Statistical Consulting and the African Universities

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Abstract
This paper canvasses for the teaching of statistical consulting as a course in African Universities. Hitherto, majority of the African Universities curriculum in statistics just provides for the teaching of the act of consulting as an intern with older statistician. Since African students, learning statistics, are given little, if any, preparation for actual consulting, they are therefore prone, particularly in their early years, to commit errors of the third kind: *the error committed by giving the right answer to the wrong problem.* Many of these errors could be avoided if the students were properly trained. The paper draws the attention of students, administrators, consultants and educators to move more rapidly in filling this wide gap in statistics training/curriculum. The paper also looks at the technical and non-technical issues in statistical consulting, and proposes remedial measures to having consultants that are measured up to the herculean task of statistical consulting.

Keywords: Statistical consulting, Young Statistician, African Universities, Error of the Third Kind, Consultation skills

Introduction
Statistics is the science and the art of collection, analysis, and presentation of numerical data. Statisticians contribute to scientific inquiry by applying their mathematical and statistical knowledge to the design of surveys and experiments; the collection, processing, and analysis of data; and the interpretation of the results. Statisticians may apply their knowledge of statistical methods to a variety of subject areas, such as economics, biology, engineering, medicine, public health, psychology, marketing, education, and sports. Many economic, social, political, and military decisions cannot be made without statistical techniques. (RSS, 2005)

As a result of the much usefulness of statistics, statisticians are usually saddled with consultancy responsibility in many areas of statistics and related fields. This consultation called has a technique and procedure to be carried out to achieve a success. This know-how is not part of the statistics curriculum in majority, if not all, African universities. A young statistician is thus left in the 'cold' when confronted with the Herculean task of consulting. How to receive clients, how to communicate in non-technical terms, what to charge for a service, and even choosing a correct method in the analysis, become a problem. Because graduate students in Africa, especially in Nigeria, are given little, if any, preparation for actual consulting, they are prone, particularly in their early years, to commit errors of the third kind: *the error committed by giving the right answer to the wrong problem* (Kimball, 1957). Many of these errors could be avoided if the students were properly trained.

Statistical consulting may therefore be defined as a process of providing statistical guidance to researchers/administrators in statistics and non–statistical subject areas. The aim is to apply statistical principles and methods to the furtherance of research.

This paper, therefore, makes a case for young statisticians to be taught the art of consulting while at school as a course and not only as an intern. The rest of the paper looks at the nature of statistical consulting in section 2, Section 3 gives the need for teaching statistical consulting, Section 4 looks at the preparation, character and educational background of a good consultant, while in section 5, we look at how consulting should be taught and section 6 concludes the paper.

The Nature of Statistical Consulting

Consulting has been described "as a craft, an art, scarcely a science, which cannot be taught but must be learned, acquired, by a process …. akin to progressive apprenticeship under the guidance of a master" (Cox, 1968). As a result of this perception of statistical consulting, students are placed as interns to 'old' eminent scholars to learn this act. This has produced many successful statistical consultants without formal, specific, training in consulting. However, an important element is the direct or 'hands-on' experience that the future consultant receives. Often this is not part of classroom course content except perhaps with role playing. Marvin Zelen (1969) noted that one can be a successful researcher in theoretical statistics by giving all one's attention to a narrow topic. Even a person who is not particularly gifted will be able to make contributions by virtue of long-term contact with the same class of problems.

Watts (1970) anticipated that statistics students, through apprenticeship, would at least in part,

- learn to communicate with non-statisticians

- learn to formulate the statistical aspects of other researcher's problems

- learn to write intelligible reports

- learn to admit ignorance

- learn to consult by observing experienced consultants in operation, and more importantly, by consulting themselves.

The apprenticeship method of learning statistical consulting is really time taken to learn salient facts about statistics and the complementary disciplines. As a result of this (Cox, 1968) recommended that a course "nicely graduated in terms of complexities and subtleties" can in fact be envisaged to complement the apprenticeship process. He did not assert that such a course would turn out master consultants but he was sustained in the idea by the remark of his teacher, Woodcock, in 1937 that no educational system will defeat the best student; few systems can help the worst. We may hope, however, that much may be done for those in between.

Statistical consulting is a complex activity that requires statistical and non-statistical skills. Together, these skills determine the ultimate success of the

consultation. Zahn, et al (1983) also contributes on the non-statistical aspects of the initial meeting between statistical consultant and client and presents a model that views consulting sessions as consisting of four parts:

- identification of relevant aspects of the problem situation;

  - objectives of the experiment, hypothesis formulation and specification; experimental plan and design; execution; analysis; and interpretation and inference.

  - time constraints, other collaborators, autonomy over the use of the data, similar research conducted elsewhere, attempts that have been made to solve the current problem, and so on.

- definition of the client's goals; i.e. research questions clarification, formulation and reformulation, etc

- determination of the actions to be taken;

  - consultant perform a state-of-the-art analysis for the client

  - teaching client on how to perform the analysis himself

- discussion of various aspects of the consulting relationship and who will do what when; i.e. cost, mutual expectation, (e.g. collaborative effort that shall lead to joint publication), time to be taken, supervisor's understanding of statistics, self presentation of analysis, etc.

Each part gives rise to specific issues and requires that the consultant have various non-statistical skills to deal with these issues.

Statistical consulting as been part of the curriculum of advanced countries' universities for more than two decades now, this has resulted in the production of better statisticians. For instance, the University of North Carolina at Chapel Hill provides a dual training that includes classroom work, but also involves a 'real' practicum. (1 – credit course on the principles of statistical consulting in second year and a classroom oriented 2 – credit course on practice in statistical consulting). This is required of all students and has been part of the curricula of graduate degree programs under the supervision of a faculty member. The student interacts with research workers in the health sciences, learning to abstract the statistical aspects of

substantive problems, to provide appropriate technical assistance, and to communicate statistical results (Bangdiwala, et al. (2002)). A graduate course (STOR 765) aims to both serve the university community and to instruct students in the art of consulting, as part of the free consulting services provided by their Statistical Consulting Centre (SCC). Also a graduate course called "Statistical Consulting, Computing, and Data Analysis" at the University of Western Ontario is a professionally (as opposed to academically) oriented course that combines these three aspects of statistical practice. A case study approach is used, along with detailed discussion of a number of current projects. Thus the course has a minimal amount of fixed subject matter. During the year (two terms), each student gradually becomes involved in consulting and with a project requiring substantial data analysis, or statistical computing, or both. (Baskerville, 1981) Others worth mentioning are University of Reading, (Mead, 1976), University of Wisconsin (Watts, 1970), Oakland University, Stanford University, York University in Toronto, Florida State University, Illinois State University and Ohio State University. (Internet Sources, 2009)

The Need for Teaching Statistical Consulting
In developed countries, consulting skills may be acquired on the job, since; in general, the 'new' graduates are expected to work under the supervision of a senior statistician who may complete his/her training in actual practice. In African countries, however, this is not true. There are not enough practicing senior statisticians, universities are worst hit due to brain drain, and many times, fresh graduate will be responsible for all statistical analyses in an institution. Unfortunately, formal academic education may not be sufficient to support such responsibilities and some alternative means of providing actual consulting experience is required.

"It is depressing to find how much good biological work is in danger of being wasted through incompetent and misleading analysis of numerical results". (Yates and Healy, 1964) It is equally true today, and of fields other than biology. A lot of research efforts are either unconcluded or rejected by clients/reviewers due to inappropriate statistical analysis and interpretation. The Royal Statistical Society asserts that Biology is forecast to be the science of the 21st century. The intrinsic variability of biological systems means that statisticians have the opportunity to play a leading role in interpreting the massive quantities of molecular data now being generated in the search for the secrets of life (RSS, 2005). Hence, we need proper and adequate training for our young statisticians in order to meet up with this Herculean task.

Teaching of statistical consulting should involve methodological training as well as learning interpersonal and negotiation skills. Lack of these has prevented many potentially useful works not to be published because statistical data are insufficiently or incorrectly analyzed with the result that the important and interesting features are not brought out.

Teaching statistics to students aims to provide the next generation of professional statisticians with the necessary skills for jobs in academics, government or industry. In all these settings, statisticians are called upon to serve as consultants to other researchers, and thus the teaching of consultation skills should be an integral part of any statistical training curriculum. Students will thus be exposed to realistic statistical and scientific problems which appear in typical interactions between statisticians and other researchers. Sprent (1970) suggested seven factors which may reduce the effectiveness of consultancy. One of them is that "there is little or no training in the art of consultancy". Teaching future statisticians requires the teaching of consultation skills since the student must learn to interact with research workers, learn to abstract the statistical aspects of substantive problems, to formulate practical problems in statistical terms, to provide appropriate technical assistance, and to effectively communicate results.

Preparation, Character and Educational Background of a Good Consultant
The needs for statistical consulting services may vary in complexity and creative statistical methodology input requirements from the routine through the innovative use of known statistical theory and methods to the development of newly specialized statistical methodology. The educational background and competence in the discipline of statistics as well as the necessary personal characteristics required of an effective consulting statistician may appear too demanding. Borrowing from Daniel (1969), the preparation, character and the educational background of a good consultant should be:

- a good scientific (biology, physics, chemistry, agriculture) background, which should have been started in undergraduate days; and it should include good training in elementary mathematics (calculus, analytic geometry, algebra, and standard matrix operations), as well as some statistics and computer science.

- a man's general attitude and manner toward technical people. The more one enjoys cooperative enterprise, the more contentment he

gets from being helpful, and the less his need to be dominant, the better consultant he will be. Brashness, arrogance, and superciliousness would cost us many opportunities than client prejudices and limited statistical competence combined.

- a few years of experience in the study of real data and of real economic interdependence, preferably (but not necessarily) under the supervision of a seasoned statistician

- a good academic statistical training .

However, a good consulting statistician must be familiar with a broad range of methodology, must have a sound knowledge of theory, and must be a capable data analyst. It is believed that it is more demanding to be a consulting statistician than to be simply a researcher in statistical theory.

It should also be noted that most Ph.D.'s in statistics are expected to go into statistical research or into teaching what they have learned; but they may not be considered as the only candidates for consultancies in statistics. Although its members are hard to locate, a much larger source of potential data analysts and consultants is the group who do not hold advanced degrees in statistics but who do have the other qualifications.

How Statistical Consulting is Taught
Perusing literatures give an insight on how practitioners have been teaching statistical consulting in their institutions. Expert opinions on different strategies of training are of immediate interest. Such information provides students with some standards to which their own training can be compared and may help guide them through the maze of courses. In addition to material on consultant training in statistics, the other helping professions, particularly psychology, have substantial literature on the training of counselors. Although the objectives of various types of helping relationships differ, there are many analogies in the interpersonal domain.

Taplin (2003) believes that we should start teaching statistical consulting, early in students' studies, (after a first-year introductory statistics) before teaching statistical methodology in later years. This, she claims, motivates some students to study statistics further and provides a framework to motivate the learning of further statistical techniques. Other authors have developed resources and courses in statistical consulting. Such authors includes Watts, (1970); Boen and Zahn (1982); Hunter, (1981); Baskerville,

(1981); McCulloch, et al., (1985); Bangdiwala, et al. (2002); and Zahn and Isenberg (1983).

Mention has been made of the apprentice method and formal teaching of consulting in section 2. Others are

- employing a scheme called "statistician in residence", whereby an experienced statistician is brought in from outside the university to occupy a central position in their consultancy services. His explicit duty is to devote half of his time to the laboratory to act as senior consultant and mentor to apprentice consultants. Provision of consultancy services by the statistics department to other departments in the university

- providing free consultancy services to other departments in the university.

- requiring students to write proposals or interim reports as well as final reports on all their consulting projects. Periodic oral progress reports, as well as final oral presentations, are also required. Notice of these presentations is sent to professionals.

- reading and discussing a few papers relevant to each topic, and considering how these topics are related, bringing out the consulting part.

- provision of a statistical consulting and cooperative research service in addition to the academic teaching and research programs of a usual university department.

A Typical Synopsis
A typical synopsis, centered on case studies, may be as follows;

Introduction to statistical consulting (i.e. Historical background, the scientific method and the role of statistics; Statistical Consulting Environments (Life sciences, Behavioural sciences, Business, Government, Telecommunication, Pharmaceutical, etc); Improving Communication Skills (How to write intelligible reports, makes presentations using PowerPoint and persuasive communication); Overview of Computational tools (Statistical Computing); Review of some methodologies (if necessary); and lastly, Various Case Studies from Industries and Researchers.

Conclusion

In order to alleviate the consulting problems of young statisticians, statistical consulting should be integrated into the statistics curriculum of African universities. It should be taught as a course and not only as an intern with experienced statisticians. If this is achieved, Africa would be able to boast of consultants in statistics that are measured up to the Herculean task of consulting, and rub shoulders with so called developed nations 'experts' .

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