

TEACHING INTRODUCTORY STATISTICS IN THE LIBERAL ARTS CURRICULUM

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Everyone who has taught a course in introductory statistics to majors in sociology, psychology, education, and the like has been faced by the Great Panic Reaction. In another course the instructor can say, "The occupational system is essentially the institutionalized differentiation of the adaptive aspect of the task-orientation area of the social system,"¹ and be met with only a soft murmur of discontent. Yet, at the mere mention of the number "three," student apprehension will rise to the panic level. Voicing an expression like "sigma-ex" will lead to a barrage of drop-slips and changes-in-major. Something in our cultural background seems to engender these anxieties; at some time in our formative years we are frightened by the magic of numbers. Genuine learning cannot take place in an atmosphere fraught with anxieties, and the fears must be allayed before students can attend to subject matter. And so the teacher—if he is to teach at all—must be concerned first with the fear and only secondly with the subject matter of statistics. He must be a religious confessor, a psychotherapist, and a numbers magician all rolled up into a neat package.

It is not the intent of the present paper to explore the basis for the Panic Reaction. That is a problem for research in educational psychology and sociology. Rather, we hope to outline a device which may help to allay the anxiety. We are convinced that much of the fear engendered by a first experience with statistics may be eliminated by sound, systematic, and logical course organization. We shall present a plan—a course outline—designed to provide such an order. It is hoped that through the application of such a plan introductory statistics may become a tolerable, perhaps desirable, course in the liberal arts curriculum.

I

Most introductory statistics texts, and we may suspect, most introductory courses, are organized along a standardized plan.² Such uniformity is beautifully illustrated by the small table of "concordances" between texts given

¹ Talcott Parsons, Robert F. Bales, and Edward A. Shills, *Working Papers in the Theory of Action*, Glencoe, Illinois: Free Press, 1953, p. 255.

in the opening pages of the College Outline Series, *Statistical Methods*.³ The student is first introduced to the statistics of measurement. He is exposed to the frequency distribution and then to the several measures of central tendency and variability. This is usually followed by discussions of sampling and the normal curve, and this in turn by the product-moment correlation coefficient. Then, the remainder of the course usually is taken up with discussions of other estimates of correlation and various tests of significance. These "tag-end" devices are often presented in a rather arbitrary, even haphazard, order.

Such a standard course plan leaves something to be desired. It requires that the student memorize a large number of seemingly unrelated rules and formulas. It presents little overall logic—no general organizational plan. The only order may result solely from the desire of the instructor to introduce the various statistics according to their computational simplicity. In other instances, an attempt is sometimes made to reproduce them in the order of their invention. In either case, this results in a rather haphazard presentation, and requires that any additional organization be imposed by the student.

Such methods have great potentialities for raising anxiety. Presented in this fashion, statistics appears to be a morass of mathematical trivia designed primarily as an ordeal for the student. On the other hand, if the student is presented with an explicit statement of the range and logical organization of modern statistics, much may be accomplished toward reducing anxiety. He must understand the role of statistical study in

² For example, see Lillian Cohen, *Statistical Methods for Social Scientists*, New York: Prentice-Hall, 1954; Sanford M. Dornbusch and Calvin F. Schmid, *A Primer of Social Statistics*, New York: McGraw-Hill, 1955; Allen L. Edwards, *Statistical Analysis for Students in Psychology and Education*, New York: Rinehart, 1946; Henry E. Garrett, *Statistics in Psychology and Education*, New York: Longmans, Green, 1947; J. P. Guilford, *Fundamental Statistics in Psychology and Education*, 2nd ed., New York: McGraw-Hill, 1950; Helen M. Walker, *Elementary Statistical Methods*, New York: Henry Holt, 1943.

³ Herbert Arkin and Raymond R. Coulton, *Statistical Methods*, 4th ed., rev., New York: Barnes and Noble, 1950, pp. xi-xiii.

scientific investigation, the types of problems which may be solved through the application of statistics, and the ways in which statistics can contribute to such solutions. The outline which follows presents a logically coherent organization of elementary statistical thought.

II

Our proposed outline describes the division of a course into four basic sections. The first of these is introductory. It is designed primarily to familiarize the student with the place of statistics in research and in science generally. The other three basic sections deal with classification, ranking, and measurement, respectively. This division reflects the assumption that one fundamental organizational principle for statistics may be found in the nature of the data available to an investigator. Each of these three sections is then divided into two sub-sections, one dealing with description, and the other with analysis or the statistics of relationship. Here it is assumed that having solved the problem of the nature of the data, the next logical question is concerned with the type of study planned. Is it the intent of the research to describe discrete phenomena, or is it concerned with problems of relationship?

One further division runs throughout the outline. Each of the analytic subsections is divided into one segment concerned with expressions of the degree of association, and another on tests of significance of association. This division is designed to express the choice which exists for the investigator between estimating the degree of association, or testing merely whether or not association exists at all. These divisions are made explicit in the outline below.

It will be apparent that the outline below follows systematically the proposition of modern pedagogy that learning takes place best whenever specific applications flow within a broad, theoretical framework. We do not hold with some post-Deweyian educators who propose to let principles emerge from a planned plethora of specific applications. It is especially in statistics that such an approach will not work, because each new application serves merely as another straw of irritation to the already number-panicked student. Reduction of this fear can best come through knowledge and understanding of *why* operations are required—not through piecemeal acquisition of rote-memorized formulas and their equally piecemeal applications. Such a program as we suggest is obvious in the general structure of our outline—proceeding from general to specific. We also feel it is desirable to follow the same program implicitly within the presentation of each of the “applied” sections and sub-sections.

III

Outline of a Course in Introductory Statistics

Section I. Introduction—Statistics and Science.

- A. Theory and Science.
 1. Intuition or logical deduction?
 2. Regularities of relationships between events.
 3. Additions to knowledge—discrimination of differences.
 4. Theory—axioms, generality, parsimony.
 5. Creating testable hypotheses.
 6. Distinguishing general and singular propositions.
 7. Specification of formal relationships.
 8. Operations as definitions.
 9. Constructing verifiable assertions.
- B. Planning Research.
 1. The role of informal hunch, guess, or insight.
 2. “Importance” of the question posed.
 3. Flexibility and rigidity in planning.
 4. Collecting data—exigencies of time, finances, sufficient data, peripheral extras.
 5. Priority of a framework for analysis—use of adequate categories.
- C. The Place of Statistics in Research.
 1. Statements of relationship are statistical.
 2. Descriptive and analytical statistics.
 3. Types of variables.
 4. Classification.
 5. Ranking, scaling, and measurement.
- D. Statistical Generalization.
 1. Sampling.
 2. Concepts of adequacy and representativeness.
 3. Generality of propositions as determinant of sampling.
 4. Statements of degrees of association.
 5. Statements of probability—significance of association.
 6. Inference—Bayes’ theorem.

Section II. Classification.

- A. Descriptive Classification.
 1. Classes.
 2. Types.
 3. Percentages and proportions.
 4. Graphic presentation.
- B. Analytical Classification — Expressions of Association.
 1. Phi point correlation.

2. Q -coefficient of association.
 3. C , coefficient of contingency.
 4. Tetrachoric correlation.
- C. Analytical Classification — Tests of Significance.
1. Chi-square.
 2. Standard error of Q .
 3. Standard error of tetrachoric r .

Section III. Ranking.

- A. Descriptive Ranking.
1. Principles of scaling — classes to ranks.
 2. Thurstone and Likert scaling.
 3. Guttman's Scalogram analysis.
- B. Analytical Ranking—Expressions of Association.
1. Rho.
 2. Tau.
 3. W , coefficient of concordance..
- C. Analytical Ranking — Tests of Significance.
1. Standard error of rho.
 2. Standard error of tau.
 3. F -test for W .
 4. Analysis of variance by ranks.

Section IV. Measurement.

- A. Descriptive Measurement.
1. Mean.

2. Median.
 3. Mode.
 4. Standard deviation.
- B. Analytical Measurement—Expressions of Association
1. Zero-order r .
 2. Bi-serial and point bi-serial r 's.
 3. Flanagan's method.
 4. Multiple R .
 5. Partial r .
- C. Analytical Measurement — Tests of Significance.
1. Standard errors for measures of association.
 2. t -tests.
 3. Analysis of variance with R .

IV

The present report has described and outlined a plan for organizing a course in introductory statistics in a liberal arts curriculum. The organization here described is based upon an attempt to place statistics in the larger perspective of the research activity. Such a course will describe the range and applicability of modern statistical devices. It will provide the student with answers for the questions: "What can statistics do?" and "How can it do it?" It is hoped that such an explicit statement of the place of statistics in research will help to allay the anxiety of the introductory student and thus to enhance the learning process.

ELECTION OF NEW FELLOWS

At the 116th Annual Meeting of the Association in Detroit the Committee on Fellows, composed of A. Ross Eckler, Chairman, Helen Walker, Paul Olmstead, Martin R. Gainsbrugh and Churchill Eisenhart, announced that the following new Fellows had been elected:

FRANCIS J. ANSCOMBE: Formerly University Lecturer in Mathematics at Cambridge University, now Associate Professor of Mathematical Statistics at Princeton University, whose original and important contributions to the theory and practice of sequential estimation, and whose lucid exposition of the statistical principles basic to comparative experimentation, have brought worldwide recognition.

T. A. BANCROFT: Director of the Statistical Laboratory at Iowa State College, who has contributed to the application of statistical method in agriculture and biology both through his own research and through his administration of a great research center, and who has advanced the mathematical theory of statistics both through his own papers and through scholarly textual exposition of the general field.

Z. W. BIRNBAUM: Professor of Mathematics and Director of the Laboratory of Statistical Research, University of Washington, author of many important papers on statistical theory, whose original contributions to the theory of distribution-free tests have greatly accelerated the adoption of minimum-assumption techniques in statistical practice, and whose numerical tabulation of the distribution in small samples of Kolomogoroff's test function has made its use feasible in practice.

DONALD J. BOGUE: Associate Professor at the University of Chicago, and Associate Director at Scripps Foundation for Research in Population Problems, whose statistical studies have contributed much to our knowledge of the movements of people within the United States, especially to and within metropolitan areas.

LEE J. CRONBACH: Professor of Education in the University of Illinois, President of the American Psychological Association, who displays continual vigilance for the appropriate use of existing statistical techniques in education and psychology and continual zeal in pointing out areas for which no existing techniques are appropriate.

GROVER W. ENSLEY: Executive Director, Joint Economic Committee, for his leadership in a strategic position toward better and more current government statistics; for providing a public forum through annual hearings involving the presentation of statistics on the role and economic impact of government policies; also, a pioneer in the development of the nation's economic budget as an analytical tool.

LEO A. GOODMAN: Professor of Statistics and Sociology at the University of Chicago, whose publications include notable contributions in the fields of integral equations, decision theory, estimation, non-parametric tests, urbanization and ecology.

C. HORACE HAMILTON: Chairman of the Department of Rural Sociology at North Carolina State College, and former President, Rural Sociological Society, who through research and teaching has been a leader in the application of more rigorous statistical methods to the study of rural society.

PALMER O. JOHNSON: Professor of Education at the University of Minnesota, director or consultant on many research commissions, for his service in acquainting educators with statistical techniques developed in many other fields, through numerous papers in educational journals summarizing current statistical developments and through his series of three well-known texts on statistics.

ROBERT E. JOHNSON: Economist and Actuary, Western Electric Company, for the application of statistical principles and techniques to business problems; for developing programs designed to improve the level of literacy of statistical assistants in industry, and for his untiring efforts on behalf of the Association, particularly in regional and section activities.

LEO KATZ: Associate Professor of Statistics at Michigan State University, author of a number of papers on statistical and mathematical theory, who in addition has worked on statistical problems arising from the study of social groups, particularly in the analysis of personal choices.

MRS. KARIN KOCK: Director in Chief of the Central Bureau of Statistics in Sweden, for leadership, for major contributions to the improvement of government statistics in her country, and for contributions to many international conferences in the field of statistics.

PAUL F. LAZARSFELD: Chairman of the Department of Sociology at Columbia University, and Associate Director of the Bureau of Applied Social Research, for many years of outstanding service in the field of social psychology, where he has distinguished himself in the use of statistical techniques, and has gained recognition as a discerning analyst in such a currently important field as voting behavior.

ERICH LEHMANN: Professor of Statistics, University of California, distinguished former editor of the *Annals of Mathematical Statistics*, who has contributed an unusually large fund of productive ideas to the statistical theory of estimation and testing hypotheses, and particularly to the new field of non-parametric methods.

GEOFFREY H. MOORE: Associate Director of Research, National Bureau of Economic Research, internationally known for his work in the field of business cycles, and for the development of such new analytical tools as statistical indicators of revival and recession and, most recently, of measures of diffusion; also for his activity in the Association's sectional and national meetings.

CALVIN F. SCHMID: Director of the Office of Population Research at the University of Washington and Chairman of the Washington State Census Board, for his long and successful service in stimulating the use of State and local data and for his outstanding work with the Washington State Census Board.

ROBERT L. THORNDIKE: Professor of Education in Teachers College, Columbia University, eminent psychologist, who by his writing, research, and activities as president of two national associations concerned with the statistical analysis of psychological data, has exerted a potent influence on the use of statistical methods in test construction and in vocational selection and prediction.

QUESTIONS AND ANSWERS—Continued from page 18

- to *Logic and Scientific Method*,⁷ Chapter XVI, "Statistical Methods", pp. 302-322. Also of related interest in this text are Chapter XIV, "Probability and Induction," pp. 273-288, and Chapter XV, "Measurement," pp. 289-301.
- (2) M. G. Kendall, "The Statistical Approach", *Economica*, May, 1950, Vol. XVII, No. 66, pp. 127-145. (Inaugural Lecture given at London School of Economics, January 17, 1950).

- (3) Jerome B. Cohen, "Misuse of Statistics," *Journal of American Statistical Association*, December 1938, Volume 33, pp. 657-674.
- (4) Morris R. Cohen, "Statistical View of Nature," *Journal of American Statistical Association*, June 1936, Volume 31, pp. 327-346.

The foregoing references are given as suggestions. I expect that I will be criticized for some of these selections as well as for certain omissions. I would appreciate additional references and suggestions that may be used in a subsequent discussion.

⁷ (New York, Harcourt, Brace & Co., 1934), pp. 467.