recognize both valid and fallacious uses of statistical information in rhetorical contexts
- Students will construct organized essays
- Students will understand rhetorical appropriateness

In a more general sense, the course is designed to bring students to what Kirk (1999) describes as the second level of statistical sophistication: the ability to "understand, select, and apply statistical measures" (Spatz, 2005, P. 16). While a more extensive and specialized education in the production an analysis of statistics remains an important part of the curricula in some disciplines, it is this ability to read and interpret summary statistics that deserves attention in general education. As preparation for public argument, this skill of reading and interpreting summary statistics in context is absolutely essential to the preparation of all students.

4. Content of the Course: Rhetorical Uses of Statistics

The course outcomes listed above enable students to assign importance to statistics. While the word "rhetoric" is sometimes used pejoratively in public discourse to refer to empty language or argumentative posturing, in the academy we think of rhetoric is "the ability, in each particular case, to see the available means of persuasion" (Aristotle, p. 36). The most frequent form of persuasion within which we find statistical measures is logic: appeals to reason. In specifically addressing the needs of inductive reasoning, for example, noted rhetorician James Kinneavy (1971, p. 115) argued that the procedures of induction are difficult to summarize unless one has a background in statistics (statistical study is fundamentally inductive). Hence, statistics constitute a critical part of the study and practice of rhetoric.

Skilled rhetoricians, on the other hand, are seldom skilled statisticians, and vice versa. Quantitative rhetoric is that aspect of rhetoric that recognizes and communicates meaning through numbers. Quantitative rhetoric involves recognizing flaws in logical reasoning located within statistical information, and these, unfortunately are all to frequent in public discourse, as are the flawed arguments that rest upon them. Students who are not comfortable or have not been acquainted with statistics tend to focus on deductive reasoning (without access to the sources of its premises), ethics (in primarily philosophical terms), and emotional appeals (mainly developed through anecdote). These non-quantitative rhetorical tactics are, to be certain, all legitimate, but they lack the gravity and universality that statistical measures contribute.

To provide complete and appropriate contexts for statistical literacy, then, we need to address statistical information as we are most likely to find it in our daily lives. Consider, for example, the following statistics representing rates of accidents and traffic fatalities involving teen drivers:

a. 16-year-olds are 3 times more likely to die in a motor vehicle crash than the average of all drivers.
b. 2,739 drivers between the ages of 15 and 20 died in motor vehicle crashes in 2008, down 13.7% from 3,174 in 2007 and down 20.2% from 3,431 in 1998.
c. About 2 out of every 3 teenagers killed in motor vehicle crashes in 2008 were males (Insurance Institute for Highway Safety).
d. Drivers ages 15-20 accounted for 12% of all drivers involved in fatal crashes in 2008 and 14% of all drivers involved in police-reported crashes.
e. 63% of teenage passenger deaths in 2008 occurred in vehicles driven by another teenager. Among deaths of passengers of all ages, 19% occurred when a teenager was driving (Insurance Institute for Highway Safety).
f. 81% of teenage motor vehicle crash deaths in 2008 were passenger vehicle occupants.
g. The number of drivers ages 15-20 involved in fatal crashes totaled 5,864 in 2008, down 16% from 6,982 in 2007 and down 26% from 7,987 in 1998. -- source: http://www.rmiia.org/auto/teens/Teen_Driving_Statistics.asp

These statistical characterizations are typical of those found in news media and public policy debates—for example, arguments for graduated driver licensing. The statistics appear to make a convincing case. The meaning of each piece of information, though, is found in the framing of the statistics, not in the statistics themselves: that is to say, the sentences containing the statistics create the meaning. The statistics in examples (b) and (g), for example, are arranged in similar fashion, but they represent different phenomena: (b) describes drivers between the ages of 15 and 20 who died in accidents; (g) describes the number of drivers involved in fatal crashes. They may or may not have survived, and those who died are presumably of all ages.

Even before encountering examples like the ones above, students of quantitative rhetoric, especially in the humanities and fine arts, need to first acquire a general understanding of statistics—their origins, their meaning, and their conventional uses. For this reason, GST 200 includes among its resources an introductory statistics textbook. There are two purpose for this text: the attainment by students of the conventional vocabulary of statistics and an overview of its central concepts. The course also includes a book specifically written to address statistical literacy: Schield's *Statistical Literacy 2009*. This book not only provides excellent background for statistical representations and

comparisons, but it also asks students to consider the relative strength and validity of differing claims based on the same statistical information. This translation of statistics into arguments is exactly at the heart of statistical literacy. The book also presents an excellent variety of statistical resources and news stories in which they are used. News articles constitute the most frequent source of arguments for analysis in this course. The content of this course, then, includes a strong focus on each of the following: causal reasoning and argument (the context for statistical conclusions); category construction in the analysis of statistical distributions (the assembly of categories to be described numerically); analysis of experimental and study designs (randomness and chance); and issues of bias (various forms of application error).

5. Statistical inquiry: Pedagogical Strategies

An important distinction is made early in this course between statistics and arguments that employ statistics. Statistics itself constitutes one area of study, and rhetoric constitutes another. While the study of rhetoric pervades the academy, one consistent location for its study is within departments of English. Because the discipline of English is primarily non-quantitative, a gap typically exists in the rhetorical training of students in these courses. By introducing quantitative measures into the discussion of public issues, though, this gap can be filled. For example, students in GST 200 are assigned to examine a contemporary social issue for their final essay, and their arguments needed to be drawn from their own quantitative conclusions. In other words, each student needed to locate a set of data and make an argument, saying what those data did or did not reveal. In the completion of this analysis, students were to answer as many as possible of the following questions:

- How frequently does the issue in question occur? What is the scope (in numerical terms) of its impact?
- In what context do the phenomena of this issue occur, and whom do they affect?
- Numerically, how are the effects of this issue distributed across one or more populations?
- What are the sources of the quantitative information, and in what forms did you find them presented?
- What numbers seem to be salient, and why?
- Do the statistics associated with this issue allow you to arrive at any clear conclusions?
- What argumentative positions concerning this issue are appropriate, given the statistical information available?

The students' abilities to answer questions such as these will, according to Kinneavy, improve their skills of induction and will allow them to both create and examine the kinds of logical premises that deductive reasoning requires. In GST 200, then, students' statistical analysis essays of news stories were judged to be successful to the extent that they met the following criteria:

- The analysis either posed or ruled our confounding causes for situation being described with the story (e.g., spurious associations or inferences of correlations as suggested causes)
- The essays examined irregularities, inconsistencies, or peculiarities in the classification or construction of the groups being described within the stories (e.g., over- or under-specification of sample groups)

- Student analyses interrogated the processes involved in the studies described (e.g., the use of convenience sampling, insufficient samples, or non-representative samples)
- The analyses exposed some form of bias in the study (e.g., the use of slanted language in survey questions or in the selection of participants for the study)
- Misrepresentation through the use of numbers (e.g., the use of percentage change in the description of studies with initially small numbers)

5.1 Essential Statistical Information Included in the Course

Given that the students in this course do not produce statistical information but rather examine the use of statistics as evidence in argumentation, the specific information to be included within the curriculum of this course is somewhat more flexible than that of a social science research methods course. In the present iteration of this course, course content was shaped around two sets of tools: concepts for statistical literacy and concepts central to the study of statistics:

For enhancing statistical literacy, students used Schield's (2010) CARE mnemonic. This model offers students distinct characteristics for the examination of claims based on statistics. Any or all of these concerns can be examined in the context of new stories or arguments of public policy:

- Context (alternative explanations: common causes and confounders)
- Assembly (non-statistically systematic choices of definitions or presentation)
- Randomness (including luck and coincidence)
- Error, bias (statistically systematic deviations from the actual)

In order to ensure that students in GST 200 would have the confidence to interrogate specific statistical measures, they were re responsible for acquiring and understanding the following statistical concepts:

- Normal distributions and skewed distributions
- Measures of center (mean, median, and mode)
- Standard deviations
- Correlation coefficients
- Measures of comparison (percentages, percentiles, ratios)

The selection of these concepts requires some explanation. While normal distributions are frequently used in descriptions of social phenomena (for example, students in this course consider arguments made in Herrnstein and Murray's *The Bell Curve*, a book on IQ's and ethnicity), explicit reference to standard deviation, as one of my colleague pointed out, virtually never occurs in news stories. Why, then, should students of statistical literacy be expected to understand standard deviation?

The answer I would offer is simply this: we don't want a person's participation in public discourse to be stopped short at the first mention of a statistical term. Given the frequency with which standard deviations are used in the descriptions of distributions, it seems important that students should know what standard deviations are and represent (the percentages of the whole within a normal distribution that lie within one, two, and three standard deviations from the mean, for example). Likewise, correlation coefficients, while they are seldom mentioned explicitly, capture important information about bivariate data.

5.2 Experiments and Studies

In order to understand the origins and derivation of statistical information, students in GST 200 must become familiar with the following essentials of research methods:

- Observational study designs (longitudinal, cross-sectional, controlled)
- Experimental Designs (controlled/uncontrolled, single-blind/double-blind)
- Sampling (random, convenience, scientific)
- Significance (Statistical significance, margins of error, confidence intervals)

5.3 Activities

For the sake of providing context and practice in the use of statistical information, students in this course participate in a number of activities:

- Issue analyses: medical risks, crime statistics, traffic accidents, economic issues (unemployment, health care, the recession), impacts of education, incarceration statistics, etc.
- Research and investigation: for example, an investigation of intelligence testing: definition of "intelligence quotient"; IQ testing; commentary on Herrnstein and Murray's The Bell Curve; association of "intelligence" with social class, race, SES; etc.
- Online discussion forums: using both the course Moodle site and odysseys2sense.com (see below for more details)

The results of these activities are typically summarized in short essays or in online discussion forums.

5.4 Odysseys: Students Subjecting Their Ideas to Public Scrutiny

A new activity added to GST 200 this year includes student participation in a series of challenges at odysseys2sense.com. These challenges, or "Odysseys," are of particular interest not only because they allow students to participate in an online forum, but also because they allow people from outside the class and the college to review the students' contributions. These evaluations are anonymous, and all participants are scored for the civility as well as the accuracy of their postings to the forum. The instructor's evaluations, which students can't tell from the others, and the evaluations of peers are included in the scoring of the Odysseys. This is a particularly important exercise because it allows direct participation in public discourse.

5.5 Statlit.org: Capturing Generalizations of Natural Language in Statistical Relations

Among its many tasks in social interactions, natural language encodes relationships among groups, subgroups, categories, and subcategories. Because our knowledge of language is largely unconscious—grammatical knowledge is acquired prior to consciousness and without need for any explicit knowledge of its operation—we don't usually notice our general tendencies in stating these relationships. The StatLit Tools page (www.statlit.org/Tools.htm) contains a Ratio Grammar Writing program for students who wish to practice the accurate articulation of categorical relationships. (For further description of this program, see Burnham and Schield (2006).)

5.6 Assessment

Students were evaluated primarily on their ability to apply a series of criteria to a variety of news articles and academic arguments, some assigned within the course syllabus and some of their own choosing. The "Take CARE" acronym, (Schield, 2010) served as a mnemonic device for remembering these criteria. CARE includes questions of context,

assembly of statistical information, randomness in statistical samples, and errors that might be identified. It is important to note that the care model itself is a method for assessment, one that can be applied to nearly any application of statistical information.

Each aspect of the statistical situation described within the CARE model leads one to interrogate statistical usage. Examinations of context, for example, lead students to look for extraneous variables and confounding explanations. Examinations of assembly require students primarily to look at the ways in which samples populations are represented or subdivided for purposes of creating statistical conclusions. The focus on randomness is expanded to include questions of experimental and study designs, scope, and issues of control. Errors include various forms of bias, etc. Student papers (each student wrote six papers during the term) are scored according to the students ability to describe the statistical strengths and weaknesses of the articles and issues they have examined.

Manual statistical calculations are minimal within the course. Students manually compute percentages and ratios, but they use Excel to calculate means, medians, standard deviations, correlation coefficients, and the like. The simple reason is that they are unlikely to remember standard equations or methods of calculations because of the infrequency with which they will use them. Once a data set exists within a spreadsheet, though, they should know what they can do with it and toward what ends. This activity—the students' examination of an existing data set—constituted the primary activity of each student's final project. The essays written to demonstrate this ability were judged according their fidelity to the skills and goals of statistical literacy named above in Section 3.

6. Summaries of Representative Student Projects

In order to demonstrate their familiarity with statistical measures and their meanings, each student in this iteration of GST 200 was required to investigate a social issue by way of an examination of available data. In order to demonstrate their skills in quantitative rhetoric—the ability to look at numerical data and see a potential story—students were required to locate data sets relevant to an issue of their choosing and then to suggest possible meanings for those data. They were not to use existing explanations for phenomena associated with this issue (e.g., expert testimony) but instead were to attempt their own explanations. Below are three examples of students' final projects.

6.1 Student A: An Examination of Incarceration Rates by Race

Student A attempted to answer this question: to what extent does the ethnic make-up of prison populations reflect the ethnic makeup of the overall population? The primary method for answering this question was to examine data sets from various state (and the District of Columbia) departments of corrections and to compare these with data from the US Census Bureau to see how close the comparisons were. As it turns out, in places like Washington DC there is a significant disparity between the overall population and the DC prison population. Also of interest was the fact that the District of Columbia has an unusually high rate of incarceration overall: 1.8% of the DC population is incarcerated, as compared with .45% of the US population. Significantly, 89.3% of the DC prison population is Black, while only 54.4% of the overall population of the District is Black. By contrast 40.1% of the District's residents are White, yet only 2.2% of the DC prison population is White.

The question the student then asked was, "Why?" Why were prison populations so different from overall populations? The best answer seemed to come from educational profiles of the incarcerated, which showed that 36.8% of inmates in the DC prison population reported having no education, and while approximately 28% of all American adults hold bachelor's degrees, fewer than 3.5% of DC inmates reported having ever attended college. This correlation led the student to conclude that disparities in educational attainment may have strong explanatory strength for disparities between prison populations and the general population.

6.2 Student B: An Examination of Disparities in Educational Attainment by Ethnicity

Student B investigated what has come to be called the "school-to-prison pipeline." At the heart of this phenomenon is the contention that school policies (use of standardized testing, culturally sensitive curricula and pedagogies, and *de facto* academic tracking) tend to increase school dropout rates and hasten entry into the juvenile and later the adult justice system, especially among minority populations. Like the study above, this study used data from the US Census bureau and state juvenile justice statistics to demonstrate a correlation between high-school dropout rates and juvenile arrests. For example, while only 16% of the US youth population is Black, 45% of juvenile offenders are Black. In all fifty states, the average annual dropout rate for Black non-Hispanics was 6.5%, compared with an average dropout rate for White non-Hispanics of 3.0%. African American students also experienced school suspensions in disproportionate numbers; in 2000, African-American youth accounted for 17 percent of the overall population, while 34 percent of school suspensions were accrued by African-Americans. These suspensions accelerate the departure of Black students from schools, thus increasing their susceptibility to unemployment and crime.

On the strength of this correlation and the disparity between the ethnic makeup of overall populations and ethnic backgrounds of juvenile offenders, Student B suggested that the explanation for the school-to-prison pipeline may be related to school policies that disproportionately affect ethnic populations. Again, this study does not reach a definitive conclusion but rather suggests fruitful directions for further study.

6.3 Student C: An Examination of Incidence of Bullying in Urban Schools

Student C wanted to examine facts relating to trends in school bullying. For example, while the U.S. Department of Education and U.S. Department of Justice tell us that reports of school bullying have diminished by half between 1995 and 2007, there still appeared to be a significant difference between the frequency of bullying in urban and suburban schools, with the incidence of bullying in urban schools (10.5% of all students in 2007 reported fear of attack at or going to and from school) being nearly twice that at suburban schools (4.7%). Again, the question is "Why?"

By looking at data sets published in the *Sourcebook of criminal statistics,* this student discovered that reports of bullying were much more frequent among non-white ethnic groups and younger students, with bullying reports decreasing at each successive grade level between 6^{th} and 12^{th} grade. The student's primary conclusion linked higher rates of bullying in urban schools to higher crime rates (which produce greater fear) and greater ethnic and racial diversity in urban schools (which can raise social tensions and fear). Student C concluded that exact causes of school bullying are difficult to attribute solely by means of statistical information, but suggested that bullying could be viewed as a form of criminal conduct, and thus other information about juvenile crime could be used as the

basis for an explanation. She also noted that another explanation is needed for the decrease in bullying reports as grade levels go up, since this trend did not appeared to be explained by juvenile crime rates.

7. Student Comments and Evaluation of this Course

Student responses on final course evaluations reflected a strong appreciation for a contextual presentation of statistical information. They suggest that students believed they were better able to learn from examples than from textbook presentations of information, especially the basic statistics textbook included in the course. Several comments included the phrase “real-world” in describing the elements of the course they found to be most helpful. Listed below are representative comments from these student evaluations.

Which aspects of this course were most valuable to your overall learning experience?

- Current events and looking for error and statistical discrepancies/slanting in the media.
- "Real world" examples
- The news stories were very applicable and the analysis of statistical information, i.e. its trustworthiness.
- Connections to "real world" examples via newspaper articles or in-class discussions about how course ideas can be applied to this, that, or the other thing kept the class engaging and interesting.
- the book *Statistical Literacy*, by Milo Schield

Which aspects of this course were least valuable to your overall learning experience?

- the book *Basic Statistics*, by Chris Spatz
- A lot of the reading was difficult to relate to practical quantitative reasoning.
- It was hard to pay attention to long discussions of the *Basic Statistics* book. I understand that this is the core of the coursework and needs to be addressed, though, so there is little else that could have been done.

Optional comment on Course Element questions

- Great feedback on data analysis papers. It was very helpful to see what areas I needed to improve, which examples of things I needed to look at more thoroughly.

8. Conclusions

Statistical literacy is a bridge between quantitative information and social meaning. Quantitative rhetoric interrogates the strategies used to create that meaning. It is thus an essential component of education for everyday life. More importantly, statistical literacy is a pressing need in civic participation today, and it should thus be included in college general education programs. It is also distinct from the direct study of statistics, since it places a strong emphasis not only quantitative reasoning but on critical thinking skills, linguistic accuracy, and rhetorical appropriateness in the use of statistics as well.

In order to grasp and retain the concepts addressed in statistical literacy courses, attention to relevant and engaging contexts is crucial. Students need to understand where and how statistics are used, to what purposes they are put, and when and how statistics become important in the construction of social realities. The ability to discern the meaning of

statistics within natural language contexts is paramount, given that this is the manner in which most students will encounter statistics in daily life.

That students need statistical education is absolutely certain. We cannot function fully and competently in contemporary society without these skills. The structure of statistical education, though, is open to a variety of approaches; the study of quantitative rhetoric is one such approach. The experiences of students in Augsburg College's GST 200 course argues for contextually situated instruction tailored to the needs of students from across the disciplines.

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Appendix 1: Augsburg College's Criteria for Quantitative Reasoning

This skill is achieved in a two-part process: learning in three foundational skill areas, of which two must be in depth, and learning in a mandatory, significant quantitative reasoning application project.

What We Expect from Students

1. At the foundational skill level, students are able to know and apply:
   - Mathematical Relationships – graphical, symbolic and numerical representations; proportions, percents, estimation
   - Statistical Relationships – data analysis (including graphical analysis), elementary probability
   - Algebraic Relationships – modeling, functions, algebraic representations
   - Logical Analysis – deductive reasoning, fallacies, arguments, counter examples

2. At the application project skill level, students are able to:
   - recognize implicit and explicit quantitative claims in discourse and evaluate and test such claims critically
   - pose quantitative questions (i.e., student-generated versus instructor-generated questions)
   - make and communicate reasoned choices as to applicable quantitative methods for the questions/hypotheses posed and the data considered
   - apply quantitative methods to quantitative information (i.e., to student generated data and/or existing data)
   - use the results of applying quantitative methods to reason and articulate answers/conclusions to the questions/hypotheses posed

Appendix 2: Outline of the course

1

January 11: Introduction to the course
- Statistics defined; Purposes for statistical information; initial problem involving statistics

January 13: Demonstrating Cause. Read pp. 14-32 in Statistical Literacy
- The rhetoric of cause; Cause vs. association or correlation

January 15: Independent and dependent variables. Read pp. 32-41 in Statistical Literacy
- Setting up associations; What "dependency" means
  - Doing the Math--Norman Draper file
  - Distracted drivers and accident rates file

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January 20: Using Statistics. Read Chapter 1 in Basic Statistics.
- Basic terminology; Types of variables; Uses for numbers; Experiments and studies

January 22: Components of statistical studies. Read pp. 42-59 in Statistical Literacy
- Context; Assembly; Randomness; Error

3 January 25: Frequency distributions and their representations. Read Chapter 2 in

Basic Statistics
- Information about populations and samples
- Graphic representations (shapes of distributions)
    - o Frequency polygons; Histograms; Bar Graphs

January 27: More distributions. Read pp. 113-119 in Statistical Literacy
- Bimodal distributions; j-curves
    - o A quick overview of your analysis essays Resource

February 1: Measures of center and measures of variance. Read Chapter 3 in Basic Statistics
4
February 3: Mean, Median, and Mode. Read pp. 127-137 in Statistical Literacy
February 5: Analyzing comparisons. Read pp. 60-76 in Statistical Literacy

February 8: The bell curve
- The Herrnstein-Murray debate; Distribution and intelligence; IQ Scores

February 10: Representing quantitative information in natural language
February 12: Looking at the design of statistical studies. Read pp. 77-84 in Statistical Literacy
5
- Experiments; Observational studies; Longitudinal studies; Controlled studies
    - o Guidelines for Experimental Design text file
    - o Overview of IQ scores file
    - o Explanation of z-scores and standard deviation file

February 15: Descriptive statistics. Read Chapter 4 in Basic Statistics
- Calculating z-scores; z-scores in same and different distributions

February 17: Outliers
- Box plots; Genetics vs. chance; The impact of anomaly

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February 19: Examples of observational studies. Read pp. 85-89 in Statistical Literacy
    - o About Box Plots in Education PDF document
    - o The Bobo Doll Experiment file
    - o On Observational Studies file

February 22: Bivariate data. Read Chapter 5 in Basic Statistics
- Correlation vs. cause; Paired variables

February 24: Correlations
- Scatter plots; Line of best fit

February 26: Regression and quantitative predictions
7
- Positive correlations; Negative correlations
    - o Shaping your thoughts about IQ Resource
    - o Guidelines for your Bell Curve analysis essay Resource
    - o Case Study in Correlation: Physical Strength and Job Performance file

March 1: Randomness. Read pp. 90-98 in Statistical Literacy
- Random samples; Exposure groups and control groups

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March 3: Minimizing the effects of chance. Read pp. 99-103 in Statistical Literacy
- Confidence intervals; Statistical significance

March 5: Minimizing bias. Read pp. 104-111 in Statistical Literacy

- Respondent bias; Measurement bias; Sampling bias

March 8: Theoretical distributions. Read Chapter 6 in Basic Statistics

- Probability; Normal distributions

March 10: Assumptions about distributions

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- Proportions; Extreme scores

March 12: More on chance and probability. Read pp. 332-335 in Statistical Literacy

- The Galton Machine file
- The Statistics of the Recession file

March 24: The Meaning of "confidence". Read pp. 349- 354 in Statistical Literacy

March 26: Confidence intervals

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- Calculating confidence intervals; Understanding their significance
  - On confidence intervals file
  - Sampling and Confidence Intervals text file

March 29: Confounders and weighted averages. Read pp. 142-155 in Statistical Literacy

March 31: Describing Ratios. Read pp. 189-211 in Statistical Literacy

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- Relationships of parts and wholes; Ratios and percentages
  - Methodology for Crime Rates PDF document

April 5: Ratios expressed in natural language. Read pp. 221--235 in Statistical Literacy

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April 7: Comparing ratios. Read pp. 238-249 in Statistical Literacy

April 9: Constructing percentage and ratio comparisons. Read pp. 250-265 in Statistical Literacy

- Instructions for Odysseys2Sense.com Word document

April 12: Common mistakes in percentage comparisons. Read pp. 266-283 in Statistical Literacy

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April 14: Misuse of ratios. Read pp. 285-307 in Statistical Literacy

April 16: Standardizing ratios. Read pp. 308-328 in Statistical Literacy

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April 19-23 Student Project Presentations

- Sample Datasets 1 file

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