STATISTICS AS RHETORIC: WHY A STATISTICS EDUCATION MUST INCORPORATE COMMUNICATION SKILLS

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While the reform movement in statistics education primarily focuses on what material to emphasize (statistical thinking, conceptual understanding); how to emphasize it (use real data, focus on context); and how to deliver it (use technology; use assessments to improve and evaluate understanding) (American Statistical Association (ASA), 2016, Guidelines for Assessment and Instruction in Statistics Education (GAISE)) one rationale behind these reforms is to design curricula that presents statistics, not as an abstracted set of rules divorced from the context-sensitive environments in which they are actually used, but as drivers of change and tools of communication. I will thus argue that a reformed statistics course should include assessments that recognize the rhetorical nature of statistics and should teach students skills in the persuasive communication of their statistical findings.

INTRODUCTION

In 2015, voters in the province of Alberta, Canada, shocked the whole country by voting in a left leaning NDP government after nearly 50 years of conservative party rule. On July 1 of that same year, the NDP made good on their election promise to raise the corporate tax rate from 10% to 12%. The increase was interpreted as either a *huge* increase "of 20%" or a *small* increase "of just 2%". Both interpretations were offered at the time by the press and other sources and tended to stratify along political lines. Which conclusion is correct? One could quibble over the preposition perhaps—should it be "of" in the first instance and "by" in the second?—but I would argue both interpretations are statistically correct *and* both are misleading. Is an increase from 10% to 12% a huge increase or just a small one? It depends, of course, on where you are standing, on which *story* you seek to tell and which argument you seek to make. As David Moore asserts, "…data are not merely numbers, but *numbers with a context* (1990, p. 96). Indeed, a statistic, in the absence of context, is meaningless at best and dangerous at worst.

Context is the story into which the numbers are set, and to sever numbers from their story—and from the language with which that story is constructed and told--cripples a robust understanding of the statistics and fails to acknowledge their social function. So, if we accept that statistics demand context, we must also accept that context is only brought to life and made meaningful through language. More specifically, I am contending throughout this paper that whenever we use statistics to urge an audience to change a belief or to take a particular course of action, we are using statistics rhetorically. And, in acknowledging the rhetorical function of communicating statistical findings, we should turn our attention to the role that language, and by extension communication, plays within our statistics courses.

BACKGROUND

To clarify use of the term *rhetoric* throughout this paper, I'm rescuing the traditional meaning of rhetoric from its common, often pejorative use. Rhetoric, as defined by Aristotle, is simply a tool for practical debate, "a means for persuading a general audience using probable knowledge to resolve practical issues" (Idalovichi, 2014, p. 715). In short, the application of rhetorical skills, as interpreted for this paper, is the act of constructing and communicating a persuasive argument using statistics. I further view rhetorical skills as falling broadly into two subsets: the *critical* and the *constructive*. The *GAISE* report (2016), and much of the reformist literature it has inspired, recognizes the importance of the *critical* in stressing critical thinking as an essential skill in statistical analysis. Specifically, the report stresses that critical consumers of statistically based results should possess the ability to "recognize whether reported results reasonably follow from the study and analysis conducted" (p. 8). The correlative of the critical is the *constructive*--using statistics and statistical analysis to support an ethical argument created with

In M. A. Sorto, A. White, & L. Guyot (Eds.), *Looking back, looking forward. Proceedings of the Tenth International Conference on Teaching Statistics (ICOTS10, July, 2018), Kyoto, Japan.* Voorburg, The Netherlands: International Statistical Institute. iase-web.org

a well-considered awareness of context and the specific needs of one's audience. Any time we frame our statistical results as an argument, directed at a specific audience with their own set of needs, interests, biases and limitations, we are using statistics rhetorically, something that has been given far too little attention in statistics education.

RHETORIC AND STATISTICS EDUCATION

The recognition of the rhetorical nature of science is not new, but any relationship between the scientific and the rhetorical is often regarded with great suspicion if not outright animosity. The sociologist Andrew Weigart argued that, "If a sociologist practices rhetoric, but identifies himself (to self and/or others) as a scientist, he renders his rhetoric immoral, the immoral rhetoric of identity deception." (p. 111). But rather than seeing the rhetorical as inimical to the scientific, I would argue that statistical results, whenever communicated for the purpose of resolving a problem (and when are they not?) are *inherently* rhetorical. Unfortunately, a quick review of relevant titles reveals the continued influence of Weigart's position, much of it belonging to what Herbert Simons called the "debunking school" of criticism (1978, p. 37). Titles such as *Statistics You Can't Trust* (1999), *Flaws and Fallacies in Statistical Thinking* (1974), *Misused Statistics* (1998), and *Is that a Fact*? (2010) are prevalent.

One refreshing alternative to the above is Robert Pearson's textbook, Statistical Persuasion (2010), in which he emphasizes persuasive and principled statistical arguments. Unfortunately, Pearson's text, though a valuable resource for our enterprise, is aimed at the graduate level and thus not suitable for an introductory-level statistics course. Victor Thiessen's *Arguing with Numbers* (1993) takes a more theoretical and philosophical approach. In it, he argues that "we do not discover social reality; rather we construct it through our theories and the interpretations we select for our statistical results" (p. 5), a view that, he asserts, distinguishes social scientists from mathematicians, an important distinction I will return to later.

Though a review of the top selling textbooks in applied statistics is beyond the scope of this paper, a quick perusal of the many textbooks that come across my desk each year exposes a still too heavy reliance on formulae and statistical argot with no overt emphasis on role of language and communication. While all include a requisite chapter on effective graphical presentations (whose construction is most certainly rhetorical), only a few offer a dedicated section on the ethics of employing and communicating statistical information. Moreover, on the rare occasions when the use of statistics to persuade is foregrounded, the emphasis tends to be how they can be used for nefarious purposes to mislead the unsuspecting data consumer.

To fully embrace the role of language and presentation in communicating statistical results, statistics texts must reach beyond ground already well trodden by Darrell Huff's whimsical and entertaining *How to Lie with Statistics* (1954): "The secret language of statistics, so appealing in a fact-minded culture, is employed to sensationalize, inflate, confuse, and oversimplify" (p. 8). Without question the ability to search and destroy statistical sophistry is imperative—and teaching our students to be skilled and vigilant in this regard should be the purview of every instructor of statistics. But as edifying and entertaining as this endeavor may be, we also owe it to our students to heed Huff's more difficult correlative: "But without writers who use the words with honesty and understanding and readers who know what they mean, the results can only be semantic nonsense" (p. 10). We must not be smug about training our students to be statistical critics, to spot fallacies and critically assess claims, without also offering them the tools for constructing and communicating cogent statistical arguments.

An important consideration, particularly within a first-year, standalone statistics course taught to students in professional programs (i.e. future *consumers*, more so than *producers* of statistics), is whether the integration of a rhetorical perspective can actually *help* students to better learn statistical concepts. While I'm not quite insisting that the acquisition of statistical concepts necessarily demands a focus on rhetoric—we have been teaching, one hopes somewhat successfully, statistical concepts for years without an explicit foregrounding of their rhetorical nature—but I am arguing that such a foregrounding can help establish stronger connections between the concepts that underpin statistical investigations and the interpretation of their results. I'm also suggesting that employing statistics rhetorically should not be simply treated as an

afterthought to be simply laid over a foundation of statistical concepts and methodology but should rather be taught alongside them, as an intrinsic part of the process of statistical investigations.

By way of example, I've begun to take a rhetorical approach to teaching one the most difficult concepts for students new to statistics—the notorious p-value. In one assignment, discussed in more detail later in this paper, students are asked to assume the role of a scientist trying to convince a skeptic that dolphins can communicate abstract information. (This exercise has been borrowed and adapted from *Introduction to Statistical Investigations* (2016). Thus, the assignment is structured to force students to support a rhetorical position. The assignment describes an experiment that requires that one dolphin (Daphne) to communicate the location of food to another dolphin (Aries), who is in a separate tank. The results of the experiment will form the basis of the scientist's (and by extension, the student's) argument that dolphins can indeed communicate. At the core of the argument is whether Aries' getting 17/20 successful responses constitutes sufficient evidence that he is not simply guessing where the food is. The students are required to use this information to write convincing dialogue, aimed at a skeptic, that this statistic does indeed qualify as strong evidence that Aries could not simply have guessed correctly 17/20 times. But before they are ready to write the dialogue, I guide students through the use of a simulated binomial distribution (where $n = 20$ and $\pi = 0.50$) to find $P(X \geq 17)$. Without actually identifying the resulting probability as a p-value, I then help students understand how this probability (0.001) will form the core of their argument in favour of dolphin communication. Left to their own devices, students inevitably find this number confusing. Is it the probability dolphins are communicating? Is it the probability they are guessing? Why not just measure $P(X = 17)$?

I try to address these confusions with the use of a simple metaphor that underscores the rhetorical nature of statistical results and, I hope, illustrates the hand-in-hand nature of a statistical and rhetorical education. I call the metaphor *the ladder of evidence*, which I sketch on the blackboard at the beginning of this discussion. I then point out the intuitively obvious: in making any argument, the stronger the evidence provided, the more convincing the argument. And in climbing a ladder, the higher we climb, the closer we get to our target destination. I then label the top of the ladder *target destination = perfect evidence of claim.* I also label the bottom of the ladder *starting point = no evidence of claim*. So what would constitute perfect evidence of dolphin communication in this experiment? Students have little trouble coming up with 20/20 as perfect evidence that Aries is not just guessing. And what would constitute no evidence? Again students have little trouble coming up with 10/20 (though some offer 0/20, which I suggest would actually be perfect evidence of that Aries and Daphne are communicating but also having marital problems). Both of these fractions are then recorded at the top and bottom of the ladder, respectively.

I then remind them that their goal is to offer the skeptic the strongest argument possible—that is, to convincingly demonstrate just how strong their evidence by showing how *close* their sample evidence is to perfect evidence--the top of the ladder. I further remind them that just as we don't necessarily need to get right to the top of the ladder to reach up and touch our target destination, neither do we have to provide perfect evidence to construct a credible argument. We just have to provide *convincing* evidence. Of course, the closer our sample evidence is to perfect evidence, the more convincing our argument will be.

At this point, I refer back to our sample evidence of 17/20. This number gets recorded near the top of the ladder, obviously much closer to our target destination than to our starting point. Finally, we return to the statistic of 0.001, which I remind them is simply the probability of getting 17 *or more* correct responses *if* Aries was just guessing. I then point out what should now have become obvious: the *distance* between our sample evidence and perfect evidence is very small: only 0.001. To wit: our sample evidence is only 0.1% of ladder's length from our target destination of perfect evidence, which means that we have climbed 99.9% of the way up the ladder, well within reach of the top—that is, within reach of perfect evidence of dolphin communication.

CONTEXT IS KEY

The above example is meant to illustrate the richness that clothing statistical concepts in a rhetorical context can provide. The example highlights two points in particular: that reframing a

statistical concept as a rhetorical goal can actually help students better understand the concept at hand; and that stressing the use of familiar language, including the use of metaphor, analogy or simile can help students more clearly communicate their statistical findings. At the heart of this lies the importance of context.

Cobb and Moore have long argued that the role of context offers insight into the important distinction between mathematics and statistics. As they contend, in mathematics context obscures structure; in data analysis, context provides meaning (1997). More recently, Cobb has argued that the undergraduate statistics curriculum must face a deep rethinking, including a stronger integration of abstract deductive thinking with interpretation in context (2015, p. 267). Cobb offers a threefold purpose for the role of context in applied data analysis: context provides meaning by inviting interpretation, by providing motivation, and by offering direction (p. 276).

But what do we mean by interpretation, motivation and direction? Surely, we cannot ignore the role that language plays in serving these ends. Mostly missing from this conversation is the importance of audience. Whom are we doing the analysis for? Why do they need it? How can we ensure they understand our conclusions? Wild and Pfannkuch (1999) touch on the importance of communicating with stakeholders as part of their investigative cycle. They point out that the statistician is constrained by the fact that the problems they work on are owned by others, which puts them in the position of having to satisfy someone else (p. 229). They argue that one cannot engage in true statistical thinking without context knowledge, and they identify communication as a key facet of the investigative cycle, noting that "inadequate communication skills limit the ability to extract vital information and ideas from clients and others" (p. 229). To this, I would add that inadequate communication skills also limit the ability to interpret results for others in a way that is clear, ethical and convincing.

So how can this be done effectively? How can the statistician—or in many cases, the working professional who must possess the ability to both *do* and *communicat*e statistics—acquire the tools for applying Aristotle's goal of persuading a general audience to resolve practical issues? While many students in professional programs are required to take a course in communications, their ability to extend these often incipient skills into the realm of statistical investigations will remain limited without some overt emphasis on persuasive communication *within* their statistics class. A mantra for effective business communication, highly relevant for our purposes, is to *know your purpose, know your message, and know your audience*. While context provides meaning to numbers, offering direction in understanding one's purpose and message, context also offers insight into the needs of one's audience. And, for learning and addressing these needs, language skills are essential. Language binds the numbers to the context and makes both meaningful to an audience.

For some, a recognition of the important role that language plays in the whole enterprise of statistical analysis might come dangerously close to treating statistics as an art rather than a science. My response: it does and it should. A recognition that meaning is both constructed and communicated through language further underscores the necessary distinction between applied statistics and mathematics and invites a greater appreciation of the role that a liberal arts perspective can play in designing statistics curricula. Moore has been arguing for years that statistics shares an affinity with the liberal arts (1998), with an emphasis on learning to reason effectively about data and chance and privileging a verbal and conceptual approach over a mathematical one (2009, p. xiv). Iddo Gal adds to this perspective by defining statistical literacy in terms that would fit comfortably within the goals of a liberal arts education, proposing that statistical literacy is something to be broadly expected of adults, including the ability to interpret and critically evaluate statistical information in diverse contexts and the ability to discuss or communicate one's reactions to, opinions about, and interpretation of statistical information (2002).

SAMPLE ACTIVITY

Unlike most other forms of writing, dialogue forces an acute awareness of audience, and when employed within the context of a persuasive argument, can give students an opportunity to convince others, using statistics, of the validity of a chosen course of action or belief. I have incorporated dialogue into several written assessments in my introductory statistics course over the

past two years. The main goal of this approach has been twofold: to harness the power of narrative for enhanced student engagement; and to foreground the importance of creating a meaningful argument aimed at a clearly defined audience towards the resolution of a specific problem, using statistics. Specifically, my colleague and I have incorporated dialogue-driven stories into our business statistics course as a means of both teaching and assessing course content. The stories consist of short narratives, which act as a vehicle for the development of statistical concepts. They all take place within a specific business context, comprising a sequence of events driven by two or more characters working towards a solution to a business problem. While the stories are fictional, they are set in realistic situations.

The stories stray from convention in that they are left intentionally incomplete. As students read through the story, they are prompted at key points to participate in the writing of dialogue between characters, and in doing so to wrestle with the ideas internally and then communicate them through simple but convincing dialogue, typically between an *exper*t and a statistically *naïve* character. The use of dialogue further serves the purpose of inviting students to grapple with the meaning and implications of a statistical concept in context and to communicate them in a way that focuses on the unique needs of the audience—an important rhetorical skill.

In the story discussed earlier, entitled *Can Dolphins Communicate?*, we use this story to introduce the binomial distribution and probabilistic thinking, and more informally, the notion of likely versus unlikely outcomes in an experiment. At the start of the story, students are introduced to the two main characters: Dr. Emily Riley, a marine biologist who works for a marine park, and Sam, the operations and marketing manager at the park. When we first meet Sam, he is under pressure to improve their struggling main attraction—a dolphin show, featuring two rescued dolphins, Daphne and Aries. Sam is an all-business skeptic who sees the dolphins as relatively unintelligent animals there to simply serve the business. Desperate for ideas, Sam asks Emily for help in re-designing the dolphin show. Emily sees this as an opportunity to teach Sam—and the public—about the great intelligence of dolphins. Also possessing a strong grounding in statistical concepts and methodology, Emily decides to convince Sam that the dolphins are much smarter than he thinks, using an experiment with their two dolphins, which then becomes a brief lesson in probability.

In preparation for this assignment, students are first asked to read the story and then, in class, are taken through an exercise in context and audience analysis, similar to what we might do in a business communications class. Questions such as “What is Sam’s specific problem in the story?”; “How would you define his level of statistical knowledge?”; “Does he have any obvious emotional resistance to Emily’s message?”; “What sorts of challenges so you see Emily having in trying to persuade Sam to accept the intelligence of dolphins?” are asked and discussed. What results is an audience profile of Sam’s needs, fears, and receptivity to Emily’s message, as well as an understanding of Emily’s challenges in communicating to Sam. Answers to these and similar questions urge the students, when writing dialogue on behalf of the expert character (Emily), to frame their explanations in a rhetorically effective manner to the naïve character, Sam.

Armed with a profile of both Emily and Sam, students are then asked to complete the unfinished dialogue in the second part of the story. At around the midway point of the story, Emily has completed an experiment during which Aries successfully followed the directions of Daphne 17 times in 20 trials. As detailed earlier in this paper, I lead them carefully through this part of the exercise, which culminates in student-written dialogue between Emily and Sam, with Emily taking the position of trying to persuade the skeptical Sam that the results of the simulation offer strong evidence in favour of her argument.

The students tend to find the assignment difficult, and the results vary widely. They are instructed to worry less about creative flair (though some can’t resist) and more about offering a clear and convincing argument that will ultimately persuade Sam that dolphins are indeed intelligent creatures.

CONCLUSION

I have argued that a reformed course in introductory statistics would benefit from a recognition of the role that language and communication play in making statistics meaningful for a variety of audiences. Furthermore, I have argued that an understanding of the rhetorical nature of

statistical findings should be developed and assessed alongside the teaching of statistical concepts and methodology, particularly in an applied statistics course, with the goal of strengthening conceptual connections between statistical investigations and how they are actually used and communicated; that is, as support for a recommended course of action or change in belief. Therefore, to better prepare students to be both critical consumers of statistics and also persuasive communicators of their statistical findings, curricula should incorporate activities that foreground the role of language in making meaning and in communicating statistical results to a specific audience with a clearly articulated set of needs and backstory.

It should be noted that the preceding suggestions do require students to do more *communicating* with statistics. That is the point, after all. This may lead to some resistance from faculty opposed to any additional grading criteria. True, the most obvious outcome will result in more writing on behalf of students and potentially additional grading on behalf of faculty. However, communication requirements should not be simply added as an additional layer to existing assessments. What I am urging is that communication—and specifically persuasive communication--be viewed and taught as an intrinsic part of the investigative cycle, not just as a delivery mechanism.

REFERENCES

Battersby, Mark. (2013*) Is that a Fact? A Field Guide to Statistical and Scientific Information.* Revised Edition. Peterborough, Ont: Broadview Press.

Campbell, S. K. (2004). *Flaws and fallacies in statistical thinking*. Mineola, N.Y: Dover Publications.

Campbell, S. K., & Hall, M. V. (1999). *Statistics you can't trust: A friendly guide to clear thinking about statistics in everyday life*. Parker, CO: Think Twice.

Cobb, George. W. Teaching Statistics. *Heeding the call for change: Suggestions for curricular action*, ed. Lynn A. Steen (Washington: Mathematical Association of America, 1992), 5.

Cobb, G. (2015). Mere Renovation is Too Little Too Late: We Need to Rethink our Undergraduate Curriculum from the Ground Up. T*he American Statistician, 69(4)*, 266-282.

Guidelines for assessment and instruction in statistics education (GAISE) college report (2016). Alexandria, VA: American Statistical Association.

Gal, Iddo. Adults' Statistical Literacy: Meanings,Components, Responsibilities 2002. *International Statistical Review, 70*(1), 1-51.

Huff, D., & Geis, I. (2006). *How to lie with statistics*. New York: W.W. Norton & Co.

Idalovichi, I. B. (2014). Symbolic forms as the metaphysical groundwork of the organon of the cultural sciences. Newcastle Upon Tyne: Cambridge Scholars Publishing.

Moore, David S and Notz, William I. (2009). *Statistics: Concepts and Controversies*, 8th ed. New York: W.H. Freeman and Company.

Moore, David. S. (1998). Statistics among the Liberal Arts. Journal of the American Statistical Association, *93*(444), 1253. doi:10.2307/2670040.

Moore, David S. (1990). Uncertainty. *On the Shoulders of Giants: New Approaches to Numeracy*, edited by Lynn A. Steen, 95-138. National Research Council; Mathematical Sciences Board.

Pearson, Robert W. (2010). *Statistical persuasion: How to collect, analyze, and present data ... accurately, honestly, and persuasively*. Thousand Oaks: SAGE Publications.

Simons, Herbert W. (1978). The Rhetoric of Science and the Science of Rhetoric. *Western Journal of Speech Communication, 42*(1), 37-43.

Spirer, Herbert F., Spirer, Louise, and Jaffe, A.J. (1998) Misused Statistics. New York: CRC Press.

Thiessen, V., & Gingrich, P., (1995). *Arguing with numbers: Statistics for the social sciences*. Halifax, N.S: Fernwood.

Tintle, N., Chance, B. L., Cobb, G. W., Rossman, A. J., Roy, S., Swanson, T., & VanderStoep, J. (2016). Introduction to statistical investigations. Hoboken, NJ: Wiley.

Weigert, Andrew J. (1970). The Immoral Rhetoric of Scientific Sociology. *The American Sociologist, 5*(2), 111-119.

Wild, Chris and Pfannkuch, Maxine (1999). Statistical Thinking in Empirical Enquiry. International Statistical Review 67, No. 3, 226.