STATISTICAL CONSULTANCY – A BASIS FOR TEACHING AND RESEARCH

Vic Barnett
University of Sheffield, U.K.

1. Introduction

Two fundamental questions are:

What is statistics?

Why is it so important?

There are so many possible answers - almost as many as there are statisticians. To some it is the **mathematics of uncertainty**. If statistical problems require interesting mathematical developments they are particularly rewarding. But I believe this attitude misses the real point. Statistics is a body of knowledge and technique for analysing information gathered in a real-life situation of uncertainty. It is important because it provides the means for solving such **real** problems (whether in archaeology, industry, medicine or zoology). In my personal view, stemming from the British tradition of empiricism, this emphasis is the **beginning-and-the-end** (if not the whole) of the importance of statistics, and I will be describing the implications of such a standpoint for teaching statistics. Such a real-life problem-solving stimulus makes it irrelevant to try to **isolate** the role of the consultant statistician – we must all be consultants in the sense that we see our skills as being designed to advise other workers in different practical areas of investigation. In doing so, we will solve real problems, but such problems will themselves be the source of research into new ideas and methods **and** the raw material which we use in training and educating others. Thus we see, tied up together, the role of the statistician as consultant, consultancy as the stimulus for research in statistics, and consultancy as the basis for teaching statistics.

I must re-assert that this attitude does **not** deny the importance of mathematics: which is essential for understanding and expressing statistics. Neither does it deny the relevance of specialists - the medical statistician, the biometrician, the agronomist all have important particular functions, but their basic roles are the same: to solve statistical problems, communicate their answers to non-statisticians, produce relevant new methods and to teach others to do likewise. The professional (even mathematical) statistician has just the same role! I stressed this theme of rooting statistical education in down-to-earth practical problems at the previous session of ICOTS (Barnett, 1982). It is further emphasised and illustrated elsewhere (Barnett, 1986a and 1987, are specifically concerned with statistical consulting, Barnett, 1986b, takes a broader view of the stimulus of practical problem-solving on the development of statistical method, on basic research and on statistical training).

2. Teaching Main-stream Statistics at University

In an international gathering the discussion of any topic in statistical education is difficult because of the vast differences in the scope, pattern and style in different countries. I hope that my comments are transferable but I have set them in university-level teaching of statistics on the U.K. model. Even then I am taking an extreme view – of a Statistics Department which offers a full programme of professional training in statistics at honours level over three years, with more than 500 hours of class contact in statistics. I assume that appropriate mathematical teaching is also provided, and that the department is playing a wide-ranging support role throughout the institution in service-teaching and research advice to many disciplines. This broader role, as well as external consulting work, provides a rich environment for the prime role of educating the statistical specialist. Whilst specific proposals assume this intense coverage, the **general principles** are universal: applying to even the 20 lecture introductory course for Social Scientists!

The programme of teaching I have in mind consists of a first year mix with about one-third statistics and two-thirds mathematics, then more than half the time in the second year, and most of the third year, devoted to statistics. Introductory principles and methods flow into more detailed methodological and conceptual development and extend in the final stage (with a degree of choice) into more fundamental and deeper study (e.g. of inference, probability modelling), specific methodology (e.g. design of experiments, multivariate analysis, generalised linear models, spatial methods, etc.) and diverse fields of application (e.g. for industry, medicine, etc.). The practical approach requires **at all levels** copious illustrations and practice sessions using real-life data-based problems from assorted areas of study. Regular practical work may start with intuitive emphasis and proceed through predictability: (the student has just heard of linear regression and sure enough the next practical exercise happens to require use of this technique). But in later stages the practical work rapidly (and crucially) becomes less obviously related to current lecture content until a stage is reached where no obvious method is indicated or even relevant and general scientific skills and vision become paramount. Anderson and Loynes (1986) will be detailing just what is implied by this approach. An increasing emphasis is placed on report-writing, oral presentation, subsidiary investigation, strict deadlines, proper validation and sophisticated computer usage (although care is needed on this latter topic to steer the student away from the undesirable trend to plug-in indiscriminantly to some general purpose, and often irrelevant, computer package).

Such a programme places heavy demands on the student but even heavier demands on the teacher. To effectively communicate statistics at university level, the lecturer must be able to base his teaching on real, solid, practical experience. For most this means that a consulting role is crucial and we shall explore this in some detail.

3. Statistical Consulting

Many university staff have come into statistics at an early age on the traditional pattern of a first degree in mathematics followed by a doctorate in, say, two-dimensional random walks: hardly an encouraging basis for teaching statistics from a realistic practical standpoint rooted in genuine experience! No wonder formal approaches prevail. The minimisation of practical emphasis is more often rooted in personal uncertainty and lack of contact, than on conviction.

In a review paper in 1976 (Barnett, 1976) I examined this ubiquitous role of the statistician:

> *. . . the statistician must be a translator and communicator: he needs to understand enough of other people's disciplines to appreciate their problems. He must express these in statistical terms, . . . and, most important, communicate answers in an understandable way. So it would seem that he has a somewhat wider brief than many – as a mathematician/statistician, a computer, a lay philologist (physician, nuclear physicist, you name it) and not least a communicator (this latter facility is not usually regarded as the stock in trade of the scientist). All in all he needs to be master of his own statistical trade, but Jack of many others.*

But where is this experience to come from? The stimulus of personal research on teaching is crucial – for freshness and immediacy. Consulting experience feeds research which in turn influences teaching content and style. Consulting as a basis for research has been elaborated recently (Barnett, 1986a and 1987). Here I concentrate on the consulting/teaching relationship specifically.

4. Implications of Consultancy for Teaching

There has been a remarkable trend in recent years for statistics departments to become more involved with other disciplines within the organisation, and with commercial or research organisations outside. This reflects a changing attitude to the role of university statistics in the service of others. We find this expressed through so-called Statistics Institutes or Statistical Advisory Services. It's a harsh wind that blows nobody any good! The present chill financial climate in universities throughout much of the world is further stimulating this movement. Departments are offering consultancy services (like the Sheffield Statistical Services Unit) partly as a means of maintaining financial solvency. So how does the consulting help teaching? In many ways which benefit both teacher and student:

The teacher with consulting experience

i) brings practical immediacy to teaching style and content;

ii) readily finds compelling real-life material to illustrate his lectures and to fuel practical and project sessions.

The student in a consulting environment

i) sees first-hand the way in which professional statisticians solve real problems;

ii) can begin to experience the consulting role personally.

This latter advantage can be acquired in various ways – from attendance as an observer at "clinic sessions", to minor involvement as an assistant on actual consultations to simulated experience of more detailed work in the formal course material.

5. An Illustrative Example

Unfortunately space allows only one example to be briefly considered. I shall use one of the simulated-coursework style, and set at the upper end of the spectrum of difficulty and skill.

In a final year data-based practical course the students are divided into groups of 2 to 3 and required to indulge in "role-reversal". They are the "consultants" and receive in their office (the lecturer's room) a client with a problem (the "client" is one of the lecturing staff). They have all the real-life difficulties of extracting from the (possibly not too well-organised) client what they need to know to formulate and validate a model, and to perform an appropriate analysis. They need to seek to understand the background of the problem ("how was the protein level measured?"; "is it medical experience that the levels in the blood are more reproducible than those in the urine?" – and so on). They need to extract data: as hard to extract as a tooth sometimes ("do you not have the original data rather than this scatter plot?" "why cannot we have the ages and weights as well?"). Clients may have to be called back to clarify or elaborate issues, or to give more data, at various stages of initial scrutiny or formal analysis. At the end, a detailed (but readable) report must be written and perhaps an oral presentation offered (with appropriate visual aid support). A typical basis for this type of approach is the material described in Barnett (1969).

This type of interactive consulting-based teaching is informative and stimulating both in developing technical skills and in fostering interpersonal communication characteristics. It is a highly rewarding activity for student and lecturer alike.

References

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