

## STATISTICAL CONSULTATION AS PART OF STATISTICS EDUCATION

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*The Department of Statistics at the University of Pretoria offers an internal consultation service to faculty and postgraduate students with the aim to support the research function of the University. This service offers unique training opportunities to our own students and from 2015 we are planning to incorporate training a statistical consultant as an integrated part of the course content of a capstone module. The goal is to develop students' statistical thinking and intuition, and to equip them with experience in the practice of statistics. Students will be expected to actively participate in the internal consultation service as a form of internship under supervision. Furthermore, they will have to familiarize themselves with the literature on statistical consulting and demonstrate their understanding by presenting a case study based on their experience in the consultation service. This paper will discuss the development of this initiative.*

### INTRODUCTION

Formal statistical training at tertiary level provides students with important theoretical knowledge but seldom prepares them to deal with research and industry problems, nor equip them for the often daunting task of converting information into data that can be analyzed. Students leave the university with an academic qualification but not necessarily with the fundamental skills to practice their profession. To address this problem at the University of Pretoria, a capstone module is planned which will incorporate a statistical consulting component. The aim is to educate students by teaching them essential basic consulting skills and giving them consulting experience by actively participating in the internal statistical consultation service that the Department of Statistics offers to University faculty, staff and graduate students.

### THE STATISTICAL CONSULTANT

Various definitions and have been put forward to describe the role and function of a statistical consultant. Kirk (1991) defines statistical consulting as "the collaboration of a statistician with another professional for the purpose of devising solutions to research problems". Barnett (1976) states that the function of the statistical consultant is to provide insight, through the analysis of data, on a wide-ranging set of problems from any subject area. Zahn and Isenberg (1983) reason that statistical consulting is a complex activity that requires both statistical and non-statistical skills.

Marquardt (1987) and Thabane et al. (2008) explain that a consultant must, at the very least, be skilled in the following statistical techniques: multiple regression, analysis of variance, the design of experiments, nonlinear estimation, time series analysis and contingency table analyses. The statistical skills needed to solve complex research problems however, should include over and above the above-mentioned necessary theoretical foundation, a sufficient measure of proficiency in the use of several statistical software packages, knowledge on how to design studies, as well as the ability to identify statistical procedures that are most commonly used in consulting and how to perform appropriate analyses on a variety of different data sets.

Boen and Zahn (1982) emphasize that good statistical skills must not mask the lack of non-statistical skills while Stegman (1985) argues that non-statistical skills are even more important than technical statistical skills. Many of these non-statistical skills can be regarded as personal skills which include the ability to communicate effectively with clients, the ability to listen well, as well as having a keen interest in solving statistical research problems. Cabrera and McDougall (2002) emphasize the importance of nonverbal communication techniques such as maintaining eye contact with the client. Russell (2001) added common sense as a skill that all consultants should possess.

A statistical consultant may thus be considered as a professional equipped with an excellent statistical background, great personal skills and a good dose of common sense.

## TRAINING A STATISTICAL CONSULTANT

The undergraduate statistics curriculum provides students with the basic statistical tools needed to analyze data: students are taught the most important statistical techniques, as well as trained in the use of statistical packages – mainly SAS at the University of Pretoria. However, students work with text book examples and topics are introduced sequentially. They are never exposed to a real-life situation where they are expected to determine the objectives of a research project and translate these into statistical hypotheses, nor do they ever have to decide on the appropriate analyses to answer the research questions. Training a statistical consultant will fit well into a capstone module.

### *Capstone Modules*

The website of the Macquarie University in Sydney, Australia, succinctly defines a capstone unit as “A final year unit of study in an undergraduate degree program which integrates the material presented across a major or program of study”. According to the UK Higher Education Academy, capstone modules - also known as synoptic modules - are designed to be based on student-centred learning and typically provide a link between the knowledge and skills gained during the years of academic study and the world of work. (The Higher Education Academy is an independent organization in the United Kingdom that supports higher education institutions with strategies for the development of research and evaluation to improve the learning experience for students.) These modules are becoming increasingly popular in higher education all over the world for not only do they provide an integrated overview of the key issues by bringing together contents and skills learned in previous years or modules at the end of a program, but they allow students to practice skills needed in their working life. Students, who often do not realize how core modules relate to each other, benefit from doing a capstone unit since these modules require integration of issues, knowledge and skills gained over the duration of their studies. The emphasis on critical analysis, synthesis, applying information and developing transferable skills, prepares students for life and the professional world beyond university.

### *Proposed Curriculum*

The planned fourteen week program will be scheduled during the second semester of the academic year. Allowance is made for three lectures of fifty minutes each plus one three hour practical session per week and will cover the following topics:

1. The research process.
2. Questionnaire design and experimental design.
3. Sampling methods.
4. Data collection and preparation.
5. Data analysis.
6. Statistical report writing.

Statistical consultation will be integrated into the program and will also form an integral part of the practical component of the module.

### *Statistical Skills*

By the time students majoring in Statistics reach the second half of their final year they should be well-versed in the theory and execution of the commonly used statistical techniques, including multiple regression, analysis of variance, the design of experiments, nonlinear estimation, time series analysis, contingency table analyses and distribution free methods. At this stage they should also be proficient in at least one statistical software package. It is unlikely though that they will know how to design studies or be able to always correctly identify statistical procedures that are most appropriate to address the research questions for specific data sets. This shortcoming will be addressed by allowing students to be observers during statistical consulting sessions of the Department of Statistics' internal consultation service. The service handles in excess of 350 projects per annum, hence offers ample training opportunities for students across a wide variety of disciplines across all the faculties of the university. Students will be expected to reflect and report

back on the sessions they attended to and perform basic analyses with recommendations of further analyses to demonstrate their understanding of the research problem. Prior to performing basic statistical analyses, students will have to ascertain the integrity of the data, i.e. they will have to confirm that the data are correct, within expected ranges and make recommendations with respect to missing values and/or obvious data errors. This will give them the opportunity to have hands-on experience of statistical consulting without compromising the level of professional service rendered by the department.

#### *Non-Statistical Skills*

The biggest gap in the training of our students is with regard to the non-statistical skills and one of the main drivers for this initiative. Statistical education cannot be regarded as complete and successful if the invaluable life skill of transferring academic knowledge to the workplace environment is not also adequately addressed.

Various aspects such as written and oral communication skills, statistical thinking and ethics in statistics will be covered by including scholarly articles as required reading related to the topics that are not routinely addressed in standard textbooks.

Examples are:

- The Human Side of Statistical Consulting (Boen and Zahn, 1982);
- Aspects of statistical consulting not taught by academia (Kennett & Thyregod, 2006);
- Communication in statistical consultation (Moolman, 2010);
- Written communication skills for consulting statisticians: Creating a collaborative environment with clients (Fenn Buderer, 2000);
- Statistical thinking in empirical enquiry (Wild & Pfannkuch, 1999);
- Ethics in Statistics (Medina, 2007).

Attending consulting sessions, especially the initial meeting between the consultant and the client, will teach students to ask the right questions to express the research problem in a form where statistical methods can be applied to solve the problem, which may be regarded as the starting point of the communication process (Moolman, 2010); they will also be exposed to the group dynamics of functioning as a team.

#### CONCLUSION

A capstone module designed to teach, inter alia, statistical consulting skills should address the gap between the academic environment and the real-life issues and problems students may encounter in the professional world. The emphasis of a capstone module is typically on critical analysis, synthesis, applying information and developing transferable skills, and generally focuses on learning outcomes with an emphasis on reflection and preparation for life beyond university. On completion of such a module, the student should be better positioned to function professionally and efficiently in an ever-increasing competitive environment.

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