

## TEACHING OF STATISTICS IN KENYA

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*In Kenya today statistics is taught at various levels in the education system to various degrees of coverage and sophistication. At secondary school level there are rudimentary elements of descriptive statistics and probability. In teachers colleges elements of descriptive statistics and statistical inference are taught to those taking mathematics as a major teaching subject in secondary school. In the universities, statistics is taught principally in departments of mathematics in science faculties; but statistics is also taught to students of commerce, economics sociology, education, engineering, agriculture and computer science. This paper reviews the curriculum in statistics, the teaching approaches, availability of qualified teaching staff, availability of teaching and learning resources and performance of students. Emphasis is on teaching of statistics at university level.*

### INTRODUCTION

A modern education should provide students with specific skills, such as the ability to read, write, understand the significance of human development indicators, operate a computer, and be able to carry out basic mathematical manipulations. The basic goal of education is to lead the student systematically to seek the truth. The study of statistics provides us with the means to discover the information about the state of nature that may be provided by a set of data.

The Kenyan society in general, and industry in particular today needs people with an understanding of statistics and the ability to communicate its use. New statistics curricula are beginning to focus more and more on understanding statistical concepts and interpreting results. Teaching approaches are beginning to reflect more and more the use of computers and calculators. Strong emphasis is placed on using real data, there is increased emphasis on methods of data analysis, and an overall focus on critical thinking and interpretation of results. The statistics curricula in the Kenyan university today are designed to make students better educated people with improved job marketability.

### STATISTICS EDUCATION IN KENYA TODAY

#### *School Level*

In Kenya today statistics is taught at various levels in the education system to varying degrees of coverage and sophistication. At Primary School level rudimentary elements of descriptive statistics such as averages and charts are taught. At secondary school level data summarisation by means of tables, descriptive measures of location and variation, presentation of data by means of graphs and charts, are taught. The concept of probability is also introduced at this level.

#### *Tertiary Level*

At tertiary level statistics is taught to Education College students taking mathematics as a major teaching subject. They cover elements of descriptive and inferential statistics. These are people being trained to become secondary school and primary school teachers of mathematics. Government Polytechnics normally prepare candidates for a Diploma in Applied Statistics administered by the Kenya National Examinations Council, which is the statutory body charged with administering examinations both at school and tertiary levels. The diploma course is intended to train middle level professional statisticians for employment both in the private and public sectors. The curriculum is in line with the recommendations of the Economic Commission for Africa. The syllabus covers, data collection, summarisation and presentation and analysis, probability distributions, laws of large numbers, statistical tests, confidence intervals, regression and correlation, experimental design, time series, index numbers, official statistics, statistical computing. A project in applied statistics is also required.

Tertiary colleges training middle level professionals in computer, agricultural, medical, veterinary, industrial chemistry, horticultural, forestry, and meteorological sciences teach elementary statistics: summarisation and presentation of data, regression and correlation, confidence intervals, simple statistical tests.

#### *Undergraduate Degree Level*

There are at present six public universities, wholly financed by the government. Among these, the University of Nairobi is the premier university in Kenya. All these universities offer a four-year bachelors degree program in Mathematics, that provides for majoring in Statistics in the third and fourth years of study. The basic curriculum offered in the universities is basically the same and include: summarisation and presentation of data, probability theory, distribution theory, estimation of parameters, confidence intervals, tests of hypotheses, regression analysis, multivariate methods, stochastic processes, sample survey theory and methods, analysis of experimental designs, time series analysis.

At the University of Nairobi, in addition to the above degree program, a bachelor's degree in statistics, designed to train professional statisticians has been launched. The first graduate will enter the job market in July 2002 after four years of training. This degree course has an applied orientation and in addition to the topics listed above, teaches exploratory data analysis, statistical computing, econometric methods, biometry, demography and population analysis and includes an applied project in statistics. Practical data analysis is emphasised throughout the course. One other public university in Kenya offers a bachelor's degree in applied statistics whose scope is similar to the course at Nairobi University.

#### *Postgraduate Level*

Four out of the six public universities have well-established masters programs in mathematical statistics. The major topics covered are: probability theory, stochastic processes, theory of estimation, tests of hypothesis, multivariate analysis, linear statistical models, design and analysis of experiments, theory of sampling techniques, survival models. All the programs require a project as a compulsory component of the course.

At the University of Nairobi where postgraduate training is more developed, the curriculum in statistics includes in addition to the above, Bayesian analysis, statistical computing, discrete multivariate analysis, asymptotic methods in statistics, robust statistical methods. The University of Nairobi has two other masters programs: M.Sc. in Biometry and M.Sc. in Social Statistics. The courses offered in M.Sc. in Biometry are: data collection and management, design of research studies, exploratory data analysis, survey methods, linear models, environmental statistics, spatial analysis, statistical methods in epidemiology, design of clinical experiments, agricultural experimentation, survival data analysis, biological assay techniques, quantitative genetics and bioinformatics, statistical ecology, statistical demography. There is also a course in professional issues in biometry.

The M.Sc. course in social statistics covers the following topics: data collection and management, design and analysis of surveys, linear statistical models, multivariate statistics, stochastic processes, statistical methods, survival data analysis, modelling and analysis of social data, advanced econometrics, analytic demography, analysis of categorical data, applied time series analysis, non-parametric statistical analysis, analysis of longitudinal data, computational statistics, statistics for psychosocial research, quantitative economics.

#### TEACHING APPROACHES

The teaching approach at school level is basically by means of class lessons and homework, and continuous assessment tests. At undergraduate level the teaching is via lectures, tutorials, home assignments, and continuous assessment tests. At the University of Nairobi, teaching is organised via a combination of lectures, tutorials, compulsory reading, practical sessions and home assignments. The broad aim is to give a practical training in statistical data analysis and in the use of statistical models to interpret data, using relevant examples and case studies; while at the same time providing the student with the necessary statistical methodology.

Lectures and group discussions are combined with computer practicals using real-life examples to make the learning process effective, enjoyable and useful. Practical work is done on personal computers using appropriate software. The often-used software packages are *S-PLUS*, and *GENSTAT*.

#### *Innovative Teaching Approaches*

At the University of Nairobi, efforts are being made to use technology more and more in the teaching of statistics e.g. use of power point presentations, CDroms, e-resources, computer aided self-study and computer aided instruction.

#### *Practical Training of Students*

In most universities the teaching of statistics stops at the academic level. At the university of Nairobi, there is increasing inclination towards professional training of statisticians. The practical training of students is achieved through vocational attachments to statistical organisations and research organisations and also through practical data analysis projects based on real life case studies. The students are also trained in communication and consultancy skills.

### PERFORMANCE OF STUDENTS

The majority of students enrolling in the first year of undergraduate degree courses in statistics will have scored at least a B grade in mathematics at Secondary School Certificate Examination (12 years).

They are required to take courses in calculus, analysis, linear algebra in addition to statistics courses during their course of studies. In the first two years the class sizes tend to be quite large ( $\geq 180$ ). In the last two years of the 4-year program the numbers thin down to an average class size of 60. Performance is generally only average. The majority (60%) obtain the C grade (50-59%). A few (20%) score B (60-69%) and above. Less than 10% fail (score below grade D (40-49%). The smaller classes perform better.

At the University of Nairobi, the B.Sc. (Statistics) degree program still enrolls only a small number of students (30) due to resource limitations. The program is just in its third year of operation and the performance so far is quite good. About 60% of the students would normally score an average of grade B and above. Of course, the students admitted to this professional degree course are selected with higher grades. All the students are required to have at least B grade in mathematics at secondary school examination.

#### *Improving quality of delivery and student performance*

Several approaches are being tried to improve the quality of delivery and student performance. These include:

- Organising group activities that increase the understanding and interest through active student participation.
- Tutorial assignments are designed to reinforce learning and extend conceptual understanding.
- Departments are encouraged to prepare course teaching guides.
- Use of real data to motivate concepts and methods.
- Prepare real data sets for use with relevant statistical software.
- Give data analysis projects using the real data sets to provide practice in exploring data and use of statistical techniques to interpret data.
- Prepare instruction manuals for students
- Encourage self-study.
- Have designated group discussion sessions.

### TEACHING STAFF

At secondary school teachers are normally holders of a B.Sc. degree with mathematics as a major subject or B.Ed. degree with mathematics as a major teaching subject. There is generally

a shortage of science and mathematics teachers in the country, but in urban schools, the problem is not as great.

At college level the majority of lecturers have a Masters degree in statistics. B.Sc. or B.Ed. graduates with mathematics or statistics as a major subject also teach in colleges. At university level the minimum requirement is a Masters degree in statistics. At Nairobi University for example, there are 20 lecturers in statistics, of whom 10 have Ph.D in Statistics. The rest are Ph.D candidates. The other universities have fewer lecturers in statistics, but the ratio of Ph.D holders to M.Sc. holders is comparable to that at Nairobi. In addition there is an active interaction between the universities by way of part-time or adjunct lecturerships.

The relatively small core of statistics lecturers available in our universities today are strained for they are usually called upon to teach statistics in other universities different from their own. The University of Nairobi over the years has trained many people both at Masters and PhD levels, but these efforts are frustrated by the flight of our lecturers to other universities outside the country. The rate of increase in the number of universities in the country (private & public) has also not been in tune with the rate at which M.Sc. or Ph.D graduates in statistics are produced. This is compounded by the fact that, due to deterioration in economic growth, the number of government or donor scholarships for postgraduate training has drastically reduced.

#### TEACHING AND LEARNING FACILITIES

The most important constraints experienced by all the public universities in Kenya are inadequate availability of appropriate books and journals, and computing equipment and software. Many departments in our public universities who teach statistics may have single copies of some recommended textbooks, but library subscriptions are almost non-existent. Due to the high cost of the books students are usually not able to acquire their own copies of the recommended textbooks. Current issues of journals are virtually non-existent.

Many of our universities are beginning to have access to computers, but access to suitable statistical software is still a big problem. In these universities access to the internet is still limited and not yet integrated into the teaching or research process.

At Nairobi University concerted efforts have been made to establish a *Mathematics Reference Library*. With the help of organisations such German Science Foundation and Rockefeller Foundation, this library now boasts of more than 200 titles of important books in probability and statistics.

The Department of Mathematics at the University of Nairobi has also established a *Statistical Computing Laboratory*, with Pentium III 20 - GB Computers all linked via a LAN to the Central University Computing facility. The Laboratory which has its own server has full access to the internet. The main statistical software for teaching and research is *S-PLUS*. The other software that are used are: *GENSTAT*, *STATA*, *MATLAB*, *MINITAB*.

#### *Sharing of Learning and Teaching Resources*

In June 2001 Kenyan Universities launched an *Inter-University Network* whose goal is to promote quality education and research in mathematics and computer science in Kenyan schools, colleges and universities. The centre for the activities of this Network is the *National Resource Centre* whose functions include:

- Coordinating sharing learning and teaching resources
- Organising courses for continuing professional development of teachers and lecturers.
- Serving as an advisory centre for teachers and lecturers.
- Coordinating exchange of lecturers and students.
- The Centre when fully operational will have a library and a computing laboratory to service member institutions. It will also have an *Educational Services Unit* to coordinate distance and continuing education courses.

The main idea is to pool the available resources and work out ways for optimal and efficient utilisation of the resources. In this way problems associated with shortage of books and

journals, shortage of specialised staff, computers and software, access to the internet, will be reduced.

#### CONCLUSION

The teaching of statistics in Kenya is fast responding to global trends. The curriculum is beginning to be more and more responsive to the demand in the job market. The teaching approaches are beginning to reflect the latest technological advances.

To manage the disturbing problems of shortage of suitably qualified staff, inadequate teaching and learning resources, the universities in Kenya have resolved to pool and share the resources available in the individual universities. This approach, it is believed will lead to homegrown solutions to problems afflicting mathematics education in general and statistics education in particular.