INTRODUCTION

"Statisticians receive little or no preparation for consultancy work, either with respect to the sort of practical statistical problems that arise, or the role of consultant. This is a definite shortcoming in the education of statisticians, especially important because of their influence on the conduct of medical research."


The purpose of statistics and biostatistics programs is to provide students with a comprehensive overview of theoretical and applied statistical methods. The emphasis of each program is quite varied, ranging from very applied with little theory to very theoretical with little discussion on how those theories can be used to solve real world problems.

However, graduates of statistics and biostatistics programs who become consultants either in academic institutions or industry quickly learn that their coursework did not adequately prepare them for what they faced in their new careers. Only a handful of programs offered some type of instruction on consulting, either formally or informally, a few years ago. Today, more programs are adding instruction in the area of training consultants.

Teaching Versus Apprenticeship Program

"Consulting is a craft, an art, scarcely a science, which cannot be taught but must be learned, acquired, by a process akin to that of learning to swim, unassisted and in deep water or, for the more fortunate, a process akin to progressive apprenticeship under the guidance of a master."

C. Philip Cox (1968)

There are two basic approaches to the training of statistical consultants, (1) classroom education and (2) an apprenticeship program. Of course, a combination of the two is a possibility. Certain information that a consultant needs to be successful can be taught in the classroom. An experienced consultant can offer much good advice regarding different types of clients one will see, different types of working relationships to expect, time constraints you will work under, and communication problems that will be encountered. Some programs require coursework in biological areas to familiarize the consultant with the particular biomedical area in which he or she will be working. This information would be obtained in coursework taught by the appropriate department outside of statistics. Our discussion will center on offerings made by statistics programs.

I do not believe that classroom instruction only is enough to prepare statisticians for the consulting world. As Cox pointed out, you cannot learn to swim or ride a bike by reading a book or listening to someone explain the techniques to you. You must actually try it yourself, flounder a few times, and then ride or swim away. You must obtain the actual experience for yourself, see what works and what doesn't for you. We are all unique individuals and just as we all have our own swimming style, so we all have our own consulting style. Thus, I believe that any successful consulting program should include an apprenticeship program where the student can become involved in real consulting projects, and begin to experience the many facets of this interesting career.

An Overview of the University of Florida Apprenticeship Program

At the University of Florida, we offer both a Master's and Ph.D. degree in Statistics. Students interested in a consulting career can obtain experience by working in a consulting unit in either the agricultural or medical school, or on one of numerous grants on our campus providing statistical support. In this paper, I will outline the methods we use for training consultants in our Health Center.

Our Biostatistics Unit is funded by the Vice President for Health Affairs to provide statistical consulting services to all researchers in our Health Center. These services include discussing research design before the project begins, advising on appropriate data analysis, performing some data analysis, teaching courses on research design and statistical analysis methods, reviewing statistical portions of articles to be published in scientific journals, and assist in developing statistical components of grant applications. These services are provided to faculty, staff, and students in the colleges of Medicine, Pharmacy, Dentistry, Veterinary Medicine, Health Related Professions, and Nursing. Thus, consultants can be exposed to a wide variety of statistical projects in many different areas.

Students begin their training by sitting in on consultations between a biostatistics faculty member and a biomedical researcher. In these meetings, the student is exposed to the dialogue that occurs between statistician and researcher. We have three faculty members in the Biostatistics Unit and, hence, the student is exposed to three different approaches to statistical consulting. As the student gains experience, he or she is encouraged to participate in these discussions with either questions or suggestions. In projects requiring data analysis, the student handles this aspect of the project, after deciding on the appropriate analysis in consultation with the faculty member. Reports are written for each data analysis project and students are shown what information to include in a report. They then write the report, which the faculty member critiques. With this interaction between student and faculty member, the student soon becomes quite adept at writing statistical reports.

As the student gains experience in each consulting area, he or she is given more responsibility until becoming an independent consultant. These experienced students are usually assigned to consulting medical and other professional
students. The rate at which students progress through our training program takes from a few months to years. Some students never master the consultant skills enough that we can "turn them loose". A student's progress depends a great deal on intellectual ability, ability to "think on his feet", both verbal and written communication skills, and motivation.

Skills Needed To Become A Successful Consultant

"I have never heard complaints from clients while they are discussing their progress and ideas with a receptive, uncritical audience. If the clinical statistician first assumes the mantle of the 'receptive listener', the biologist must, in turn, be more sympathetic to the consultant's comments.

Lyon Hyams (1971)

Of course, to succeed in any area, a person must possess a certain level of intellectual ability. We shall assume that a student progressing satisfactorily through the coursework in statistics possesses the statistical knowledge for consulting. However, in my opinion, there is no correlation between intellectual standing and consulting ability. Some students with excellent academic records have been unable to master consulting while I have had some very average students, in terms of academic records, turn out to be excellent consultants. I believe the key to success is how that intellectual ability meshes with the ability to think on your feet and on communication skills.

Some students have a natural ability to synthesize information during a discussion, to store vital information and facts and forget irrelevant information. The students can form a complete picture of the project and ask appropriate questions so that he pretty well knows at the end of the consultation that all important areas have been covered. The consultant may later change his mind, for example, on the analysis to be performed but he or she has obtained enough information during the consultation to consider alternative designs or analyses. Students who sit and listen to the researcher (client) present his case and then need time to let the information sink in before giving advice or asking questions are at a disadvantage when consulting. A consultant quickly learns that he or she only gets so much time to spend with a client and must make the most of that time. Repeated appointments to clarify points and ask more questions are difficult to obtain and frustrating to the client. I believe that the ability to think on your feet is more important than native intellectual ability as a quality successful consultants must possess.

The ability to communicate effectively, both verbally and in writing, is absolutely essential to being a successful consulting statistician. The consultant must be a good listener and take in all that is being said. Likewise, he or she must be able to clearly, concisely, and correctly ask questions and present relevant statistical information. The student must learn how to interpret "Medicalese", that foreign language used by many biomedical researchers to explain the research project. Likewise, the student must learn to avoid "Statisticalese", an equally foreign language, when presenting statistical information to the researcher. I find it amazing how a light discussion on sports, weather, or family at the beginning of a consultation can put everyone at ease and improve the dialogue for both parties. Excellent written communication skills are also needed to clarify the inevitable reports that must be written for every project in which the statistician becomes involved. I believe the success a statistical consultant finds is highly correlated with his or her verbal and written communication skills.

Let us look at a few typical types of consultations that a student must learn to handle to be an effective consultant. I believe that a student can only learn about these areas by actually experiencing them in a real consulting environment.

Types of Clients

"The most frustrating relationship requests the students see are those that come from clients who insist on a child-to-parent or parent-to-child relationship."

James R. Boen (1972)

The student must learn that there are a number of types of clients. Boen (1972), Sprent (1970), and Hyams (1971) discussed different types of clients and Boen (1981) has gone into great detail on this topic in his book. Basically, clients range from wanting total control of their project, including control of statistics and the statistician, to clients who lean heavily on the statistician for leadership. The student must learn how to identity these types of clients and decide what is the best way to handle each situation. Hopefully, the student will learn that the most successful approach in consulting is that of a team, where the researcher makes decisions and leads in the biomedical context of the project, and the statistician makes the final decision and provides leadership in the statistical areas of design and analysis. A healthy and mutual respect is needed by all people involved in the project for each other.

It is important for the student to learn that a consultant must be flexible to handle the wide variety of clients and requests that will present themselves. A consultant must learn when to come on strong and when to back off. Just as there are common client stereotypes, so are there consultant stereotypes, as identified by Hyams (1971). These stereotypes will have little chance of being successful consultants. Bross (1974) philosophized on the statistician's role of a scientist or shoe clerk and made the relevant observation that "anyone who acts like a shoe clerk will end up being treated like a shoe clerk".

Research Design Concepts

We have convinced many of the researchers in our Health Center of the need for research design considerations before beginning the data collection portion of their study. Thus, re-
searchers often ask us a question regarding needed sample size, sampling techniques, implications of a non random sample, repeated measures concept, and randomization techniques. Because there are almost always practical constraints which prohibit the ideal statistical design, the statistician must discuss all reasonable alternatives with the client and choose the design that is most satisfactory from a scientific and practical standpoint.

One type of consultation frequently begins with the client saying "A friend told me that I needed a sample of size 30. I just wanted to verify that." Most studies do not need a sample of size 30, some require less and many require more. So the statistician must be prepared to handle this type of inquiry. Also, many researchers do not consider the implications of a non random sample, yet few studies have samples which are truly random. The consultant must learn to question the researcher as to how the sample will be chosen, possible biases that may occur using the chosen sampling scheme, and the implications of a biased sample.

There is a great amount of information for a statistician to discuss with a client regarding research design. Because of the unique aspects of all research projects, the necessary information cannot all be taught in a classroom setting. It can only be obtained through actual experience; hopefully, under the supervision of an experienced statistician.

Data Analysis

Students are exposed to numerous types of statistical analyses in their coursework and mastering the use of each technique is usually straightforward. Yet, the aspiring consultant quickly learns that the choice of an analysis can be quite difficult after discussing the project with the client. Consultants must learn what information to seek from the client so that a correct decision can be made regarding the statistical analysis. The consultant must learn how to elicit this information, which is not always easy because of the "Medicalese" and "Statiscalicalese" languages we sometimes use instead of the English language.

There are also compromising situations that arise which the statistician must learn to handle. One such situation occurs when the client requests a particular analysis because the client "knows the desired journal publishes this type of analysis". How does the consultant respond if he or she believes the requested analysis to be incorrect? Hopefully, the consultant will usually be able to convince the client to use the correct analysis. If you cannot, should you take a hard line stance and refuse to perform the analysis? Or give in and perform the statistical procedure requested, even if you feel it to be incorrect? There is no single, correct approach to this dilemma but if the aspiring consultant can be exposed to this situation in an apprenticeship program, he or she will be prepared to face it later on. This type of situation can develop into a direct confrontation between statistician and client. The statistician who is properly prepared to resolve this situation can gain a lot of respect (or avoid losing respect) at a critical, early point in the consulting career.

Another common situation is when the researcher is unsure of the research objective and suggests that "all comparisons be made". The unsuspecting consultant can then easily generate a computer printout three or four inches thick, just filled with one way ANOVA's or 100 x 100 tables of correlation coefficients. How can the consultant or client begin to draw the proper conclusions from all these analyses? The client would probably quickly go through the entire printout searching for significant p values and report those as "significant findings". A consultant will quickly learn the difficulties in trying to interpret a mass of results and will realize that the researcher should be encouraged to decide beforehand research objectives which are most important and statistical procedures are then carried out to answer only those objectives.

Discussion

In an apprenticeship program, a student can learn many of the traits and skills needed to be a successful consultant. Although these concepts can be taught in a classroom setting, many are subtle when occurring in practice and the student can only really learn about them by directly experiencing them. In many instances the difference between whether a consultant will be a success or failure is whether he or she has been adequately prepared to confront and handle many situations such as those presented here in a training program or whether he or she is surprised by them in "on the job" training.

Students in our apprenticeship program at the University of Florida Health Center spend anywhere from six months to four years in training and are exposed to all the situations described in this paper. By discussing each of these situations with experienced consultants, the student (1) learns about the situations, (2) observes how each situation is handled by an experienced consultant, (3) can discuss alternative techniques for handling that situation, and (4) formulates his or her own philosophy for handling this situation when it occurs in his own consulting practice.

Students completing our statistics program who have gone through our apprenticeship program generally assume a position as a consultant and feel their training has been a big help in making the transition from student to consultant a comfortable one. Even when their first job involves consulting in an area different from their apprenticeship experiences, the student sees that the problems and concerns encountered, types of clients, and philosophy for consulting, are generally the same in all areas. The key to success is that the student has been exposed to different consulting situations and is prepared for the unexpected.

I would like to make one final observation regarding the mixture of statistics and biology courses that a student should take in order to become an effective consultant. The consensus of recruiters whom I speak with prefer the stu-
dent to learn as much statistics as possible. They feel that the particular biology needed for their company can be learned on the job. Thus, our program contains no required courses in any biological area but students may take optional courses in any area they desire.

References