Comment

David S. Moore

My first reaction on rereading Hotelling's classic essays is distress that the situation he described has improved so little in nearly half a century. My second reaction is that we largely deserve our fate.

Despite great progress in statistical science itself, in the application of statistical methods to many areas of study and in the organization of statistics as a profession, statistics remains inadequately recognized as an independent discipline. The word calls to the mind of most scholars in other fields a few more or less routine methods learned by their graduate students—regression to the economist, control charts to an industrial engineer, repeated measures designs to the psychologist and so on—rather than "a coherent, unified science" ... "embodying the modern version of the most important part of inductive logic."

In so describing statistics, Hotelling was preaching to the converted of the 1940s. In agreeing here that statistics is a separate and fundamental discipline, we are preaching to the converted of the 1980s. The number of the converted remains small. Statistical methods are certainly much more widely applied than in Hotelling's day. In the past, even routine use of the more complex methods required a specialist, so that data analysis was a collaborative effort. The resulting demand for working statisticians has been an important justification for university programs in statistics. Now analysis is automated, and software is becoming increasingly capable of directing the user's judgment in design and diagnostics as well. What will the working statistician of the future have to offer the engineer or medical researcher or psychologist? This is the practical version of the question whether statistics is in fact a separate and fundamental discipline. In the absence of a convincing answer, the future of both working statisticians and university programs is in doubt.

Failing to obtain wide recognition as a science in its own right, statistics has also failed to remedy the educational problems that were Hotelling's primary concern. His description of the fragmentation of statistics teaching among more reputable disciplines could have been written yesterday. Many academic statisticians would also accept his corollary that this arrangement leads to inferior quality and productivity in teaching and places a burden of divided intellectual loyalty on teachers. I am not fully convinced that this corollary is true, given the nature of statistics as taught in many departments of mathematics and some departments of statistics. Our teaching is too dominated by mathematical modes of thinking that do not reflect the separate identity of statistics. The spirit and content of what we teach to students in other disciplines represents our *de facto* case for recognition as a separate science. If that practical case is weak, arguments from principle will gain us few allies.

In the rhetorical spirit that is appropriate in the discussion of such large issues, I want to argue two strongly put propositions. First, that statistics is not only an independent discipline but a fundamental discipline, in fact, one of the "liberal arts" in their modern guise. Second, that the major threat to the independence of statistics in many academic institutions is its self-inflicted subservience to mathematics.

STATISTICS AMONG THE LIBERAL ARTS

Hotelling, no doubt recognizing that his audience accepted statistics as a fundamental discipline, did not offer much in the way of explicit argument to support this opinion. I believe that such an argument, in outline, is as follows. A pervasive aspect of modernization is differentiation, the division into distinct institutions of functions that were once integrated. This sociological process has occurred as clearly in the intellectual area as in any other. It is illustrated by the gradual emergence of statistics as well as many other newer disciplines, including sociology itself. As a result of differentiation and other social changes, there is no longer any core of learning common to all educated persons and to all programs of "liberal education."

Some scholars lament this irreversible change. Attempts to specify a core of liberal knowledge are the focus of debates over the curriculum at many universities, and have reached the best seller list in E. D. Hirsch's book *Cultural Literacy*: *What Every American Needs to Know*. Such attempts invariably favor the older academic disciplines, which retain a certain prestige. More seriously, the "liberal arts" as reconstituted by those who regret the differentiation of knowledge too often focus on content rather than method, on learning certain facts rather than learning to learn. There is little hope that statistical science will be seen as fundamental from this perspective, although a few statistical facts may appear in a core curriculum as a result of the voting power of social science faculty.

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