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Observer

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PRINT EMAIL SHARE

Teaching Quantitative Reasoning

How to Make Psychology Statistically Significant

By Neil Lutsky

How can psychology contribute to the public good? The Human Capital Initiative (HCI) report, prepared with the assistance of APS, cites an important means of doing so: *helping people to improve their statistical reasoning.* "The goal of learning statistical reasoning" it notes, "should be to develop better statistical 'instincts,' not just knowledge of particular statistical procedures" (Human Capital Initiative, 1998, p. 24).

Those instincts are crucial to contemporary life, for, as the National Council on Education and the Disciplines (Steen, 2001, p. 1) observed, "The world of the twenty-first century is a world awash in numbers." Although data are not always used well (e.g., Best, 2004), data-based claims are nonetheless a staple of policy debates, advertisements, medical news, educational assessments, financial decision-making, and everyday conversation, as well as of pure and applied research in psychological science. In sum, our students need sharp statistical instincts to navigate psychology and to contribute to life beyond it.

Are we as faculty in higher education doing enough to help students develop quantitative values and skills? According to colleagues in mathematics, the answer is no. In a 1998 report, "Quantitative Reasoning for College Graduates," the Mathematical Association of America suggested, "too many educated people... are quantitatively illiterate." Some mathematicians hold their own discipline partially responsible. Lynn Steen (2004) of St. Olaf College has cogently argued that the postsecondary mathematics curriculum channels college students away from quantitative study. Psychology, then, has the opportunity to help undergraduates develop needed statistical instincts.

Psychology's Special Role in Promoting Quantitative Reasoning

There are at least four reasons why psychology as a discipline is well-suited to contribute to undergraduate education in quantitative reasoning (QR).

Psychology has Wide Exposure to Undergraduates. Approximately 1.2 million students take introductory psychology courses annually (M. Sugarman, McGraw-Hill Publishers, personal communication, June 1, 2005) and nearly 75,000 graduate each year with a degree in psychology (American Psychological Association, 2005).

Psychology has a Natural Affinity for QR. As the historian of statistics Stephen Stigler has shown, statistics and psychology are "inextricably bound together" (1999, p. 189). (Unfortunately, Stigler rejects the hypothesis that psychologists were so much quicker to adapt statistics because they were smarter than other social scientists; he might be wrong of course!).

Psychology has Rich Incentives to Hone Students' QR Instincts. Not only is quantitative reasoning an essential component of training in a psychology major (see Task Force on Undergraduate Psychology Major Competencies, 2002), it is important to public understanding of contemporary psychological research and practice.

Psychologists can Appreciate the Educational Rationale for QR Across the Curriculum. We recognize that students need to encounter a broad array of stimulus conditions calling for QR if they are to develop and strengthen generalized QR cognitive tendencies. Psychology represents one of a number of content areas besides mathematics in which QR might naturally come into play for students.

What is QR?

In literatures addressing quantitative reasoning and literacy, many authors attempt to specify lists of skills or outcomes constituting QR (e.g., Steen, 2001). Although there is variation among lists, most lists include the following: descriptive and inferential statistics, chance and probability, graphical presentations of data,

modeling, and research design and methods. At my own institution, these are embedded in a broader goal: *helping students learn to use and evaluate quantitative information in a principled way in accounts of phenomena and in the construction of arguments.* This intertwining of QR with argument in learned and public discourses builds upon a theme articulated by psychologist Robert Abelson in 1995, "the purpose of statistics is to organize a useful argument from quantitative evidence, using a form of principled rhetoric" (p. xiii). In our approach, we do not only view statistics as a form of argument. We also view argument in general as potentially involving a form of statistics. Within this framework, QR involves (a) appreciating the value of quantitative approaches to understanding, (b) being willing to use QR electively in constructing an argument, (c) knowing or knowing how to find or generate relevant quantitative information, (d) evaluating implicit and explicit quantitative claims in light of relevant standards and critical issues, and (e) representing and communicating quantitative information or evaluations in a clear, informative, and responsible manner.

QR in the Classroom

How can we help move our students toward quantitative literacy? In what follows, I will concentrate on suggestions for general or service psychology courses where teachers of psychology encounter the largest number of students. Students majoring in psychology are repeatedly called upon to use QR through statistics and methods courses, laboratories, readings, and research in psychology (Messer, Griggs, & Jackson, 1999). Whether psychology majors develop generalized statistical instincts, however, remains an open question. The suggestions below, then, might be used profitably across the psychology curriculum.

Focus Student Attention on Quantitative Information. Quantitative information is a content staple of basic psychology texts and class presentations on psychology. However, students may not attend carefully to numbers, figures, and tables they encounter in these sources. An instructor can elicit such attention by (a) highlighting key quantitative findings, (b) walking students through the interpretation of tables and figures, and (c) discussing when and why a particular degree of quantitative precision is warranted in psychology. An instructor can reinforce these points by telling students that examinations will assess their knowledge and use of meaningful quantitative information in psychology.

Invite Students to Interpret Quantitative Findings. A key QR goal is that students learn to interpret research results and recognize critical questions they ought to raise about quantitative claims. An instructor can facilitate this by presenting a quantitative stimulus in class — such as a graphic or table of results on a slide —and asking students to make sense of quantitative findings in a discussion or brief in-class writing assignment. The simple question, "What is this quantitative stimulus telling us?" will get students thinking about quantitative information and relating that information to key arguments in a psychological literature. The natural follow-up question, "What additional information would be useful to evaluate this quantitative presentation (e.g., graphic)?" can encourage critical thinking about quantitative claims as well as generate new research ideas.

Teach Students to Seek Quantitative Information. Students need to learn how to find and evaluate quantitative information relevant to psychology, for example, when they consider the cross-cultural or ecological validity of research results or learn about the epidemiology of mental disorders. Even basic quantitative facts about world population and literacy may help set psychology in context. It may be useful to collaborate with a local college librarian to develop instruction for students about finding sources of relevant quantitative information. Likewise, instructors can provide students a description of the standards employed in psychology to evaluate the adequacy of an informational source (e.g., peer review). An instructor could then expect students to use these skills to frame any oral or written presentations they are assigned.

Involve Students in Data Analysis. One method of getting students to learn and think about statistics is to give them a reason to use statistics. This is common in statistics and research methods courses in psychology, where students write research proposals and complete canned and novel empirical projects. It is also possible to involve general psychology students in data analysis through course laboratories or data set projects.

In my introductory course, for example, students complete two web-based research modules. In one, they take personality and happiness measures and then pose an empirical question answerable from the course data set to which they have contributed. Students then conduct a simple statistical analysis to answer their questions and submit short research reports. A benefit of projects such as these is that they give the instructor a meaningful context in which to assign the statistics appendix of an introductory text and to provide guidance on using and interpreting quantitative findings.

Require Students to Write About Data. Commonly, when students are asked to find quantitative information or to analyze data, they are also called upon to write about what they have discovered. Translating numerical information into words can be an effective means of strengthening statistics students' computational and interpretive skills (Beins, 1993). Beins suggests asking students to write in jargon-free terms about quantitative information found in almanacs, psychology journal articles, and other sources. Because written work in psychology, even at the introductory level, commonly addresses quantitative information, students need to be taught when and how to present and use quantitative arguments. Writing about quantitative information should stimulate students to think about both the meaning of technical concepts (e.g., confidence intervals, statistical significance) and principles that apply to the effective communication of technical information and the construction of arguments. Miller (2004) and Tufte (2001) provide two excellent sources for instructors wanting to address these issues.

At my own institution, we are in the midst of a Department of Education Fund for the Improvement of Postsecondary Education (FIPSE) project (QUIRK, 2005) in which teams of faculty are reading course papers from across the curriculum to study how students incorporate or neglect relevant quantitative information in written arguments. For example, we have found that students are needlessly ambiguous, using words like "many" or "often" to represent a quantitative claim without providing supporting specifics (how many?). One goal of our project is to use what we learn to help faculty develop course work, writing and speaking assignments, and instruction that will teach students to use and present quantitative information more effectively.

Relate QR to Topics in Psychology. Instructors can relate the psychological science of everyday judgment and perception to issues in quantitative reasoning. For example, a presentation can contrast the cognitive tendencies to overgeneralize from single cases and to notice illusory correlations to concerns in formal statistical reasoning such as a reliance on incomplete data (see Lawson, Schwiers, Doellman, Grady, & Kelnhofer, 2003, for an elaboration). In this way, a discussion of a psychological phenomenon may help students appreciate the value of systematic quantitative reasoning.

Model QR and Make the Case for QR. We as faculty need to model quantitative reasoning for students. For example, when we present, assign, or encounter case studies or anecdotes we need to remind our students to ask how representative of some category a particular instance is. We need to draw student attention to the questions we would ask when we discuss quantities (e.g., questions about outliers, subgroups, and variability when we think about averages). We need to demonstrate how we use quantitative information to illuminate phenomena, construct responsible arguments, and express caution about what we believe we know.

The larger social significance of quantitative reasoning may be obvious to most psychologists; it probably is not so to students. I find it useful to remind students that quantitative reasoning is not only fundamental to psychology as a discipline but is also pertinent to a wide variety of professional and public discourses students will encounter and even rely upon in their lives (e.g., Poundstone, 2003). When I teach general psychology courses, for example, I encourage all students, whether they intend to major in psychology or not, to take a statistics course during their undergraduate careers, and I tell them why I believe such a course would be worthwhile.

QR for Psychology Faculty

Although psychology faculty tend to be well-trained in statistics, we may be less familiar with the broader conversations occurring about quantitative reasoning as a fundamental goal of undergraduate training and how colleges and universities are attempting to address that goal. Because we may have an important role to play, we should consider becoming more involved in those discussions. Here are suggestions for doing so.

Read the Literature. There is a growing popular and educational literature on quantitative literacy and reasoning. I highly recommend recent books by Lynn Steen (2001, 2004) and Joel Best (2004), as well as the classic series on graphics by Edward Tufte (e.g., 2001).

Join the Networks. Link up with faculty across disciplines who are interested in quantitative reasoning. Good places to start are the National Numeracy Network, which has its web home at www.math.dartmouth.edu/~nnn, the Mathematical Association of America's portal for quantitative literacy at www.maa.org/ql/index.html, and the Statistical Literacy web site, www.statlit.org. Lynn Steen also maintains a web list of higher education programs that address quantitative literacy and reasoning at www.stolaf.edu/people/steen/papers/qlprogs.pdf.

Get Involved in a Campus QR Initiative

Psychologists have the potential to play an important role in curriculum and faculty development and assessment efforts to address quantitative reasoning, and such participation may, in turn, enhance attitudes toward psychology as a scientific discipline. Teachers of psychology have served as consultants for other faculty at their institution on quantitative reasoning, helped draft curricular definitions and standards for QR, developed methods for assessing students' quantitative reasoning, and led campus workshops on integrating QR into the curriculum. Teachers have also configured their statistics and methods courses in psychology to meet QR standards at institutions that have a QR requirement.

Conclusion

There is a movement afoot in higher education to raise both appreciation for and the quality of training in quantitative reasoning. Psychology and psychologists have important roles to play in this initiative, both as teachers and as participants, in local and national educational communities.

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