An Investigation into the Performance of First Year, First Entry Students in Information Systems and Technology in Relation to their Matriculation Results

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Abstract

*While much work has been published on the relationship between school leaving results and the success at various first year University courses, not much literature is available on the correlation between school leaving results and first year Information Systems and Technology (IS&T) courses at University. This exploratory study attempts to correlate the performance, as opposed to the potential for success, in first year IS&T, of matriculants in Mathematics, English First Language and Zulu First Language with their first year IS&T results. Additionally, the study explores whether any relationships exist on a racial and gender basis between these matriculation results and first year University IS&T performance. Only first entry students for the first examination are considered, that is, repeat students and those sitting supplementary examinations are not considered. With the exception of the African race group, which showed no mathematics*IS&T correlation, all other race groups showed a positive correlation, however in all cases the IST*first language correlation was found to be greater than the IST*mathematics correlation.*

Research Background

Merger and National Policy

The Council for Higher Education (CHE) report (Department of Education, 2001), makes reference to " ….. attempts to engage with a number of implementation challenges and issues currently facing those who design, teach and administer academic programmes" (p. 107). The goals of the National Plan for Higher Education relate to issues of accountability of funds and, the effectiveness, efficiency and quality of academic programmes. Additionally, the report indicates "….. targets for the size and shape of the system in terms of growth and participation rates, graduation rates, procedures for planned institutional programme mixes and equity and research goals" (Department of Education, 2001, page 42). The recommendations of the CHE create obvious impacts on the planning and progression principles of all tertiary institutions in general and to Faculties and Schools in particular.

There is increasing pressure to effect change and to accommodate the requirements as set out by the Department of Education (DoE). In its *National Plan* the DoE explicitly states that the participation rate of 15% of the 20-24 year old cohort is too low. While it proposes a growth rate figure of at least 20% in the next 10-15 years, it recognises " ….. the chronic mismatch in output from the schooling system and the entry requirements of higher education", (Department of Education, 2001, page 109). This problem is further amplified when one considers the following statistics from the SAQA Report.

In 1999 only 12% of all Grade 12 candidates who offered the Senior Certificate qualified for entry to universities. When one includes the high drop-out factor, the percentage drops to 6%. A closer consideration of that cohort of students indicates that an even smaller percentage (indicated by DoE as less than 2%) of learners had Mathematics (either at functional, standard or higher grade) within their qualifying subject package (*SAQA FETC Policy Document*, April, 2001, page 11). Likewise, the DoE

noted that in 2000, less than 20 000 school-leavers obtained a Higher Grade Senior Certificate pass in Mathematics (*National Plan*, 2001, page 20).

While it is widely recognized that the Senior Certificate examinations are problematic and do not always provide a reliable basis upon which to base our University entrance requirements, this is currently all that is available. Whilst SAQA is against the imposition of an additional overlay (or coarse sieve) on the proposed FETC, SAQA nevertheless recognises the right of individual higher education institutions, granted in the *Higher Education Act*, to impose additional entry requirements at the level of particular programmes on condition that these are publicly and transparently stated (Department of Education, Dec 2001). This appears to be not yet widely implemented at tertiary institutions in South Africa, and in particular at the University of KwaZulu-Natal (UKZN). The success of such programs remains the subject of an alternate discussion. In the interim, an investigation into the reasons for and causes of failure of students, in particular African students was conducted at UKZN by Professor Hugh Africa (Africa, 2005) in March-April 2005.

UKZN and the Africa Report

The Africa-Report (Africa, 2005) was initiated and supported by both the student body and the University executive. It presents findings into the reasons for failure particularly of African students and then proceeds to recommend steps that should be taken to create a new University that recognises past shortcomings and adopts and entrenches policies and practices that are consistent with its future image, vision and mission. The study (Africa, 2005) was conducted University wide, encompassing a number of faculties and schools. Perhaps one of the major prompting factors was that the African student population increased by 42.6% from 2000 – 2004. Given the population size, the consequences to the University of a high failure rate amongst the African population group are self evident.

Rather than a single outstanding reason, the report cited a mixture of a variety of reasons as contributory factors for the abnormally high failure rate. The major reasons for this high failure rate are, according to the Africa report (Africa, 2005), a combination of, personal, financial, institutional, attitudinal, racial and academic reasons.

Significant among the variety of recommendations to the University Council was the issue of language. The report recommended that measures be introduced to ensure that language does not constitute a barrier to successful learning. It further recommended that all students entering UKZN should undergo a language test to determine their ability and capacity to pursue academic studies. In support of the recommendations, the report advocated that provision must be made to offer support to those students whose language competencies required improvement. Interestingly our research found that language, in particular English as a first language, surpassed most other success performance indicators for the Information Systems and Technology Course.

In this paper we are not just interested in whether a student passes or fails. Instead we try to predict how well a student passes or fails. That is, we try to determine whether there is an indicator that can predict the grade that a student will obtain in first year IS&T?

UKZN and the School of Information Systems & Technology

Whereas the Africa study was very broad-ranging, its recommendations affecting the very fabric of the University, this study attempts to determine factors related to the matriculation criteria that could be used to correlate performance of students in the first year of study of Information Systems and Technology (IS&T). By this it is hoped that better guidance may be provided to prospective students and that the pass rate for IS&T courses would be accordingly improved. Additionally, it was felt that high school students intending to major in technology courses may be guided as to their choice and emphasis placed upon courses chosen at school for entry to the matriculation examinations.

This study correlates the performance of first year, first entry student's matriculation results in each of English First Language, Zulu First Language and Mathematics with their first year IS&T results. We have also considered a composite variable derived from the matriculation scores for all languages attempted (the language grade average or LGA). Additionally, the study explores whether any relationship exists on a gender and race basis.

The sample considers only students whose first languages are English or Zulu (in most cases Zulu first language students are English second language students) and correlate these high school results with that obtained for IS&T. The history of the South African education system, based as it was on racial criteria, has necessitated a detailed statistical analysis along racial and gender lines. We are of the opinion that the inequities of this system have still not filtered out and continue to seriously advantage, and disadvantage, students on a racial basis. Interventions that attempt to address these inequalities have to be carefully designed to take these historical factors into account.

Presented below is a brief summary of prior research relevant to our study.

Prior Research

In a recent paper by Rauchas et al (2006), the authors show that high school first language results correlate better with University results than do the high school mathematics results. Like Rauchas et al (2006) we consider other languages but concentrate on Zulu and English specifically and define what we call the language grade average (LGA) to accommodate all languages attempted by the student in Grade 12.

Barton and Neville-Barton, (n.d.) carried out a study that determined whether general English language competency was sufficient for mathematical learning. Their study was based on the fact that educational institutions in New Zealand were increasingly accepting foreign students who were second language English speakers, that is, their primary language was not the same as the language of instruction. They investigate whether students with English as a second language perform differently in mathematics from students with English as a first language. They determined that mathematics is not "language free" (page 8) and that second language English speakers are disadvantaged in their first year mathematics course.

While South Africa does not have significant numbers of immigrant students this situation clearly obtains also in South Africa because of the historical context of its educational system and consequently the question of whether IS&T is "language free" is significant.

On the other hand, Campbell and McCabe (1984) studied the statistical relationship between a student's entrance characteristics and his or her success in the first year of a computer science major and have found that students who major in the sciences differ from those who left computer science for other degrees. These differences were related to the student's background in mathematics and science. While they concluded that gender is not an achievement indicator, it consistently appeared as a variable in their classification models. They state that the observed gender related difference in persistence may reflect a reaction to the demands of the major subject. While similar results are not presented here, this is a subject of ongoing research as we follow the 2005 IS&T cohort through the University system.

Kruck and Lending (2003) describe a model to predict academic performance in an introductory college-level information systems course. Their hypothesis that the model for academic performance will not be affected by the individual's gender was not supported. Kruck and Lending's results are supported by Casey (n.d). The preliminary results from this study (tables 6 – 10) seem to indicate otherwise. This is a matter for ongoing investigation.

A study similar to this one has been detailed by Golding and McNamarah (2005). In their paper they

investigated the existence of relationships between students' personal attributes and other factors, and their performance in the School of Computing and Information Technology at the University of Technology, Jamaica. They found, as we have, that mathematics is a weak predictor of performance in IT.

While we do not discuss our results correlating Grade 12 computer studies courses to IS&T scores our results do indicate, as also shown by Butcher and Muth (1985), that exposure to computer courses in high school did not influence performance in the introductory computer science course. Our analysis is due for publication at a later stage.

Limitations of the Study

The study did not take into account whether the student has a standard or higher grade pass in matric. We did not consider this to be important in the first approximation since entry requirements into the faculty automatically cater for different grades of pass in the University exemption examinations.

Not considered also are the cases where the first language is neither English nor Zulu. A small number of our sample offered Afrikaans and other African dialects as well as German and Chinese as a first language. We did not consider the size of this sample set to be sufficiently large to be meaningful.

Methodology and Analysis

We obtained the first semester examination results of first entry IS&T students from all three campuses of the University of KwaZulu-Natal that offered the course. Using this student list we obtained their matriculation results. All analysis was performed initially using Microsoft Excel®, Microsoft Visual Basic®, Microsoft Access® (to clean up the data) and once we had the data in the required format this was loaded into SPSS® for the statistical analysis. P-values where quoted, have been converted to a percentage. The characteristics of the final data set are reflected below:

Table 1: Race and Gender

	Frequency	Female	Male
AFRICAN	320	179	141
COLOURED	25	11	14
INDIAN	701	390	311
WHITE	137	49	88
OTHER	1	1	0
Total	1184	630	554

Table 2: Matriculation Mathematics Results

		Total	Mean	Median	Std. Deviation
African	All	273	65.3114	64.0000	16.28498
	Male	120	66.9250	66.0000	17.37242
	Female	153	64.0458	63.0000	15.31740
Coloured	All	23	69.4783	70.0000	14.63765
	Male	12	68.2500	67.0000	13.96180
	Female	11	70.8182	70.0000	15.91112
Indian	All	665	69.8406	71.0000	13.60673
	Male	298	70.4698	71.0000	13.35077
	Female	367	69.3297	71.0000	13.80812
White	All	120	71.7167	75.0000	14.55398
	Male	77	71.1558	74.0000	14.14313
	Female	43	72.7209	77.0000	15.38138

Table 3: Matriculation English First Language Results

		Total	Mean	Median	Std. Deviation
African	All	131	65.60331	65.0000	8.87666
	Male	41	64.7561	65.0000	9.65604
	Female	90	65.9889	66.0000	8.52688
Coloured	All	21	68.5238	69.0000	8.77849
	Male	11	67.0909	66.0000	7.93038
	Female	10	70.1000	70.5000	9.80306
Indian	All	656	72.6768	72.0000	8.36217
	Male	291	69.9828	70.0000	7.67327
	Female	365	74.8247	74.0000	8.27594
White	All	117	75.9915	76.0000	7.98220
	Male	76	74.5789	73.0000	8.17845
	Female	41	78.6098	79.0000	6.96735

Table 4: Matriculation Zulu First Language Results

		Total	Mean	Median	Std. Deviation
African	All	148	72.1419	73.0000	8.36498
	Male	82	70.7561	71.0000	9.06160
	Female	66	73.8636	74.0000	7.10555

In the following table we enumerate the results for our sample in terms of their grade average for all the languages (LGA) that they have attempted in their matriculation year. As in all the cases in our study we do not distinguish, in this first analysis, between the standard and higher grade results. We have assigned the following weightings: A • 1, B • 2, C • 3, D • 4, E (and lower) • 5, where we understand that these numbers arbitrarily refer to the middle of the range, so 1 is 90%, which means for example that a mean of 2.5 implies a mark of approximately 70%.

Table 5: Language Grade Average (LGA)

		Total	Mean	Median	Std. Deviation
African	All	320	2.7256	2.5000	1.00851
	Male	141	2.9305	3.0000	1.09714
	Female	179	2.5642	2.5000	0.90365
Coloured	All	25	2.3400	2.0000	0.95438
	Male	14	2.6786	2.5000	1.04894
	Female	11	1.9091	1.5000	0.62523
Indian	All	701	2.1006	2.0000	0.89655
	Male	311	2.3810	2.5000	0.91510
	Female	390	1.8769	1.5000	0.81612
White	All	137	1.9818	2.0000	0.89231
	Male	88	2.1284	2.0000	0.89404
	Female	49	1.7184	1.5000	0.83483

Table 6: IST scores

		Total	Mean	Median	Std. Deviation
African	All	320	51.0469	50.0000	13.65246
	Male	141	52.3972	51.0000	13.99637
	Female	179	49.9832	50.0000	13.31826
Coloured	All	25	62.7200	62.0000	13.64893
	Male	14	63.7857	62.5000	11.35564
	Female	11	61.3636	58.0000	16.60887
Indian	All	701	63.0271	63.0000	11.72680
	Male	311	65.6013	65.0000	11.16396
	Female	390	60.9744	60.0000	11.77354
White	All	137	69.7883	69.0000	12.01986
	Male	88	69.9545	69.0000	12.02670
	Female	49	69.4898	70.0000	12.12628

The overall statistics do not provide us with any detailed understanding of the relationship between the various categories in respect of the IS&T scores. To obtain some measure of such a relationship we performed a cross tabulation and Pearson R correlation for the various category scores with the IS&T score. The results are tabulated below. For ease of comprehension all values have been converted into integers by multiplying by 100 and rounding.

Table 7: Correlations, White

White	IST*Eng	IST*Math	IST*LGA
All	60	40	60
Male	61	36	60
Female	56	49	69

Table 8: Correlations, Indian

Indian	IST*Eng	IST*Math	IST*LGA
All	38	40	33
Male	46	36	37
Female	48	43	43

Table 9: Correlations, Coloured

Coloured	IST*Eng	IST*Math	IST*LGA
All	60	51	43
Male	46	14	56
Female	80	80	57

Table 10: Correlations, African

African	IST*Eng	IST*Math	IST*LGA	IST*Zulu
All	46	0	35	18
Male	56	-1	40	7
Female	44	-1	34	45

Discussion of Results

For the White racial group, (table 7) the results are consistent with those found in other similar studies that are not racially categorized, in that the correlations between the IS&T scores and English scores are significantly higher than the corresponding correlation with Mathematics, even when considered on a gender basis. We consider the language correlations strong, with a score of 60, while the Mathematics correlations with a score of 40, we consider to be weak.

If we define the ratio of the correlation between IST*Eng and IST*Math to be the cor-ratio (ratio of correlations) then we have

Table 11: Ratio of correlations

Race	Cor-ratio
African	•
Coloured	1.18
Indian	0.95
White	1.5

The infinite value for the African race group arises because of the 0 correlation value that we have obtained for IST*Math. In other cases a higher value indicates a stronger correlation between IST*Eng than IST*Math.

Interestingly, for the Coloured students, there is a clear difference between Males and Females in that while there is effectively no correlation between Math and IS&T for Males (14), there is a strong correlation for Females (80). However, we view these results with caution as the Coloured student sample set was small.

In the case of African students we have found that while there is a stronger correlation between IS&T and English, all other correlations are weak (see table 10). There is effectively no correlation between the Mathematics results in grade 12 and the first year IS&T results. In the Faculty of Management Studies, with minor exceptions, a higher grade pass in mathematics is required for entry. However, our results show that we should not use these results to make any conclusions at all, especially for the African students. The anomalous situation between the male and female scores for the IST*Zulu correlations are puzzling and require further investigation.

The LGA score was calculated using all languages, including other first languages such as Afrikaans, Chinese, German, and a small number of indigenous South African languages apart from Zulu. This explains why in some cases the IST*LGA correlations were equal to or greater than the IST*Eng score.

It is interesting to compare the pass rates in IS&T of African students who chose Zulu as a first language and who chose English as a first language. Of the 160 students who attempted Zulu as a first language only 37% passed IS&T at their first attempt and of the 141 students who chose English as their first language 74% passed IS&T at the first attempt. The results are represented below:

Table 12: African Students – First Language

	English	Zulu
Mean	57.0780	45.8000
Median	55.0000	45.0000
Std. Deviation	13.50136	11.56812
Percent Pass	74%	37%

While this is a significant result, it requires further analysis. We have not factored into this analysis the different schools from which our students come. This result may well be attributable to the school from which the student originated. It is natural to assume that most of the schools that offer Zulu as a first language will be ex-Department of Education and Training Schools which have yet to shed the yoke of Bantustan education. We believe that what has long been perceived as a language bias is in fact a systemic bias. We hope to demonstrate this in a companion paper to be published soon.

Conclusion

Like Rauchas et al (2006) have shown for computer science we have shown that language is also an important predictor of performance levels in IS&T. However it is clear from our analysis that it is a significant predictor of performance only for the White race group. However if we consider success, as opposed to performance, we have shown that for African students that English as a first language is significant. In fact we have shown that African students who attempt English as a first language in Grade 12 have twice the likelihood of passing IS&T than African students who do not (table 12). We have clearly shown, in table 12, that IS&T is not language free.

As has been shown in other studies, Mathematics is not a good predictor of success in IS&T at University, we have furthermore shown that Mathematics is not even a good predictor of the IS&T scores for any students irrespective of race group. For the African race group, Mathematics may not be used to draw any conclusions whatsoever. In fact the requirement of Mathematics as a matriculation subject for this race group is questionable. Clearly the total absence of any correlation between the matriculation Mathematics results and the IS&T results may indicate the need for directed and specific interventions for African students. Too often, generic interventions of the "one size fits all" variety are implemented at Universities with limited success. Our results indicate that if Universities want to make meaningful interventions to improve student pass rates in IS&T then they need to be tailor-made to accommodate different student backgrounds.

While our results do not categorically exclude the language of instruction as a contributing factor to our conclusions it would be instructive to carry out a similar study in which the students' first language and language of instruction are different from English, for example, Afrikaans. However, as has been shown by Barton and Neville-Barton (n.d) that skill in English, in an English medium institution is not sufficient and that students' also require technical language skills.

The multi-level stratification (gender, race, school, examination grade) of our data set at school and University implies that we should be performing a more detailed statistical analysis than that carried out here. We are convinced that the preliminary results that we have found may be refined to provide us with a much clearer picture of the relationship that exists between school leaving results and University IS&T results. A similar exploratory analysis may also be carried out for other first level University subjects. Once all the data is available it is our intention to subject this data to a multi-level analysis (Bell, 2003) and in doing so obtain a more detailed picture which we believe will have strong predictive value.

Ongoing Research

Current research directions being investigated are:

- Extending the investigation to access environmental factors, especially those relating to private and ex-model C schools.
- An investigation into the contribution of standard and higher grade matriculation passes.
- To determine whether there is a "flattening out" of environmental factors upon entrance to University

- To determine whether the exists a gender bias in relation to students' performance in relation to their matriculation performance

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