

Response to “Statistics à la Mode” in *Math Horizons*

A statistics course may indeed be one of the most important courses that a student takes. Arthur Benjamin concluded his Ted Talk [\[listen\]](#) by saying, “instead of our students learning about the techniques of calculus, I think it would be far more significant if all of them knew what two standard deviations from the mean means.” As more and more data are collected the future will belong to those who can make sense out of that data. In fact, Hal Varian—Google’s chief economist—in an interview with *McKinsey Quarterly* (January, 2009), said, “the sexy job in the next ten years will be statisticians.” [\[Read article.\]](#)

Statisticians have many tools at their disposal to help make sense of data, including mathematics. Statistics, however, is not a subfield of mathematics. Like economics and physics, statistics uses mathematics in essential ways, “but has origins, subject matter, foundational questions and standards that are distinct from those of mathematics.” (Moore, 1988, p. 3). David Moore, statistics educator and former President of the American Statistical Association, gives four compelling reasons why statistics is a separate discipline from mathematics:

- Statistics does not originate within mathematics;
- The aims and foundational controversies of statistics are unrelated to those of mathematics;
- The standards of excellence in statistics differ from those of mathematics; and
- Statistics does not participate in the interrelationships among subfields that characterize contemporary mathematics.

Statistics exists because of the need for other disciplines to examine and explain variation in their data. As such, any introductory statistics course would be remiss if it did not put data at the center of the curriculum. In fact, the recommendation of a joint committee of the American Statistical Association and the MAA to discuss the curriculum in elementary statistics, reflected this viewpoint stating, “any introductory course should take as its main goal helping students to learn the basics of statistical thinking” (Cobb, 1992, p. 5). Statistical thinking includes the need for data, the importance of data production, the omnipresence of variability, and the quantification and explanation of variability. These views were echoed in the [Guidelines for Assessment and Instruction in Statistics Education \(GAISE\)](#) and endorsed by the ASA in 2005.

The focus in a course with the goal of promoting this kind of thinking should not be on the mathematics, but rather on the “intellectual framework that makes sense of the collection of tools that statisticians use and encourages their flexible application to solve problems” (Cobb, 1997, p. 815). It is not that mathematics and probability have no place in such a framework, but rather that they are not the focal point. Ideas of design, inference and reasoning about uncertainty all have a more prominent role in the introductory statistics curriculum. The [CUPM Curriculum Guide \(2004\)](#) (p. 38) says, “The fundamental ideas of statistics, such as the omnipresence of variability and the ability to quantify and predict it, are important subjects that can be studied without sophisticated mathematical formulations. In particular, the notion of sampling distribution – which underlies the concepts of significance testing and confidence interval – is challenging enough on its own to justify a first course in statistics. “

Statistics has at its core, data and inference, and as Moore (1988) so pointedly declares, “it is unprofessional for mathematicians who lack training and experience in working with data to

teach statistics” (p. 3). The important part of Moore’s statement is not that mathematicians should not teach statistics, but rather that experience working with data is crucial for a teacher of statistics. It would be no more advisable to have a poet teach calculus than it would be to have a person with no data experience (be they a mathematician, economist, or psychologist) teach a statistics course. In each case, the person lacks the scholarship necessary to be taken seriously. To teach effectively in any field one needs to understand more than just subject matter. It also requires a deep understanding of the methods that practitioners in that field use to approach problems. In teaching statistics, it is important for students to experience data, and also the methods of statistics (not only mathematics).

A course (or more) in probability and a course in mathematical statistics would help most people’s understanding of statistics along with the 2-3 other courses in basic and intermediate statistical methods they should take. However, only a select few students will take 5 courses in probability and statistics in their college career. Then, the question becomes which course to take. We think that most statistics educators agree that if you have to choose only one, a course in statistical thinking would supersede one in probabilistic thinking. We need to do a better job as educators thinking about where we want our students to be at the end of the course and then what the crucial skills are that they need to get there. Understanding the conceptual framework of a hypothesis test or of inference from data, even without any probability theory (including even the central limit theorem through methods like a randomization test) is a more useful skill in today’s data-driven world than predicting how many heads you might get when you flip a coin 100 times (although again, the latter is very helpful in understanding the former).

It should also be clear that there are some mathematicians who are phenomenal teachers of statistics. It is not your degree that matters, but rather your knowledge in statistics and statistical pedagogy. Just as when a physicist teaches a mathematics course, when a mathematician teaches a statistics course they are teaching in a field different from their training. To teach in a different field one needs to understand the ways that practitioners of that field approach problems and to have experienced the joy of making discoveries in that field. We need to convey to our students the excitement of solving problems using all of the tools of statistics. It is wonderful to be teaching statistics in the 21st century because there are so many resources to help beginning and experienced statistics teachers. After the many years that we have amassed teaching statistics each of us continues to learn a lot every time we participate in a professional development experience.

Each year there are several events at the Joint Mathematics Meetings to help us all become better teachers of statistics. Many of these are sponsored by the SIGMAA on Statistics Education. Teachers of statistics should think about joining the SIGMAA! The Business meeting and reception is a good chance to get together with a nice group of statistic educators in an informal setting.

Not going to JMM? Next summer the MAA will sponsor a PREP workshop – Beyond Introductory Statistics: Generalized Linear and Multilevel Models with Jim Albert and Brad Hartlaub <http://www.maa.org/prep/2012/statistics.html>.

CAUSE (the Consortium for the Advancement of Undergraduate Statistics Education) sponsors a website (<http://www.causeweb.org>) with lots of useful information and a number of important professional development opportunities including:

- Frequent webinars on statistics education that one can participate in (from your office computer) or watch the recording at a later time. <http://www.causeweb.org/webinar/>
- USCOTS (the United States Conference on the Teaching of Statistics) in odd numbered years.
- In May 2012 CAUSE will sponsor an electronic conference – ECOTS. <http://www.causeweb.org/ecots/>

All teachers of statistics should be familiar with the Guidelines for Assessment and Instruction in Statistics Education (GAISE) which includes recommendations for introductory statistics courses. <http://www.amstat.org/education/gaise/>

In addition, there are several publications for teachers of statistics.

- the Journal of Statistics Education - <http://www.amstat.org/publications/jse/>
- the Statistics Education Research Journal - <http://www.stat.auckland.ac.nz/~iase/publications.php?show=serj#archives/>
- Teaching Statistics - <http://www.rsscse-edu.org.uk/tsj/>
- the Statistics Education Web (STEW) - <http://www.amstat.org/education/STEW/>
- Technology Innovations in Statistics Education - <http://tise.stat.ucla.ed>

The opinions expressed here reflect the views of the authors and not the SIGMAA on Statistics Education.

Brian Gill, Seattle Pacific University
Chair, SIGMAA on Statistics Education

Andrew Zieffler, University of Minnesota
Chair-elect, SIGMAA on Statistics Education

Nancy Boynton, SUNY Fredonia
Past-chair, SIGMAA on Statistics Education

K. Scott Alberts, Truman State University
Chair-elect-elect, SIGMAA on Statistics Education

Patricia Humphrey, Georgia Southern University
John McKenzie, Babson College
Michael A. Posner, Villanova University
Former chairs, SIGMAA on Statistics Education

References:

- Cobb, G. W. (1992). Teaching statistics, in L. A. Steen (ed.), *Heeding the Call for Change: Suggestions for Curricular Action*, MAA Notes 22 (pp. 3–23). Washington DC: Mathematical Association of America.
- Cobb, G. W. & Moore, D. S. (1997). Mathematics, Statistics, and Teaching. *The American Mathematical Monthly*, 41(9), 801–823.
- Moore, D. S. (1988). Should mathematicians teach statistics (with discussion). *College Math. Journal* 19, 3–7.
- Barker, W., Bressoud, D., Epp, S., Ganter, S., Haver B. & Pollatsek, H., (2004). *Undergraduate Programs and Courses in the Mathematical Sciences: CUPM Curriculum Guide 2004*.