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AN INVESTIGATION INTO THE PERFORMANCE OF FIRST YEAR STUDENTS IN MATHEMATICS AND STATISTICS AT A SOUTH AFRICAN UNIVERSITY

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1. Introduction

Statistics departments, and indeed universities, in South Africa are at present in a considerable state of flux. If one examines the state of tertiary education in South Africa (S.A. henceforth) ten years ago the changes are evident to even a casual observer. Although for many years the traditionally liberal campuses have defied apartheid legislation in formulating admission policies, it is a fairly recent phenomenon that universities such as Natal, Cape Town, Rhodes and Witwatersrand have clearly stated their intention (often as a Mission Statement) to make both the student body and the staff correspond as closely as possible to the community in which each university finds itself. This has resulted in a long overdue change in the type of applicants for entrance, and in particular to Statistics courses, that these bodies receive. In Natal the position is exacerbated by the large number of school education departments that issue matriculation certificates to school leavers; these are meant to allow the individual to enter a university without further examination. The proliferation of such departments is a glaring legacy of apartheid and their incorporation into a single education department appears certain under a new political dispensation. During 1991 and 1992 the Statistics & Biometry Dept. at the University of Natal admitted students from: Natal Education Dept.; Department of Education and Training; KwaZulu Education Dept.; Joint Matriculation Board; House of Representatives; House of Delegates; Cape,Transvaal and Orange Free State Education Dept.'s; as well as a large number of "homeland" departments, such as Ciskei, Transkei, Venda, Bophutatswana and adjoining states, in particular Zimbabwe.

What are the consequences of these facts to admission policies? Several South African universities have recently adopted a system whereby affirmative action is implemented. White students who have enjoyed a privileged and trouble free education, along with the so-called Indian and

Coloured students, are treated on the basis of points achieved. Black students, who have often experienced disruptions to their schooling such as burnings, loss of teachers, disruption of home life, are assessed on the basis of "potential to succeed" as evaluated by experts. Nevertheless, the "points system" is often used by faculties and departments to make recommendations to students on which courses to pursue.

2. The "points system"

Students who write matriculation examinations under any education body are awarded points according to which mark was achieved at a particular grade. Scoring is as follows:

	A	B	C	D	E	F
Higher grade:	8	7	6	5	4	3
Standard grade:	6	5	4	3	2	1

Marks below an F do not contribute to a student's score.

A decision on the suitability of a student for a particular course is then commonly based on points achieved, either total (for six subjects), Mathematics or English. It should be stressed that although black students are not formally subjected to a points evaluation for entry into university the points that such a student achieves in a subject are nonetheless informally considered in deciding whether or not a student should be admitted to a given course in Mathematics or Statistics. This practice is subjected to scrutiny in this paper.

3. The sample

Students considered here were registered during 1991 and 1992 at the University of Natal for courses in Mathematics (QM110) and Statistics (QM120). Although some students did one course only, attention is restricted to those who did both. Student numbers were roughly 500 in each course. Two outliers were rejected from the sample: the first was a student who had been without a teacher for over a year after the closure of his school; the second was a mature student who had matriculated in 1963 under quite different conditions. It could be argued that these anomalies occur in the correct proportions and should thus be included in the analysis. It is not thought that this would greatly affect the conclusions below. For the sake of brevity only the 1992 data are analysed below, but results were very similar for 1991.

4. A look at the data

During 1992 students registered for the courses concerned belonged to four faculties: Arts, Social Science, Agriculture and Commerce. They can thus be considered as representing a fair cross section of the student community, although due to degree requirements the majority were Commerce students.

It was felt relevant to consider the following variables: Matric marks for both Mathematics and English (as language competence was thought to be a possible factor in a student's understanding of lecture material), QM110 mark at university, QM120 mark and a mean of QM110 and QM120 reflecting general success in Mathematical/Statistical subjects. This mark is called QM henceforth.

Let us examine as a preliminary step in the analysis the distribution of marks achieved for QM110 and QM120 and the QM mark indicative of overall performance. These are shown below as Figures 1 and 2.

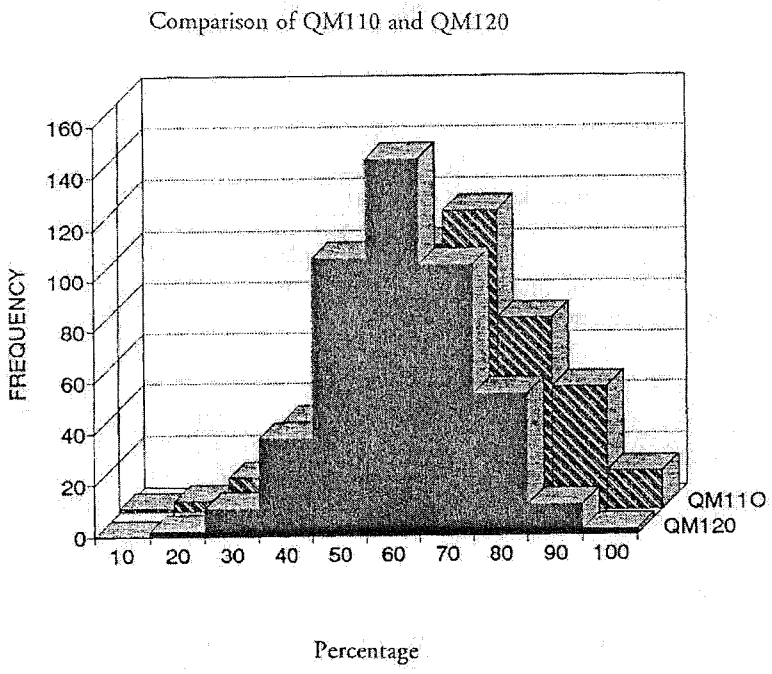

Figure 1. *Histogram of QM marks*

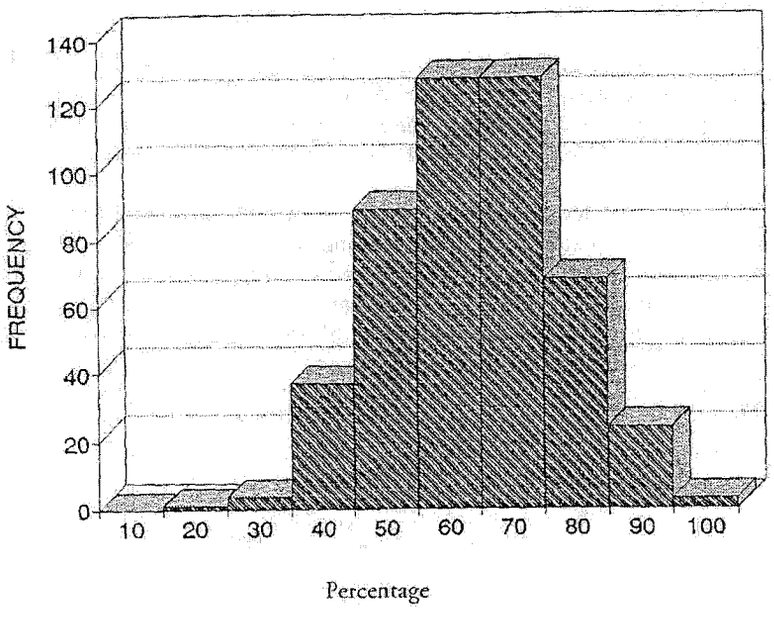

Figure 2

There is a slight skewness evident in the distributions; also it is evident that students fared somewhat less well in Statistics (QM120) than they did in Mathematics (QM110). The sample size was 415 after excluding students who for one reason or another were not doing both courses. Summary statistics are shown below:

	QM110	QM120	QM
Mean:	61.66	56.48	59.07
Median:	62	56	59

	MATRIC MATHS	MATRIC ENGLISH
Mean:	5.49	5.89
Median:	5	6

Correlation of QM110 with QM120 = 0.68 ($P<0.001$)
Correlation of QM with Matric Maths = 0.62 ($P<0.001$). Correlation of QM with Matric English = 0.21 ($0.01<P<0.05$) (all on 413 d.f.).

It should be noted that the pass mark is officially 50% although students scoring 49% are inevitably passed.

We now turn to the usefulness or otherwise of the points scored by a student in Maths or English at Matric level in predicting the mark of such a student in university courses in Maths and Statistics.

5. The models

Some of the analysis below constituted part of a scheme in which promising students at the University of Natal are financially rewarded for involving themselves in the solution of statistical consultation work related to their syllabi. Such work is carried out during university vacations and is supervised by a member of staff. In this paper the analysis is thus restricted to fitting straightforward linear models of the type where the expected QM mark is expressed as a linear function of one or more independent variables with unknown parameters.

6. Data analysis

As an initial step it was decided to keep things simple and thus to focus only on Matric points for the two subjects as independent variables, therefore ignoring grade (Higher or Standard) and all interactions, as well as education authority under which a student matriculated. The preliminary analysis is summarised below:

a) Only Matric Maths as X

CONSTANT	22.9266
SE OF Y EST	10.4252
R SQUARED	0.3799
X COEFF	6.5872
SE OF COEFF	0.4141

b) Only Matric English as X

CONSTANT	41.2692
SE OF Y EST	12.9370
R SQUARED	0.0450
X COEFF	3.0186
SE OF COEFF	0.6840

c) Maths as X1 and English as X2

CONSTANT	18.2788	
SE OF Y EST	10.4025	
R SQUARED	0.3841	
X COEFF'S	6.4143	0.9487
SE OF COEFF'S	0.4260	0.5669

It is a little surprising that Matric English appears to be of so little value in predicting university marks in the areas of Mathematics and

Statistics. The Matric Maths mark seems to perform in a similar fashion to the results reported by Fresen (1990).

It was now thought desirable to extend the analysis to incorporate other factors into the analysis. These included in particular the grade (H or S) on which each student wrote his/her Matric examination as a factor in the analysis. A variety of models was also fitted incorporating interactions. The highest R squared value achieved was for the model incorporating points for both subjects, grades for both subjects and interactions; it is however interesting to note that this model achieved an R squared value of only 0.418, thus very little better than the simple one based on Matric Maths alone.

Multivariate analysis by principal components in order to examine the effect of "department" under which a student matriculated was not highly successful owing to the large sample size. Research on this topic continues.

An attempt to obtain the conditional distributions university marks for QM (on Matric points achieved) was carried out. The results closely correspond to those of Fresen (1992) at the University of the Western Cape and are not reproduced here for reasons of space. Details and data sets are available on request to the author.

7. Some Conclusions

The results obtained in this study for 1992 were very similar to those for 1991, and are extraordinarily similar to those obtained at the University of Cape Town, the University of the Western Cape and the University of the Witwatersrand (Fresen, 1992). There is reason to recommend that Matric marks and points should be treated with considerable scepticism in the context of South African education at present. The predictive value of such marks/points for two fundamental subjects (English and Mathematics) is clearly low. It is to be hoped that recommendations for course or faculty entrance will not in future be based on such predictors; this will become more and more important as South Africa's turbulent education systems coalesce and develop, along with the creation of a new political dispensation.

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