some primary school programmes such as the Comprehensive School Mathematics Programme developed by CEMREL, Inc., For a long time to come it does not appear that pocket calculators can be sold cheaply enough for every secondary school child in Nigeria to be able to buy one.* The use of the computer for statistical work is not within reach of many developing countries.

A committee could be set up to look into the needs of developing countries for the production of teaching aids. Apart from the television, films and film-strips will also be found useful for the teaching of statistics but they have to be carefully produced.

10.3.4 *The curriculum*

Most developed countries are experimenting and improving their curricula all the time. Unfortunately there is not enough experimentation going on in Nigeria. Experiments in developing new curricula do take time and are expensive. It is not often that developing countries can divert much-needed funds to experimentation. Some of the well tested programmes on the teaching of statistics may be adopted for use in selected areas in developing countries.

10.3.5 *Need for visiting lecturers*

There is need for specialist lecturers who can generate interest in the teaching of statistics to pay periodic visits to developing countries to help out with various statistical programmes – be it the training of teachers, or of other users of statistics. Even at the University level there is an acute shortage of statisticians to run courses in the Universities. Help is therefore needed also at the University level. One way to do this is for Universities in developing countries to enter into agreements with Universities in developed countries whereby Professors can go to Universities in developing countries for short periods to help in building up strong departments of statistics. Universities in developed countries might also offer places to students from developing countries to train.

* Since this report was prepared pocket calculators have become easily available in Nigeria. For ₦ 10 or ₦ 15 it is possible to buy a simple calculator.

CHAPTER 11

Statistical Education in Schools in Uganda and Other East African States

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11.1 HISTORICAL BACKGROUND

Formal education was introduced in Uganda about 90 years ago by the Christian missionaries and later by the colonial administration. Education then was of a rudimentary nature and consisted largely of learning how to read, write, simple arithmetic, English grammar, Swahili, hygiene, and religious education. It was also designed primarily for sons (and later daughters) of local Kings and Chiefs, and schools were segregated according to religion. Thus when time came – about 1915 – to move a step forward and formalize the educational system into primary, secondary and technical sectors, the few Church of England secondary schools which emerged then, and for about 40 years to follow, were modelled on the lines of English public schools like Eton and Harrow. The Roman Catholic ones were modelled along the lines of the country of origin of the missionaries – France or Italy. Not surprisingly, therefore, when Makerere University was established in Kampala as a College for Higher Learning in East and Central Africa in 1922, it was also done along the lines of Oxford/Cambridge (Oxbridge). The essential point that emerges, therefore, is that up to the late fifties, the educational system of Uganda and other East African states was closely linked with that of English institutions. The University of Cambridge did the final examining for secondary schools (awarding the well-known O-level and A-level certificates) and the (then) Makerere College operated as a College of the University of London. This point has a direct bearing on the current state of the teaching of statistics in schools in this region as we shall see below.

Just before independence – at the end of the fifties – the then colonial administration saw it fit to depart from the Christian-missionary-dominated Eton-type schools and start Government-owned schools where formalism and classics were pruned down to a bare minimum and emphasis was put more on experimentation and innovation. However, before long these schools, too, were 'sucked' into the stream as they had to conform to standards dictated by the O-level examining body, namely the Examinations Syndicate of the University of Cambridge.

Four things happened after independence in all the three East African states:

(i) schools were desegregated so that pupils could cross the boundaries of religion in (up to then) largely missionary schools;

(ii) educational structure was reformed as we shall discuss in the next section;

(iii) an East African Examinations Council was set up to administer the equivalent of O-level and A-level examinations (in place of the University of Cambridge);

(iv) the (now defunct) University of East Africa consisting of Makerere University College, University College of Nairobi, University College of Dar es Salaam (all formerly affiliated to the University of London) was established.

Although this may look like the onset of independence in education, the syllabuses and syllabus content both in schools and Universities continued to be guided by former affiliations, although with American interaction certain subjects – especially those related to the Social Sciences – became very quickly established typically at University level.

The University of East Africa was dissolved in 1970 with the three constituent Colleges emerging as full-fledged Universities on their own. The East African Examinations Council still functions. Statistics was not taught at University level until 1968 (at Makerere first, followed by Dar-es-Salaam and later on Nairobi). Schools started offering statistics as an A-level subject (details are given in § 11.4 below) at about the same time. The half-heartedly reformed educatinal system operates now more or less as it did around the beginning of the 1960s.

11.2 THE EDUCATIONAL SYSTEM

The educational system operating in East Africa is on the following lines:

Stage	*Approximate Age* on Entry*	*Duration in Calender Years*
Pre-Primary	3–4	3–4
↓		
Primary	6–8	7
↓		
Secondary	13–15	4
↓		
Higher Secondary (or Vocational Training Colleges)	17–19	2 (3)
↓		
University (1st degree) (or Vocational Training Colleges)	19–21	3–5

* The approximate ages apply to children from middle class families only. In general, children from lower class families enter the school system at older ages. Nor do such children benefit from Pre-Primary education.

After the Pre-Primary stage, every pupil must do a public examination in order to move from one stage to the next. It is important to note that, in contrast with some countries, e.g. UK, the educational system in East African states is highly centralized and perhaps over-controlled by the Government. It is also greatly subsidized by the Government from public funds. All public examinations (except University examinations) are set and marked by the East African Examinations Council which is directly controlled by the Government(s). Admissions to various schools at all stages are also done centrally. The same Council is also responsible for drawing up all recognized syllabuses for all schools and some vocational colleges. (An extreme example is that the Government of Uganda does not recognize secretarial qualifications other than those administered by the Examinations Council – with very few exceptions like Pitmans of London). Although the Government of Uganda set up a Curriculum Development Centre (about ten years ago) to reform syllabuses, this body has achieved very little. Indeed, at one stage it looked as if this body was on a collision course with the Examinations Council. The Ministry of Education runs the whole educational sytem without check or balance.

Part of the problem of introducing new subjects like statistics meaningfully into school curricula is that education is, and continues to be, very expensive and its direct benefits go only to a privileged few. For instance, in Uganda only about 10 per cent of the primary-school-going-aged children get admitted to Primary One due to limited facilities. Of these, only about 60 per cent (viz. 6 per cent of those 'globally' eligible) to go to secondary school. Only about 40 per cent (viz. between 2–3 per cent of the 'globally' eligible) go on to the Higher Secondary stage. Barely 1 per cent of the globally eligible obtain access to University education. With such dismal figures, Governments are more readily persuaded to expand *existing* facilities to cater for larger percentages of the population than to experiment with new ideas for the same limited numbers.

11.3 TEACHER TRAINING

There is no doubt that one of the key issues in curriculum reform is the availability of suitable teachers. In the case of (imaginative) introduction of statistics in schools, this problem is a recondite task in Uganda. Currently, statistics is only taught at Higher Secondary Schools (as one of the A-level subjects). The teachers are basically mathematicians. Many of them have never done statistics themselves. What is more, it is taught as part of mathematics. A recommendation has been made by us to the Government to extend the teaching of statistics lower down the ranks to Secondary Schools and later to Primary Schools. Apart from the money, the main problem is teachers.

Apart from Pre-Primary or Kindergarten teachers, there are basically three groups of trained school teachers in Uganda. The *first* are the primary teachers who receive their training for three years at one of the many Teacher Training Colleges in the country after O-level. These are selected from amongst those

who 'fail' to continue to Higher Secondary School to do A-levels. Since English and Mathematics are compulsory subjects at O-level a typical candidate for a Primary Teacher Training College is likely to have a pass slip reading as follows:

Subject	*Grade*
English	Credit (4 or 5)
Mathematics	Pass (8) *or* Fail (9)
History	Credit (3 or 4)
Geography	Credit (3 or 4)
Physics-with-Chemistry	Credit (4 or 5)
Biology	Credit (4 or 5)
Religious Knowledge	Credit (5 or 6)
English Literature	Credit (5 or 6)

Thus most primary-level teachers wind up where they are because they are poor at mathematics. There is a real problem here. After O-level, successful candidates select three subjects for A-level either in the 'Arts Stream' *or* in the 'Science Stream'. The more successful ones obtain (competitive) entry to the University. A section of the unsuccessful ones go to Teacher Training Colleges (for 2 years) to train as teachers for the lower classes in Secondary Schools. It might look on the surface that such teachers (the *second* group), or some of them, would be well suited to introduce statistics in Secondary Schools, but this is hardly so as only a very small cross-section of O-level holders opt to do mathematics beyond that level. However, some beginning could be made, especially if such teachers could obtain refresher courses in the teaching of statistics.

The *third* group of teachers in Uganda are the University products – who are meant for the higher classes at Secondary Schools and for Higher Secondary Schools. These should be able to teach statistics at those levels except that – as aforementioned – they do it from the mathematical approach only. Some of them do it on a 'read-it-up' basis even.

Historically, teacher training has been a mixed affair. What we have described here is current and has been in force for about 15 years only. Some of the old teachers – especially at Primary Teaching level – are very much less qualified and by and large beyond repair in so far as assisting with the introduction of new subjects such as statistics is concerned.

11.4 STATISTICS AS TAUGHT

In Uganda and other East African states, statistics is taught only as an A-level subject. It is taught as part of mathematics. As mentioned before, after O-level, successful candidates opt for 3 subjects – so-called Principal Subjects. Candidates must offer at least one subject at a lower level of scope and depth – a so-called Subsidiary Subject. A General Paper – dwelling on liberal studies, etc. – is compulsory as a subsidiary subject for everybody at A-level.

At A-level, Mathematics is offered as follows:

(a)	Pure Mathematics (Old)	Principal Subject
(b)	Applied Mathematics (Old)	Principal Subject
(c)	Mathematics (Alternative S)	Principal Subject
(d)	Further Mathematics (Alternative S)	Principal Subject
(e)	Subsidiary Mathematics	Subsidiary Subject
(f)	Subsidiary Mathematics (Alternative S)	Subsidiary Subject

The scheme is that (a) and (b) must be taken together. Candidates may choose (c) only *or* (c) and (d) but (c) is a prerequisite for (d). Statistics appears only in the syllabuses for 'Alternative S' Mathematics which are relatively more modern. (a), (c) and (e) are a hangover from the old A-level syllabuses of the Examinations of the University of Cambridge and contain no statistics. Candidates, therefore, have the choice of doing the 'old' type Mathematics or the relatively modern 'Alternative S' to which most schools are now switching.

From the syllabuses (see the Appendix), it is clear that the current statistics syllabuses in mathematics are rather mathematical – leaving out very many and interesting aspects of applied statistics. This imbalance needs to be redressed. It is rather surprising, therefore, that when the Examinations Council saw it appropriate (relatively more recently) to introduce statistics as a Principal Subject at A-level (again see the Appendix) no effort was made to introduce applied statistics into the syllabus. Reform is required here.

But even greater reform is required to ensure that a larger part of the educated populace acquires some kind of *informed numeracy*. By leaving the teaching of statistics at A-level, as an option *or* part of Mathematics for which very few opt, one is denying future generations the ability to read data critically – which deficiency surely must catch up with them in their working life-time.

11.5 CONCLUDING REMARKS

Thus, due to the slow pace of reform in a post-colonial experience, the teaching of statistics in schools in East Africa is still in its infancy (if born at all). Four problems seem to dominate the scene:

(i) lack of suitable teachers;
(ii) lack of suitable curriculum;
(iii) lack of suitable textbooks and other source materials, but most importantly,
(iv) lack of conviction and will to change on the part of the decision-makers.

Much, therefore, remains to be done to bring the message of the need for recognition of quantitative methods and data-based study to all the people – as a Government objective – just like literacy.

APPENDIX *Statistics in A-level Mathematics and Statistics Syllabuses*

(Annotated extracts from the published syllabuses of the East African Examinations Council, published with the permission of the Council.)

MATHEMATICAL SUBJECTS

NOTES

1. At PRINCIPAL SUBJECT level, there will be the following subjects:

(a) P410 Mathematics Syllabus A. This subject may not be taken with any other mathematical subjects. [– Includes Statistics]
(b) P420 Pure Mathematics. This subject may not be taken with subjects 840, 869, 874. [– No Statistics]
(c) P430 Applied Mathematics. This subject may not be taken with subjects 840, 869 and 874. [– No Statistics]
(d) P470 Statistics. This subject may not be taken with subjects 840, 869 and 874. [– Contains Statistics (100 per cent)]
(e) P440 Mathematics Alts. S. This subject may not be taken with subjects 840, 842, 844 and 846. [– Includes Statistics]
(f) P460 Further Mathematics Alt. S. This subject may not be taken with subjects 840, 842, 844, 846. [– Includes Statistics]

At Subsidiary level there will be the following subjects:

(g) S471 SUBSIDIARY MATHEMATICS. This subject may be taken with any other subject in the mathematics group. [– Contains some Statistics]
(h) S476 SUBSIDIARY MATHEMATICS ALT. S. This subject may not be taken with any other subject in the Mathematics group. [– Includes Statistics]

2. Candidates who fail in both Pure Mathematics and Applied Mathematics or in both Pure Mathematics and Statistics will be considered for an award in the subject Mathematics (840). The highest award for such candidates will be Grade D in Mathematics.

3. Candidates will be provided with a formulae sheet for use in the examination. Mathematical tables will also be supplied.

4. S. I. Units will be used exclusively in all question papers. In compound units, where necessary, negative index notation will be used, e.g., acceleration in metres per second per second will be written m s^{-2}, not m/s^2.

P410 MATHEMATICS SYLLABUS A (Principal Subject)

Scheme of Papers

For EAACE Mathematics Syllabus A (Principal Subject) there will be two

papers. Candidates must not give up answers to more than eight questions in either paper, and will be required to reach a satisfactory standard in both the pure and applied (and/or statistics) part of the subject. Successful candidates will be certified as having passed in Mathematics (EAACE Principal Subject).

Mathematics 1 (3 hours). Pure Mathematics (11 questions).

Mathematics 2 (3 hours). The paper will be divided into two sections.

Section 1 will contain 7 questions on Mechanics and 7 questions on Statistics. Section 2 will contain 4 questions on Pure Mathematics. Candidates may not answer more than 2 questions from Section 2.

Note: In the detailed syllabus below, the 'pure' topics printed in roman type will be examined in Paper 1, and the 'pure' topics printed in *italic* type will be examined in Paper 2. It will be appreciated, however, that certain overlaps may occur, and the division is intended for guidance only. It is expected that the syllabus will be treated as a whole.

. . . .

P440 MATHEMATICS ALTERNATIVE S (Principal Subject)

AIMS

EACE and EAACE Mathematics (Alternative S)

The aims of all syllabuses in this series of subjects are essentially the same, varying only in depth and emphasis to take account of the differing ages, aptitudes and abilities of the candidates for whom they are intended.

These aims are as follows:

1. To encourage an attitude of clear thinking and logical thought.
2. To provide an understanding of basic mathematical concepts.
3. To develop an ability to use and construct mathematical models of physical situations.

so that the student will be capable of

(a) developing his mathematics to the limits of his ability;
(b) applying his mathematics with confidence to unfamiliar real problems i.e. having a positive attitude to problem solving;
(c) being trained in such specialised mathematical techniques as may be required for his further education and/or vocation;
(d) appreciating, as far as is possible, the satisfaction and enjoyment that may be gained from pursuing the subject for its own sake.

Introduction

A knowledge of the work in EACE Subject No. 461 Mathematics Alternatives S is assumed.

Candidates should be able to express physical situations in mathematical symbols and to use their judgement as to the degree of accuracy appropriate to any particular problem.

. . . .

Compulsory component on Statistics in P440.

9. Probability and Statistics
   Scope and limitation of statistics.
   Frequency distributions, histograms, cumulative frequency.
   Mean, median, mode, quartiles, percentiles.
   Variance and standard deviation in the case of discrete and continuous distributions.
   Elementary permutations and combinations.
   Introduction to probability: 'a priori' and frequency interpretations of probability.
10. Numerical Calculations
   Precision and accuracy. Limited accuracy of physical data.
   Propagation of errors.
   The use of table of functions. Linear interpolation.
   Rounding and truncation errors.

Statistics
(The questions set will test appreciation of method, use of method, and inference rather than mere mechanical calculation.)

Frequency interpretation of probability. Sample and population. Average and expectation. Mean and median. Variance and standard deviation.

Laws of probability (including conditional probability). Binomial distribution.

Continuous distributions. Frequency and cumulative frequency (distribution) functions. Normal distribution, including use of tables.

Presentation of statistical data. Sampling distributions. Properties of a good estimate. Interval estimation (e.g. confidence limits in small samples). Significance testing. (Proof of the formula $\sigma/\sqrt{n}$ will not be required.)

Quality control by means and ranges. Two-sample and paired sample t-tests. Ideas of Association. Rank correlation (preferably Kendall's).

P470 STATISTICS (Principal Subject)

Scheme of Papers

For EAACE Statistics (Principal Subject) there will be two papers. Candidates must not give up answers to more than eight questions in either paper. Successful candidates will be certified as having passed in Statistics (EAACE Principal Subject).

Statistics 1 (3 hours) (10 questions)
Statistics 2 (3 hours) (10 questions)
Attention is drawn to the statement concerning units on page 42, Section 4.

Detailed Syllabus

Statistics 1
Frequency interpretation of probability. Sample and population. Average and

expectation. Mean and median. Variance and standard deviation.

Laws of probability, including conditional probability.

Discrete distributions; binomial, Poisson. Probability generating function.

Continuous distributions. Frequency and cumulative frequency (distribution) functions. Normal distribution, including use of tables.

Bivariate distributions. Product-moment correlation.

Statistics 2
Presentation of statistical data. Sampling distributions. Properties of a good estimate. Interval estimation (e.g. confidence limits for small samples). Significance testing. (Proof of the formula $\sigma/\sqrt{n}$ will not be required.)

Two-sample and paired sample t-tests.

Least squares. Simple analysis of variance.

Ideas of association. Contingency tables. Linear regression. Rank correlation.

χ^2 tests of goodness of fit.

Simple experimental design and survey methods.

Optional component on Statistics in P440.

This section (B) has *five* optional topics. Two out of five must be selected. A large percentage of candidates choose Statistics.

Section B
11. Probability and Statistics
   Probability and finite sample space, mutually exclusive and independent events; union and intersection of sets of events and corresponding probabilities.
   Addition and multiplication laws of probability.
   Conditional probability.
   Expectation: expected values, calculated for discrete and mathematically defined continuous distributions.
   The binomial distribution: its mean and variance.
   Knowledge of normal and rectangular distributions, confidence limits.
   Use of related tables in simple examples.

P460 FURTHER MATHEMATICS ALTERNATIVE S

Compulsory component on Statistics

Section A
1. Statistics
   Expectation and expected values, calculated for discrete and mathematically defined continuous distributions.
   The binomial distribution, its mean and variance.
   Knowledge of normal and rectangular distributions, confidence limits.
   Use of related tables in simple examples.

Optional component on Statistics. Many candidates choose the Statistics in Section B.

Section B (Two Options should be studied)

6. Statistics
   Poisson probability function.
   Simple Markov chains. (No queuing theory).
   Estimation of population parameters from sample statistics.
   Significance tests for discrete and simple continuous distributions.
   Student *t*-test. Sampling methods. Chi-squared test for goodness of fit, simple contingency tables and use of Chi-squared distribution.
   Coefficient of rank correlation (preferably Kendall's).

S471 SUBSIDIARY MATHEMATICS

Statistics component (has now been introduced also as an optional element in an O-level syllabus)

Statistics

(Credit will be given for the choice and use of appropriate methods and for valid deductions from results, as well as for the ability to carry out mechanical processes. Proofs will not be required).

The tabulation and appropriate representation of numerical data: choice of class intervals.

Measures of central tendency: mean, median and mode. Percentiles. Measures of dispersion: interquartile range and standard deviation. Use of assumed mean.

Moving averages.

Index numbers.

The sum and product laws of probability. Expectation.

Discrete variable. Simple probability and frequency distributions, particularly the binomial distribution and its mean and standard deviation.

General ideas of sampling and surveys. Estimation of the limits of a mean of a population from a large sample.

Scatter diagrams. General ideas of correlation. Calculation of a rank correlation coefficient (preferably Kendall's).

S476 SUBSIDIARY MATHEMATICS ALTERNATIVE S

Statistics in Section A.

5. General ideas of sampling and surveys. Histogram.	Problems arising in the collection of data; precautions against bias, including unequal class intervals.

Statistics in Section B.

9. Use of the binomial distribution. Moving averages. Calculation and interpretation of standard deviation. Simple applications of the normal distribution, and use of the relevant tables. Kendall's rank correlation coefficient and its interpretation.	Including s.d. from grouped data; lengthy arithmetic will be avoided. Formulae for mean and s.d. to be given, together with percentages for i s.d. 2 s.d. etc.

. . . .

11. Matrices applied to probability and topology.	
12. Systematic approach to combinatorial problems. Scheduling problems.	Examples: polyominoes, routes through a network. Examples: duty rotas, timetables, competitions.