George W. Cobb and the Undergraduate Statistics Curriculum

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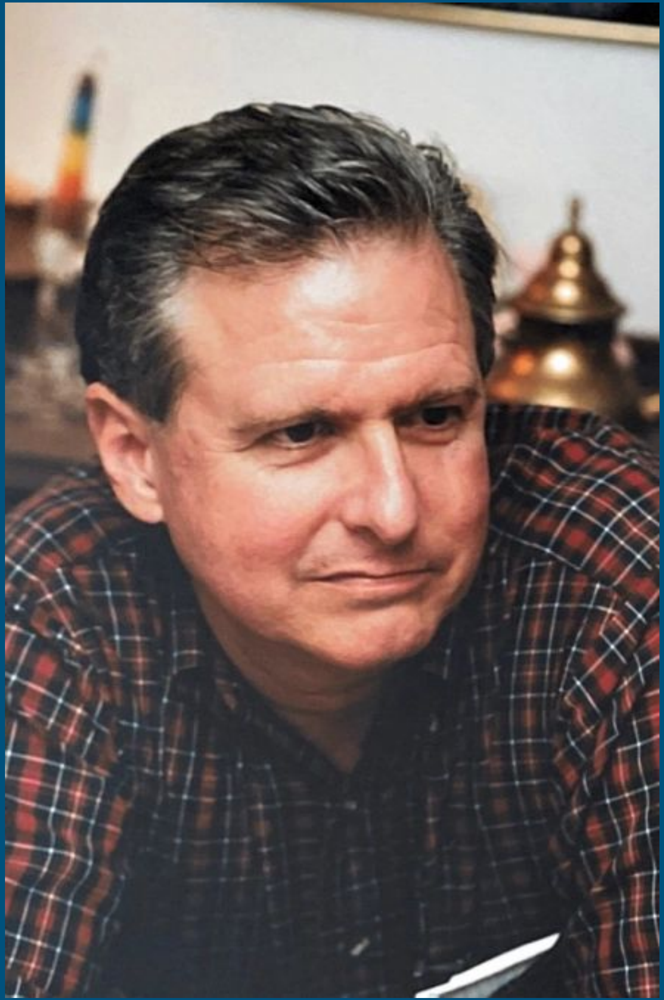
https://github.com/Amherst-Statistics/Cobb-Memorial

An appreciation of George's published papers
(his impact is far broader in his personal and professional lives)

Never afraid to speak his mind

Are we about to see a major national reemphasis on teaching? Bears will use indoor plumbing first. Whether for bears or academics, there is no economic incentive to change. My pessimism trickles down from the dismal twin clouds of supply and demand:

DS Moore, GW Cobb, J Garfield, and W Meeker (1993), “Statistics Education Fin de Sie`cle,” *The American Statistician*



Reconsidering Statistics Education: A NSF Conference, *JSE* (1993)

The mystery writer Dorothy Sayers once wrote, "Facts are like cows. If you look them in the face hard enough they generally run away" (Sayers 1927, p. 68). In our particular field, the usual herd of cud-chewing introductory courses has been a standing fact of life for much too long.

Keen ability to see the big picture

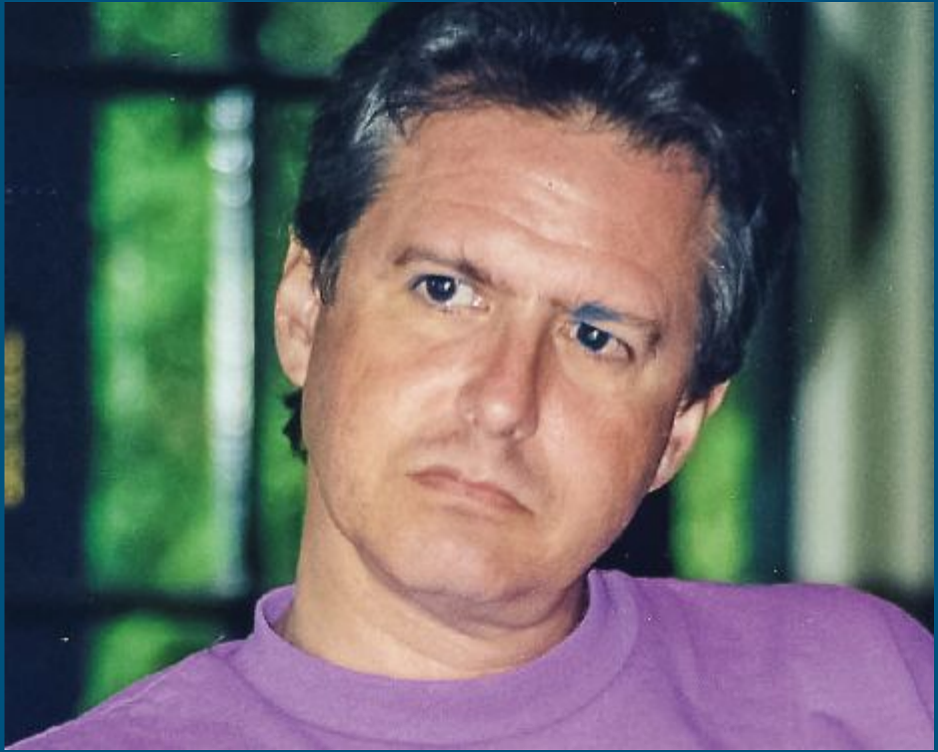
Rejoinder to “Mere renovation is too little, too late” (TAS, 2015)

Willingness to identify junior people and help disseminate their work and ideas

- *1950s: Making the teaching of statistics legitimate at the elementary level.* Frederick Mosteller (1961).
- *1960s: Teaching us to teach with real data, before computers.* John Tukey (1977).
- *1970s: Interactive computing and data analysis.* Francis Anscombe (1981).
- *1980s: Real data in the first inference course.* Freedman, Pisani, and Purves (1978); Moore and McCabe (1984).
- *1990s: Activity-based statistics.* Richard Scheaffer, et al. (1996).
- *2000s: Randomization-based inference.* Peter Nemenyi and others. (Note here that Nemenyi developed and taught his randomization-based course in the 1960s. It has taken us 50 years to catch up. For more, see footnote 3.)

Cobb and Moore (1997)

The ultimate focus in mathematical thinking is on abstract patterns: the context is part of the irrelevant detail that must be boiled off over the flame of abstraction in order to reveal the previously hidden crystal of pure structure.



Heeding the Call for Change (1992)

Teaching Statistics

George Cobb

MOUNT HOLYOKE COLLEGE

Introduction

This report on teaching statistics will present the Statistics Focus Group's recommendations under three headings, corresponding to *statistics* ("Recent Changes in the Field"), *mathematics* ("Some Differences Between Mathematics and Statistics"), and *teaching* ("What Research Tells Us"). A fourth section ("Examples") illustrates ways these recommendations can be put into practice, and a final section ("Making It Happen") offers two meta-recommendations about implementation.

> What do we want students to be able to *do*, themselves, in terms of performing statistical work after their course is completed? What kinds of statistical reasoning, or arguments, do we want them to be able to *understand*? What kinds of *experiences* should the students have had in the course?
>
> —*Jim Landwehr, AT&T Bell Labs*

Heeding the Call for Change (1992)

Recent Changes in the Field of Statistics

> Statistics has moved somewhat away from mathematics back toward its roots in scientific inference and the analysis of data. ...The most important driving force in this shift of emphasis is the computer revolution.
>
> —*David Moore*

During the last two decades, statistics has been changing simultaneously on three levels, which correspond to technique, practice, and theory. On the technical level, cheap, powerful computing has made possible a number of important innovations: graphical methods for data display, iterative methods for data description, diagnostic tools for assessment of fit between data and model, and new methods of inference based on resampling techniques such as the bootstrap. On the level of practice, such things as pattern-searching, model-free description, and systematic assessment of fit have all become more prominent, at the expense of formal inference, most especially hypothesis testing. Statisticians now put more effort into the complex process of choosing suitable models, less effort into doing those things—simpler by comparison—which take the choice of model as given.

Heeding the Call for Change (1992)

The distinction between mathematical theory and statistical concepts remains an important one even in thinking about the standard introduction to mathematical statistics.

> I don't think students who take the standard mathematical statistics course come away with even the faintest appreciation for what statistics is about. Unless students have had a previous course that does justice to data analysis, and so provides a meaningful context for the mathematical statistics, the course is mainly an opportunity to practice advanced calculus techniques. I think only three positions are tenable here:
>
> 1. The mathematical statistics course should *never* be taught to students who haven't first taken an applied course;
> 2. The mathematical statistics course must be radically revised, to integrate data analysis with the statistical theory; or
> 3. The mathematical theory of statistics should be introduced via an optional adjunct to the beginning applied course.
>
> —*George Cobb*

Heeding the Call for Change (1992)

2. Intellectual Inertia:

Learning to handle the ambiguities of statistics takes time, practice, and hard thought. Even with software installed and data sets in hand, doing a proper analysis and interpretation is a kind of challenge that many who teach statistics are not prepared to meet, mainly because, through no fault of their own, they've rarely if ever seen it done, and their training and experience have not prepared them either to do it or to value the doing of it. Remember that in Plato's curriculum, students were to devote their entire first decade of study to mathematics, because the other subjects, being less clear-cut, were understood to be *harder*. (Mathematics is often mistaken for being harder because the absence of ambiguity makes the subject much less forgiving of low quality effort.)

Reconsidering Statistics Education: A NSF Conference, *JSE* (1993)

As a metaphor, we can usefully regard assessment as a kind of composite function, first from statistician space (where we live) to task space (where our students live), then from task space to evaluation space (where the grades are).

With a test, there is a clear and direct route from what it is the student does (i.e., provides a set of answers) to the grade the instructor assigns. In contrast, with a project, the scoring is much more subjective. Scoring a test has very high inter-rater reliability; grading a project not nearly so high. BUT -- the scoring is only half the path. The other half of the connection runs back from the task (project or test) to what it is that we want our students to learn. For the project, the connection is so direct that no one even raises the issue.

Objections to projects are always logistical ("Students don't know enough to plan a decent project until late in the semester." "Dealing with the interpersonal aspects of teams is such a hassle." "Grading is too subjective, and besides, I don't have the time to read all those papers."); **objections never take the form "When you come right down to it, answering test questions is closer to what statisticians actually do in practice."** For the test, the connection to statistical practice is an unexamined article of faith, or, absent the faith, simply unexamined.

Discussion of Hogg's "CQI" paper (1999)

of mathematics. Both Hogg and Higgins, like many before them, reiterate that statistics is not mathematics, and yet this fundamental article of dogma stubbornly refuses to submit to the facts and slink away. Why? Why can't intelligent and otherwise well-informed people recognize the truth? Because *the importance of data* is not yet established in the public mind. Why is this especially true of mathematicians? *Statistics is a branch of mathematics only to those who would rather make an assumption than look at the data.*

Discussion of Hogg's "CQI" paper (1999)

easily, on a fundamental anomaly: *Although statistics is still widely thought to be a branch of mathematics, and although nationwide sections of elementary statistics taught in mathematics departments outnumber sections taught in statistics departments by more than three to one, mathematics and statistics are irreconcilably at odds over the importance of applied context.*

Chilean Journal of Statistics (2011)

When we teach statistics, what is it that we want our students to learn? Surely the most common answer must be that we want our students to learn to analyze data, and certainly I share that goal.

But for some students, particularly those with a strong interest and ability in mathematics, I suggest a complementary goal, one that in my opinion has not received enough explicit attention: We want these mathematically inclined students to learn to solve methodological problems.

Chilean Journal of Statistics (2011)

When it comes to abstraction, there is an essential tension between wholesale and retail, nicely captured by Benjamin Franklin's childhood impatience with his father's habit of saying a lengthy blessing before each meal. "Why not save time", young Ben asked, "by saying a single monthly blessing for the whole larder?" Franklin senior was not amused. He thought there was value in systematic, concrete repetition with minor variations. In this section, much as I sympathize with Franklin junior's wish for abstract efficiency, I end up siding with Franklin senior and his recognition that understanding grows from repeated encounters with concrete examples.

Rossman and Cobb interview (2015)

AR: Can you comment on some ways in which you achieved such a cooperative approach to active learning in your courses?

GC: You make it sound more deliberate than it actually was. I more or less stumbled into it, much as I stumbled into statistics. One semester I decided to teach our probability course using Fred Mosteller's *Fifty Challenging Problems in Probability* (1965). There was no textbook. Instead of proving theorems, students would solve the problems, and instead of competing as in a Moore-method course, they worked in small groups. It worked really well, better than when I did more of the talking. I also started requiring semester projects in my design course, and students could choose whether to work alone or on a team with one or two others. From that point on, I relied on term projects in almost all my courses. Then I had the good fortune to be

Rossman and Cobb interview (2015)

AR: Among all of your contributions to statistics education, and I don’t doubt that more are to come even in your retirement, can you pick one or two of which you are most proud?

GC: Instead of particular accomplishments, I’d rather suggest two themes that to me, looking back, have motivated much of my work.

The first is the importance of the so-called “soft” aspects of our subject: tolerance of ambiguity as well as uncertainty, interpretation in context, and the like. I’ve come to regard the tension between Pascal’s two ways of thinking – his “spirit of subtlety” and “spirit of geometry” as an essential energizing force within statistics.

A second theme is the way computing allows us to make basic concepts and practice of data analysis more accessible, less reliant on technical prerequisites.

Mere renovation is too little, too late (TAS, 2015)

2. OUR THINKING ABOUT CURRICULUM HAS BECOME A "TEAR-DOWN"

I borrow my metaphor from the California real estate market, where territory has become so valuable that perfectly good structures once considered state-of-the-art and still acknowledged as serviceable have nevertheless been overtaken by rapid change, and risk losing out to more modern competition. For our profession, the valuable territory is the science of data; our competition takes place in the marketplace of ideas; and our statistics curriculum, though still serviceable, is increasingly at risk. "Big data" is one threat, from computer science; "analytics" is another, from business; "bioinformatics" is yet a third.

Mere renovation is too little, too late (TAS, 2015)

It is little wonder we felt then, and still feel, that others have been eating our lunch. The cliché of eating our lunch is not quite the right metaphor, however. It is more apt to say that the lunch we have been offering does not appeal to a broad enough clientele. We have insisted on seating only those who bring enough mathematics to the table, and who are in addition willing to sit patiently as we serve their meal linearly, one course at a time. Meanwhile, our competitors offer fast food. Their presentation may be inferior, and their diet may be heavy on the salt and fat of short-term gratification, but customers can drive up, get the McNuggets of their virtual Happy Meal in a bag, and be done. On a loftier level, above the merely metabolic,

Rejoinder to Mere renovation is too little, too late (TAS, 2015)

- *The tear-down.* It is not our *curriculum* that is the tear-down, but rather, less drastically short term, but more ambitiously long term, it is our *thinking* about curriculum that needs to start from the ground up. Unless I misread, not one of the respondents wants us to continue to debride the skins of our noses on the same old curricular grindstone. We all want change. All the same, our thinking about change is too somnolent.

The distinction between *how we think* and *what we do* needs to be recognized more explicitly. What we *do* is constrained by reality. How we *think* is not, and should not be. To borrow from Robert Browning (1855), our reach should exceed our grasp.

George W. Cobb (1947 - 2020)

Your papers will continue to resonate widely

Your mentorship and guidance will always be appreciated

Your friendship and wisdom have touched the lives of many

You will be missed...

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George W. Cobb (1947 - 2020)