

Quirks of Rhetoric: A Quantitative Analysis of Quantitative Reasoning in Student Writing

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This paper offers a preliminary report on Carleton College's effort to develop an empirically-grounded method for evaluating uses, non-uses, and misuses of quantitative reasoning in student writing. This effort is central to Carleton's Quantitative Inquiry, Reasoning, and Knowledge (Quirk) initiative, which is supported by grant P116B040816 from the Fund for the Improvement of Postsecondary Education (FIPSE) of the United States Department of Education.

Carleton's Quirk Initiative

Quirk's Rationale

Carleton's Quantitative Inquiry, Reasoning, and Knowledge (Quirk) initiative is taking an "across the curriculum" approach to improving undergraduate education in quantitative reasoning. We are doing so, in part, in light of sound educational advice. Derek Bok (2006), for example, has argued that "...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." But there is a deeper intellectual justification for such an effort. If, as Stephen Stigler (1999) has claimed, "Statistical concepts are ubiquitous in every province of human thought," then students and faculty should find a facility with quantitative reasoning relevant in the wide variety of disciplinary, professional, and societal discourses in which they commonly participate. In particular, we believe quantitative reasoning to be intertwined with the construction and presentation of arguments, which is of relevance both to individual liberal arts disciplines and to the broader goal of critical thinking in undergraduate education.

The aim of our educational program is to help students strengthen basic quantitative reasoning habits of mind. These include:

- (a) Electively asking "What do the numbers show?"
- (b) Seeking to support claims with sound empirical evidence.

- (c) Being able to find or generate relevant evidence.
- (d) Evaluating quantitative information in a knowledgeable and principled manner.
- (e) Communicating quantitative information clearly and meaningfully to others.
- (f) Acknowledging and respecting uncertainty.

Quirk represents an attempt both to give students background and experience that would be useful in evaluating quantitative claims critically and to promote appropriate uses of quantitative reasoning to help illuminate issues and answer questions.

Quirk's Curricular and Campus Program

How might we accomplish these ends? In part, Quirk is mounting a local curricular reform effort that includes (a) new first year seminars that involve students in using data and course revisions to existing courses to provide students with reinforcing encounters with numerical analysis, (b) faculty development activities (workshops and lunch sessions) to strengthen faculty expertise and resources to help address quantitative reasoning, and (c) campus events to raise attention to quantitative reasoning in the intellectual culture of the college. The first year seminars we have introduced include courses on "Media and Electoral Politics," "Geology and Health," "Chance in the News," and "Measured Thinking: Reasoning with Numbers about World Events, Health, Science and Social Issues." Course revisions we have sponsored include introducing statistics for a course on The Perception of Music, developing a data base for student projects in a history course on the trans-Atlantic slave trade, and preparing research assignments on small-town movie-going for a course in Cinema and Media Studies. Faculty workshops have addressed "Medical Research and Personal Health," "Writing with Numbers," and "Statistics for Faculty." And we have sponsored campus visits from Joel Best (University of Delaware), author of *More Damned Lies and Statistics*, and David Hemenway (Harvard School of Public Health), author of *Private Guns Public Health* (2004), a public health and empirically-informed approach to gun violence in the United States.

Assessing Quantitative Reasoning in Student Writing

At its core, however, Quirk is an assessment driven program rooted in evaluations of student uses of quantitative reasoning in arguments as those are represented in written work. We sought to employ assessment to inform our teaching and curriculum development efforts by helping us identify tendencies in how students used or failed to use quantitative reasoning. And we needed to find a means of gauging whether our educational initiatives were, in fact, accomplishing what we hoped they would. Because we believe quantitative reasoning to be central to the construction and presentation of arguments, we identified an available campus vehicle for capturing natural samples of students' arguments: Carleton's required writing portfolio.

At Carleton, all students are required to submit writing portfolios by the end of their sophomore year. Students are asked to include 3-5 course papers in the portfolio as well as a reflective essay they write specifically for the portfolio on their development at Carleton as writers. The papers the students select must represent two of the four divisions in the Carleton curriculum and address five domains of writing: observation, analysis, interpretation, documented sources, and thesis-driven argument.

Phase I: The Quant Squad

In June of 2005, a group of eight Carleton faculty and staff began the process of reviewing student writing for quantitative reasoning. This represented the first step in an attempt to assess the baseline character and extent of quantitative reasoning used in written arguments by students who were not influenced by Quirk activities. We did so by first identifying and then jointly discussing quantitatively rich papers from student portfolios. This unsystematic immersion led us to the tentative identification of three common shortcomings in student uses of QR. First, students would present numerical information absent the frames of reference or comparison that might make that information meaningful. We came to call this the *comparison problem*. Second, students would staple tables and figures to papers without addressing the numerical findings represented in these in the paper's presentation of arguments. We came to call this the *staples problem* (under the tongue in cheek assumption that students assumed the meaning of attached

tables and figures would be conveyed through the staples that bound the paper together). Third, students would use terms like "many" and "often" without numerical precision and documentation. We came to label this the *weasel-word problem*.

The Quant Squad also began discussions about a specification of goals and outcomes for student writing using quantitative reasoning. The draft list we generated is available at http://apps.carleton.edu/collab/quirk/resources/writing_protocol/

These preliminary observations about student use of quantitative reasoning in written argument informed subsequent faculty development activities on campus. For example, we organized a lunch presentation at Carleton's Learning and Teaching Center for faculty on what we had found during the portfolio reading process. We also co-sponsored a winter break workshop with the Carleton Writing Program on "Writing with Numbers," facilitated by John Bean of Seattle University (see Ramage, Bean, & Johnson, 2007). And faculty shared resources such as Jane Miller's (2004) book, *The Chicago Guide to Writing about Numbers*, to help us teach students to present quantitative information more effectively in their writing.

Phase II: An Empirical Assessment of QR in Student Writing

Our Phase I readings and discussions provided the foundations for a more systematic approach to assessing quantitative reasoning in student writing, again as part of our attempt to document a pre-grant baseline for subsequent comparisons. In Phase II, we randomly sampled one paper coded by the student as demonstrating analysis, interpretation, or observation from each of 200 randomly selected 2004 and 2005 student portfolios. We restricted ourselves to these categories because they were the richest potential sources of papers incorporating quantitative reasoning.

Each paper was read and, we coded the *potential* uses of quantitative reasoning in the paper as central, peripheral, or incidental/irrelevant. Central uses of QR referred to the potential use of numbers to address a central question, issue, or theme. Peripheral uses of QR referred to the potential use of numbers to provide useful detail, enrich descriptions, present background, or establish frames of reference. Miller (2004) wrote

that “Even for works that are not inherently quantitative, one or two numeric facts can help convey the important or context of your topic” (p. 1). Works that are inherently quantitative correspond to what we coded as central; the other uses of quantitative information correspond to what we coded as peripheral.

Note that this coding represented the reader’s judgment about the potential use of quantitative reasoning in the paper, regardless of what the paper did include (or the assignment required). We next coded the extent to which quantitative reasoning was in fact employed, implemented competently, communicated clearly, and interpreted effectively. We also coded the forms the quantitative information took and other features of the paper. (A complete codebook is available through the Quirk website at http://apps.carleton.edu/collab/quirk/resources/Research_Codebook_for_Assessing_QR/.)

What have we found so far using this codebook? First, we found that quantitative reasoning was relevant in one way or another to 64% of all papers sampled. We found that 36% of these potential applications of quantitative reasoning were central and 28% were peripheral. Most (66%) of the papers for which quantitative reasoning was potentially centrally relevant in fact used QR; few (12%) of the papers for which QR was judged potentially relevant peripherally in fact used QR. The papers in the former group tended to represent the natural and social sciences, while the papers for which QR was potentially peripherally relevant came from across the curriculum. Given the random selection of papers, these findings permit a challenging inference: the same students who could use QR when called upon to do so centrally when assignments presumably require QR tend not to do so electively in other papers.

What happened when quantitative reasoning was not used but could have been? Again in this sample, we found that students used undocumented quasi-quantitative terms such as “many”, “some”, “a number of”, and “most” instead of anchored numbers. Here, for example, is the opening of a paper on Chronic and Psychogenic Pain: “At one time or another, some of us have gone to see a physician for pain treatment only to be told, ‘It’s all in your head.’ Many people experience acute or chronic pain whose severity, duration, or degree of resulting disability cannot be explained by a possible, underlying physical disorder alone. Others suffer

psychogenic pain...” In sum, in this instance, what was chronically painful was the degree to which weasel words were found.

Phase III: The Quant Squad Reads Again

We are currently refining the coding scheme used in Phase II of our project and applying it to papers randomly selected from 2006 student writing portfolios. These are the first portfolios from a class of Carleton students exposed to Quirk initiatives. Moreover, we are attempting to address a central limitation of our Phase II assessment, namely that it was conducted by a single rater (the author) and lacks an evaluation of its inter-rater reliability.

We are also examining the writing contributed by students who participated in the first set of first year seminars developed under Quirk and comparing that writing, using our rubric, to that submitted by students in control first year seminars. We already know, using a quasi-experimental research design, that participation in our first year seminars had a statistically significant impact on attitudes toward quantitative reasoning. QR first year students reported being more inclined to evaluate arguments in terms of data, to be interested in developing their statistical skills further, to see QR as important to professional roles, and to perceive QR as important to citizenship. What remains to be seen is whether exposure to Quirk will be reflected in evidence of stronger quantitative reasoning in students’ written arguments.

Assessing the quantity and quality of student quantitative reasoning in light of our efforts to enhance the curriculum to strengthen QR remains the central goal of the efforts reported here.

References

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