Consulting : Training and Teaching in the Working Environment

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1. Background

Much of the commentary below relates to consulting and to training of consultants in general. These methods and beliefs have evolved out of particular experiences which cannot be separated from the tentative conclusions, so it may perhaps help to give some background on the statistical consulting environment in the Institute of Statistics and Operations Research (ISOR) at Victoria University of Wellington (VUW).

Following the establishment of an academic post designated the "University Statistician" in 1978, a second academic position was established in 1981 to deal with the increasing workload. Both posts were recognised as academic positions but carried no formal teaching responsibilities. Instead, their function was to provide a statistical consulting service to the university research community, consisting of staff and post-graduate students in other university departments. VUW has neither a formal training programme for statistical consultants, nor formal coursework on consulting *per se* for statistics students; training is rather more on an apprenticeship basis.

Some 400 internal projects have been undertaken over the past ten years. Perhaps the most surprising aspect has been that these projects are not restricted to the sciences, or even the social sciences. There have been projects from Law, History, Librarianship, Criminology and even Classics, for example. Projects from the "hard" sciences are very much in the minority.

2. A schema for statistical consulting

In the ideal situation, both consultant and client are familiar with scientific method, and taken together are also fully conversant with all relevant subject matter

detail and the appropriate statistical techniques. The initial common ground is scientific method, in the mode of conjectures and refutations (see, for example, Popper (1969)). This common understanding of the process of discovery facilitates dialogue, expanding the interface between statistics and the particular subject matter; this communication is ideally two-way. The growth of understanding, over time, leads to the growth of knowledge. For routine statististical consultancy projects, the growth is confined to the subject matter area; for more complex projects the growth may also extend to development of new statistical methods. The relationship is between two equals, one familiar with the subject matter, the other with statistical methodology; communication extends the initial common ground of scientific method to a more extensive shared understanding of the interface between two disciplines.

So much for the ideal. The realities are often different and there are various pathologies. For example, "rubber stamp" consulting can follow from an unwillingness to communicate on the client's part, in an attempt to get a statistician's implicit agreement to a *fait accompli*. For novice researchers, even where there is a will, the basic understanding of scientific method is sometimes absent. There may also be failure to communicate about subject matter or about delineation of responsibilities (e.g. for statistical computing). As a final example, the experienced consultant to a particular discipline may know more about the particular subject matter than the student; the temptation here is for the consultant to "take over" to get the job done.

3. Internal consulting

The initial brief for the two Research Statisticians was to provide a statistical consulting service across the whole range of disciplines at VUW; this we call internal consulting.

Few organisations operate without resource constraints, and ISOR is no exception. In particular, there is no technical support within ISOR for the two Research Statisticians. This has had a number of consequences.

Even if it were desirable, it is not possible to fill the demand for statistical computing from students or staff. This is not a view we have arrived at suddenly. In the early 1980s, for example, we gave a great deal of one-to-one instruction in the IBM's operating System, CMS, and in SAS. This had a considerable benefit. Many university research workers were very grateful that someone at least was willing to help them with their statistical computing problems; the Computing Services Centre's resources were too stretched by the changeover of computing systems. From a political point of view, in terms of university-wide support for ISOR's work, there have been very real spinoffs, but the workload was not possible to sustain long term. So we had to be at some pains to indicate, particularly to faculty members, that we were not a technical service.

The students requiring consulting advice are a variable lot. They range from the highly self organising to the highly dependent. Curiously perhaps, these characteristics are not strongly related to formal statistical training. What seems much more important is an enquiring mind with a good grasp of a particular problem. We have stopped being surprised that good students with little grasp of formal mathematics are often able to provide good indications of the appropriateness of particular multivariate statistical

techniques, once they have been explained in concept; the mathematical details may be beyond them, but this is of little account.

To encourage students to learn the process of learning, we have developed a pragmatic approach to helping postgraduate students from other disciplines. What we provide is guidance in the choice and use of appropriate statistical techniques, and in their interpretation in particular contexts. We will not do students' work for them. The question at issue in postgraduate research is the extent to which the student understands the material, and possesses at least a conceptual understanding of the techniques used in analysis. It should not to be the consultant who is being assessed, when a thesis is presented by a student in a non-statistical discipline (compare Hand and Everitt (1987, p.5.))

There is another reason which makes this policy imperative. The statistical consulting service provided by ISOR has no authority to ensure that recommended techniques are followed. While we encourage supervisors to attend at least the first consulting session, we have no power to coerce. Students have been known to play off the consultant against the supervisor, either by reinterpreting the advice each gives, or by using the consultant as a "rubber stamp" once data collection and analysis are essentially complete; ideally the latter group of students would prefer to see a statistician only at a considerable distance, if possible through a telescope!

Our response to this is two-fold. Without authority there should not be responsibility. We make recommendations only. The second part of our response is to monitor how much of the advice we offer is taken by the student, and how much of the work is the student's own. We reserve the right to send to the supervisor an assessment of how well the student has coped with the statisical aspects of his/her research. This often works to the student's benefit, especially where the student is motivated and able, and the supervisor not particularly numerate, but also provides a safeguard in pathological cases.

Another benefit, which applies also to consultations with staff, is that we are able to make a clear distinction, at least in principle, between internal consulting and collaborative research. The distinction is this: internal consulting involves providing (routine) statistical advice and suggestions on statistical computing which are undertaken mainly by the client; collaborative research, in addition, involves undertaking the statistical analysis and, on occasion, developing and applying novel statistical techniques. In summary, as consultants we provide an advisory service, not a technical one.

There have been a number of administrative measures that we have instituted to avoid *de facto* responsibility for students' projects where they are enrolled in other disciplines. Frequently, we involve supervisors at the first consultation. We also provide occasional reports to the supervisor or the Head of Department at the end of the project, in which we indicate the extent of the statistical analysis, and how much of it is the student's own. These two measures, together with interim discussions with supervisors as necessary, seem to iron out most problems, without involving the consultants in the formal assessment or supervision machinery. Forming subcommittees in statistically intractable situations also helps take the heat out of what might otherwise become personality battles.

4. External consulting

The external consulting is rather variable in type. Broadly, it can be categorised into two types, on the basis of clients' statistical literacy. The first is "exploratory" consultation. The second is "well-defined packaged" research problems. The latter tend to develop in time from the former, but considerable experience in consulting rather than highly developed statistical skills are the requirement for "exploratory" work, while the balance is more in the direction of statistical skills for "well-defined" research projects. We are not attempting to compete with commercial organisations, and as a general rule we become involved in exploratory work only if we see some medium term well-defined research as the consequence. We attempt to encourage clients to assume responsibility for their own problems and for the implementation of solutions; in the end the question is not only whether we can devise a system or technique, but also whether the client understands and wants to use it.

If undue pressure is not to be put on staff and postgraduate statistics students, the essential focus of a university consulting service in statistics must be on projects which fit in with the structure of the academic year. This rather precludes involvement in purely commercial consulting projects, with their emphasis on short-term timing, even if fully commercial consulting were seen as a possible university prerogative. In fact, the major benefits of a university service, from the viewpoint of a commercial client, are the focus on the technical excellence and interest in the particular problem.

5. Involvement of graduate students

There have been two models for the active involvement of graduates in statistics in the internal consulting process.

The first of these involves a technical role, the second joint research. The technical role consists of *paid* data input and calculation of summary statistics. The purpose is not so much training as income for students; we will return to the fact that the work is paid in the comments on external consulting. We have found that for conscientious statistics students there is another advantage: by the time the data have been input and the summary statistics calculated, the student is sufficiently familiar with the data that good dialogue is often possible beween the student and the client on the one hand, and between the student and the consultant on the other. For the student, the first interchange facilitates communication skills, the second the appropriate application of statistical methods to applied problems.

The second type of student involvement is rare, both because suitable research projects with the right balance and timing are unusual, and also (and perhaps more importantly) because it requires two talented students, one in statistics and the other in some particular subject area, who are willing to learn, communicate and cooperate with each other. This cooperation need not be at PhD level. In fact, it would seem more appropriate for a one year qualification. Our most successful example involved design, analysis, and interpretation of a series of experiments on the effect of silt on scallops, a bivalve mollusc; the study involved one student studying for an Honours degree at Bachelor level in Zoology and another studying for a Postgraduate Diploma in Statistics. The topic was of interest for the commercial scallop fishery in Golden Bay/Nelson, at

the northern end of the South Island of New Zealand, because clogging of the developing scallops' gills caused by commercial dredging was seen as a possible threat to the fishery.

The nature of the external consulting work rather restricts the type of student involvement. As for internal consulting, we have two models.

The first is again the technical role, involving data input and transfer and calculation of summary statistics. Where possible the student gets to meet the client and limited interaction is possible. To some extent we have found that by being able to pay students to use their statistical and computing skills, good students have been attracted into the postgraduate programme; this is a development we are wanting to encourage.

The second model involves work on a well-defined part of a project, with some interaction with the client. This is sometimes possible even where the project as a whole is an exploratory one. An example of such a well-defined part is the pilot studies for measuring volumes and revenue from overseas mail for New Zealand Post.

The client is not always right, whether in internal or external consulting. It is important that the trainee consultant see that it is his/her professional responsibility to indicate when an analysis is inappropriate and to learn to consider declining further involvement; the statistician's role otherwise becomes purely technical. For external consulting, the lesson is that, where appropriate, the aim is to free the client from the need for continued consulting advice.

6. Further comments

Statistical consulting at VUW is not a static discipline, even in terms of the process as distinct from the projects. New computer systems both within the university and ISOR have been and are radically changing the day-to-day operation of the consulting service, with the proliferation of operating systems on mainframes and of statistical packages and programming languages on a variety of machinery. Rather than channelling the majority of clients into using SAS on an IBM4381, we are now looking at using SAS under VMS, the statistical package S-PLUS on Sun SPARC stations under UNIX, and (if we were to meet all client requests) various statistical packages for personal computers. In some sense this is where postgraduate statistics students can be a considerable aid to experienced consultants; the exchange of information on computing and statistics can be of considerable benefit to both. We are also looking at spreading the consulting (and formal teaching) load across more of the staff, now that teaching in statistics, formerly in the Mathematics Department, has been absorbed into ISOR. This will allow consultants to further develop teaching skills, while allowing teaching staff the opportunity to be involved in the rich vein of applied statistical problems that consulting provides.

Finally, we would like to bring together a number of strands under the rubric of "expert" versus "facilitator" (or "teacher"). These comments are not particular to ISOR. We think they have wider applicability.

The first of these strands is that teaching "how to do the job" seems to be an important part of almost any consulting job, whether this involves teaching the client, teaching the trainee consultant, or teaching the consultant. It is clear that consultation

must communicate both statistical methodology and particular subject matter, and since the knowledge must be shared, all have something to learn. The extent to which the consulting job is done well depends on how well relevant material is brought to the interface and developed; posturing as expert is counterproductive in most cases.

In the end the client, the trainee consultant, and the more experienced consultant, all share the same essential task, whether in an external or internal environment. We have to ensure that the best possible approach is taken to determining what the problem is, and how to solve it, in the face of the unknown. Distinguishing what is unknown to one party but not to some other, from what is known by no-one and needs research, seems to require nous, and communication (willingness to listen and share), regardless of individual levels of skill within some particular aspect of the problem.

References

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