

From **Brunelli, Lina & Cicchitelli, Giuseppe (editors). Proceedings of the First Scientific Meeting (of the IASE).** Università di Perugia (Italy), 1994. Pages 123-131. Copyright holder: University of Perugia. Permission granted by Dipartimento di Scienze Statistiche to the IASE to make this book freely available on the Internet. This pdf file is from the IASE website at <http://www.stat.auckland.nz/~iase/publications/proc1993>. Copies of the complete Proceedings are available for 10 Euros from the ISI (International Statistical Institute). See <http://isi.cbs.nl/sale-iase.htm> for details.

123

STATISTICAL EDUCATION IN DEVELOPING COUNTRIES: THE PROBLEM OF 'MARKETING' UNIVERSITY GRADUATES

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1. Introduction

The focus in this paper is on the attempts of the Statistics Department at the University of Zimbabwe (UZ) to adequately equip its graduates to become useful contributors to society. The needs of a developing country such as Zimbabwe are of primary importance; a consequence is the careful design of syllabi and course structures to be as relevant as possible. We distinguish between general trends in Africa and the particular issues faced by UZ.

It is encouraging to note that in the last decade more attention has been paid to researching aspects of statistical education in African countries. Two recent examples are Fresen and Fresen (1990) and Fresen (1992). It is imperative that developing Africa maintains itself statistically during the coming decade.

2. Historical background

The challenges and problems experienced by the Statistics Department at the University of Zimbabwe are in one sense unique and in another sense part of a pattern evident in several developing African countries. A clearer understanding of these challenges and problems may be achieved by a brief overview of general trends, similarities and differences between tertiary institutions offering statistics education in developing African countries. A comprehensive survey of all institutions has not, as yet, been conducted; the intention here is to provide a context for the subsequent discussion.

Statistics courses are offered by virtually all universities in developing Africa though in some instances it is impossible to major in the subject or

to pursue postgraduate studies. Statistics at such institutions is often seen as an area with which students should be reasonably familiar; no specialised knowledge is required, merely an ability to summarise data and perform simple inference. It is difficult to criticise this attitude, as the host country usually has more pressing needs.

The following description of a "typical" African university statistics department is a generalisation based on:

- a random sample of South African universities;
- the University of Namibia (UN);
- the National University of Lesotho (NUL);
- the University of Zimbabwe (UZ);
- the National University of Science and Technology (NUST) in Zimbabwe, as part of the Department of Applied Mathematics.
- the Anambra State University of Technology (ASUTECH) in Nigeria.

A total of seven Universities in the region were thus considered. We briefly describe below a statistics department which is as representative as possible of the above institutions.

- The institution is typically fairly new. Of the above mentioned institutions four (Vista in South Africa, UN, UZ and ASUTECH) have statistics departments which are less than ten years old. A consequence of newness is a necessary concentration on service course teaching, coupled with a difficulty in attracting staff with research interests. Offering postgraduate courses is commonly not feasible.

- In most cases statistics has been taught prior to the formation of a department by:

- a) pure or applied mathematicians with relatively limited backgrounds in statistical theory; or
- b) social scientists with interests in fairly restricted areas of statistics, such as community surveys and nonparametric statistics.

This again impacts on the ability of staff to arrange for higher studies to be pursued by students.

- In a typical Southern African university a high proportion of expatriate staff is to be expected. While this is not in itself wrong, it is clearly desirable that in the long term a majority of academic staff at such an institution should be nationals of the country in which it lies.

- At two of the institutions arrangements were in place for the sharing of teaching duties: staff of the University of Cape Town have assisted in teaching at the University of Namibia and staff of the University of Zimbabwe have given courses at NUST. This is a desirable development, but the high cost of travel inevitably leads to courses being taught intensively rather than at a more leisurely pace.

- In all institutions an encouraging development is detected: changes to school syllabi have led to a greater understanding, on the part of university entrants, of the nature of statistics. It is not as difficult to attract able students to the discipline as it was in the past. However, increasing student numbers have led to:

- difficulties in providing adequate facilities for the incorporation of computer work into the courses. Here the primary difficulty is in the provision of terminals for student use;

- increasing entry qualifications to programmes. All institutions use a school-leaving points system for entry decisions. When inadequate schooling is available the question of reliability as indicators of these points must be addressed.

Such then are the general features of a tertiary institution offering statistics courses in developing Africa. We now address as a particular case the University of Zimbabwe.

This paper is concerned with the 'Marketability' of University Graduates in Statistics, in Zimbabwe today. In order to substantiate our claims to this we first need to describe the structure and content of the university statistics programmes.

3. Production of graduates in Zimbabwe

3.1 Degree structure

The Statistics Department, University of Zimbabwe, is located in the Faculty of Science and thus our regular students, working towards BSc degrees, study science subjects. The Department accepted its first students in March 1989 and has since then produced two sets of graduates, in 1991 and 1992. Students, aged between 18-20 years, are accepted into the Statistics Department on the basis of their A-level results, where the A-level examinations are those of the University of Cambridge Examining Board, UK (Zimbabwe has been in the process of localising its O-level syllabi since independence in 1980, which localisation is now virtually complete, and hopes to move towards localisation of A-level syllabi as from 1995). Any student entering the University of Zimbabwe is required to have a minimum of two subjects passed at A-level with additional requirements for particular faculties. The Statistics Department has, up to now, required that a student is eligible for entry only if he/she has achieved a grade C in mathematics in these A-level examinations. Exceptions are often made, since the department is well aware that the schooling system is far from perfect and a student with an E in Mathematics at A-level, from a school with no mathematics teacher, is

likely to be a 'better' student than one with an A from an established, well-to-do school, with modern facilities.

A first year student takes three subjects; in the case of a student taking Statistics I he/she is also required to take Mathematics I and then takes one additional subject, viz one of physics, chemistry, biology, biochemistry, computer science, geology, or geography.

Having successfully completed first year each student, usually, continues studies in two of the three subjects, which will then form the degree majors. A course unit system has recently been introduced in the Faculty of Science, enabling students to 'pick-up' courses in other disciplines, but the overall structure remains that of two majors. A student will study these two chosen subjects through second and third year and will then have qualified for the award of a BSc degree, majoring in those two subjects.

There are various options open in each subject which will entitle the better students to pursue an honours option. For statistics the option is available to those who perform particularly well in the first year; such students are invited to join the honours programme, in which case he/she will study statistics only, as a double subject, through second and third year, and will emerge with a BSc Honours degree in statistics. This same qualification is available as a fourth year Honours degree after obtaining the BSc general degree. The department offered the Part III/IV Honours programme for the first time in 1992.

The Department will be offering a one-year Diploma in Statistics for the first time in 1994 and hopes to enrol students for the MSc programme by 1995. A post-graduate research degree, the MPhil, is currently available but is hampered by the lack of stable staff for supervisory services.

3.2 *Course content*

In the first year of study in statistics a student receives a basic grounding in theoretical and applied statistics; thus the first year courses consist of Probability I, Inference I and Applied Statistics I and II. The use of a computer package (MINITAB in our case) in practical sessions enables students to work with 'real life' data sets, using standard exploratory techniques, including non-parametric methods and introductory regression.

In the second year of study we aim to prepare a student to deal with statistics today, specifically statistics in Zimbabwe. Further theoretical work is pursued, viz Probability Theory II and Inference II. Further computing is introduced via the statistical computing course which focuses on SAS but includes introductory sessions on DOS; the use of word-

processing packages, data-bases and spreadsheets. Further statistical techniques are introduced via the course on regression analysis, including residual analysis. The relevance of Statistics in Zimbabwe today is introduced via the two courses:

- a) Social and Economic Statistics;
- b) Survey Methods.

In the first, Social and Economic Statistics, we endeavour to present an overview of micro-economics in the Zimbabwean context and an introduction to demographic techniques. Students are made aware of the importance of a governmental statistical agency, of the value of socio-economic indicators, of the uses of demographic data, etc.

In the second, Survey Methods, we require the class to conduct a survey, from beginning to end, including questionnaire design, sampling procedures, interviewing, and ethics, analysis of data collected and report writing. Topics surveyed in the past include Student Health Services, Library Use and Mis-Use, and Sports Participation. Each of these has had the student population as the study population. This year, 1993, we aim to move off campus and to interview residents in a high density suburb of Harare on matters of readership, i.e. 'What are People Reading in Zimbabwe Today?'

In the third year of study we aim to equip a student with the statistical techniques he/she is likely to need in the real world of Zimbabwe. We offer a final course in inference, focusing on distribution-free and asymptotic methods. Further statistical techniques are presented via courses in Experimental Design, Time Series Analysis and Multivariate Methods, all of which are dependent on computer usage in practical sessions and one of which requires project work to be undertaken. Students are, in addition, required to study two courses from the following four, viz Official Statistics, Operations Research, Demography and Econometrics; unfortunately not all options are available every year due to staff shortages.

At the Honours (fourth year) level, a student selects courses from a variety of topics including Stochastic Processes, Risk Theory, Biological Assay and Modelling, Statistical Ecology, further Official Statistics, further Econometrics, Industrial Quality Control and others. In addition, a project has to be undertaken and here we require that a student identifies for him/herself a topic for investigation, so seeking to promote the growth of an inquisitive, enquiring approach as a statistician. Some examples of project proposals for this year (1993) are:

- a) Modelling the Consumption Function for Rural and Urban Zimbabwe;
- b) A Study of Electrical Load Forecasting in Zimbabwe;

c) A Retrospective Study of Cardiovascular Disease Mortality in Zimbabwe;

d) The Impact of AIDS on the Economically Active Population of Zimbabwe.

Each of the above seeks to explore a topical subject and is thus relevant to the people of Zimbabwe today.

At the Diploma Level the Department seeks to upgrade a graduate with a degree in an applied subject, such as economics, psychology, agriculture, business, etc., to the Honours level so as to prepare him/her to enter the MSc programme in Statistics at a later date. Thus students here will study a variety of courses selected from the second and third years and honours programmes, each according to his/her needs. For many such students the need will be for additional theoretical courses as well as further training in techniques such as survey methods, experimental design, multivariate methods, etc.

At the Masters level we hope that a student will be able to select courses concentrated in one of two streams, viz the economic, industrial, governmental, insurance stream or the health, agricultural, environmental stream. We aim to rely on subject experts to provide relevant background material to the students while we statisticians focus on relevant techniques within the subject matter. Thus for example in a course on epidemiology we will expect medical staff to provide a subject matter basis from which we can develop relevant methods for data collection, analysis, interpretation, and dissemination. The programme will be part-time, emphasising our wish that statistics is to be used daily and thus encouraging students to work with what they learn. The second half of the programme will consist of individual research, focusing upon a relevant topic in the field of interest.

4. 'Marketability' of graduates in Zimbabwe

4.1 *Expectations from students*

Now we can move to consider the future of our students. It is not only those who graduate with a major in statistics that we consider, since the student with only first year studies in statistics is also liable to be called upon to utilise his/her knowledge. As stated previously, we aim, in the first year, to provide a solid foundation in statistical theory and techniques. Many of our students will become school teachers; our first year content well prepares them to teach statistics to A-level and, in addition, provides them with experience with real data so as to make the classroom situation relevant and exciting. Similarly, for those who will

find employment in the public and private sectors, the familiarity gained with statistical techniques of data analysis and computing prepares them adequately for applications in their field of employment.

We can consider our studies to degree level from three aspects, viz theoretical, technical and applied. The theoretical knowledge provided through the three years of study exposes students to all the well known notions of inference including non-parametric methods, sequential analysis and asymptotic methods. The technical knowledge provided covers in depth the techniques of regression, design of experiments, time series, sampling and survey methods and multivariate methods. The techniques presented, with the all-important practical computing experience, combine with the theoretical justification to equip a student to face the challenges of statistics in practice in various employment sectors.

It is in the applied courses offered that we aim to really ensure that our graduates are valued by employers in all sectors of the community. The course in social and economic statistics followed by those in econometrics and demography are aimed at a student seeking employment in the economic sector, including banking and insurance. Replacing demography by operations research aims for the commercial and industrial sectors while replacing econometrics by official statistics looks to the governmental sector. We aim to give students the confidence to develop further their basic knowledge so as to expand those particular skills required in the job situation. Their computing experience serves them well since many employers today demand computer literacy coupled with particular expertise in one or more fields. We encourage students to select the second major subjects with care and encourage them to market themselves using the complementary pair of majors as their background. Research oriented jobs in laboratories will thus become available to students with biology, chemistry or biochemistry complementing statistics. Industry will find places for those with mathematics, physics or geology as the second subject. Geography will secure a place with the development sector while computer science will very well suit the computer servicing sector.

Postgraduate studies in the department aim to enable a student to identify and pursue an area of specialisation in applied statistics. The Honours programme seeks to further develop the basic courses along the two streams mentioned previously. These students usually have no second major subject and thus we feel it is imperative that they be given a grounding in the applied area so as to equip them to adequately interpret results. Economically based studies continue with courses in stochastic processes, risk theory for potential actuarial studies, and further econometrics. Governmental applications are continued with further

official statistics while industrial uses are explored in the quality control course. Specific to agriculture, health and the environment are the bioassay and modelling and the statistical ecology courses.

The Diploma studies are aimed at the better students from other disciplines; students who have obtained a first degree in the applied area, with some statistical content, and now wish to pursue in depth the statistical aspects of their specialisation. Such students thus require theoretical and technical support and the second and third year courses adequately provide what is required. Each student is assessed on an individual basis and provided with a programme suited to his/her specific needs.

By the time a student reaches Master's level we hope that he/she has selected a stream in which to concentrate his/her studies. We hope to be able to cater for the two streams of students offering a variety of courses in the specialist areas. We hope that these students will find employment at the management level, drawing on their specialist knowledge to direct research, to restructure production procedures, etc.

4.2 *Staff participation*

Ambitious aims as we have in the Statistics Department, UZ, depend for their fulfilment on staff cooperation and staff activities. At present the Department has members of staff, on contract terms, from 6 different countries. While we have a programme of staff development which necessitates, at present, the sending of eligible Zimbabweans out of the country for further training, we will nevertheless be dependent, for some years, on employing expatriate staff. We feel students can benefit from such visiting staff in the matter of experience in, exposure to and variety of, the statistical activities of those staff from different areas of the world. We encourage staff to seek opportunities to conduct research with prospective employers in various sectors of the community. For example the past year has seen staff involvement with the Central Statistical Office in the conduct of the National Census (1992) and in the production of an Environmental Statistics Handbook for Zimbabwe, with the Ministry of the Environment in the Monitoring of the Environmental and Socio-Economic Aspects of Illegal Gold Panning in Zimbabwe, with the Ministry of Social Welfare in the Monitoring of the Social Dimensions of Adjustment within the ESAP programme, with leaders in industry in training managers in the use of the 7 tools of statistical quality control, with agriculturalists in experimental design and analysis, with health experts in the monitoring of AIDS and other epidemics and the training of health workers in this area, etc. Free advice is constantly given to members of the University who require statistical support, including

computing, in their research activities. By these activities we hope to illustrate to students the vast potential for statistical applications that awaits them on graduation.

5. Conclusion

We in the Statistics Department, University of Zimbabwe, feel we are designing a unique and innovative programme of studies for our students. In offering courses such as Official Statistics and Statistical Ecology we aim to show that developing Africa has the potential and the ability to properly prepare students for prospective employment. We have produced some 60 graduates in our short life time and thus it is too early to demonstrate that our aims and aspirations are effective. The economic recession further confounds our outlook since few employers are looking to expansion at this point in time.

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