Analysis of factors influencing first year University Undergraduate performance in selected pure Mathematics courses at the National University of Science and Technology – Zimbabwe

Kudakwashe Hove & Amon Masache and Sarudzai Showa*
University of Namibia & National University of Science and Technology - Zimbabwe

Abstract:
In 2012, the National University of Science and Technology (NUST) in Zimbabwe reviewed the University qualification entry cut-off points downwards in the Applied Mathematics Department. Following the review, there has been a worrisome and distinct change in student performance in first year mathematics courses. To explore the possible causes of the poor performance amongst students, a two-stage probability sampling technique was used to collect secondary data covering mainly admission entry level qualification for each student. A one-way Sir Ronald Fisher's Analysis of Variance model (ANOVA) was used to explore the contribution of various hypothesised factors to performance in first year undergraduate courses. Mathematics grade at advance level and overall performance in all subjects done at Advanced level by a student have a significant influence on his or her first year pure Mathematics courses performance at NUST. We recommend that the Department should employ remedial strategies to first year pure Mathematics courses if students with low scores in advance level mathematics are to be admitted. Instead of focusing on service courses with large classes only, the Department should prioritise allocating extra tutorial hours to pure Mathematics courses. Furthermore the effects of brain drain can- not be ignored, hence the University should find ways to curb or deal with the gap that the highly experienced staff who left, created.

1. Introduction

It can be argued that there is a perceived decline in the abilities and preparedness of students entering the National University of Science and Technology (NUST student records, 2012). Such a decline in performance is noticeable especially when investigating students' competences in Pure Mathematics courses like Calculus, Linear Algebra and Discrete Mathematics, which are offered at first year. The performance of first year students doing Mathematics Degree programmes (Bachelor of Science in Applied Mathematics Honours Degree and Bachelor of Science in Operations Research

* **Kudakwashe Hove** is a Statistics Lecturer at the University of Namibia, Ogongo Campus.
Amon Masache is a Senior Lecturer in the Department of Statistics and Operations Research at the National University of Science and Technology (NUST) - Zimbabwe.
Sarudzai Showa is a Research Fellow in the Department of Applied Mathematics at the National University of Science and Technology (NUST) - Zimbabwe.

and Statistics Honours Degree) is a cause for concern. As a result, there is a growing interest among researchers in exploring the reasons for the decline in first year students' performance in pure Mathematics and how it relates to students' high school Mathematics performance. Researchers like Kun (2007), noted that many high school students admitted for college-level studies might not have developed the habits of the mind and heart that will act as a good foundation to successfully grapple with more intellectually challenging tasks.

The University through the Department of Applied Mathematics noted (from summary statistical records on admission from the Department of Admissions and students records, 2011-2012) that very few high school students from the surrounding provinces that is, Matabeleland South and Matabeleland North were enrolling for Mathematics programmes offered by the Department. The Department of Applied Mathematics went back to the communities through an enrichment programme called the National University of Science and Technology Schools Enrichment Programme (NUSTSEP) in an attempt to improve Mathematics Performance of students at Advanced level. The driving hypothesis for the founders of the enrichment programme was the belief that low enrolment numbers in mathematics related programmes of study are due to poor performance in Mathematics at high school. NUSTSEP founders and coordinators felt that, what was lacking was probably the preparedness for the Mathematics courses of those who qualified for University level (Hove, press communication). In the current work thus, we focus on the students already qualified for University entry and have actually been admitted but reflecting poor performances in Pure mathematics courses. This observation on abilities and preparedness of students leads to the following questions: Is high school Mathematics performance (school leaving symbol) contributing to decline in performance in first year Pure Mathematics courses? Would advanced ("A") level serve as a more effective predictor to first pure Mathematics performance? Is the number of points at "A" level contributing to first year Pure Mathematics performance? Would the number of points at "A" level serve as a more effective predictor to first pure Mathematics performance?

1.1 Background

The introduction of a multi-currency system in the country economy saw most universities increasing their enrolment capacities. NUST was not spared from this up siege. This has caused the Applied Mathematics Department, which used to take an average of 15 students per year, to increase its enrolment to 60 students The Department offers Calculus, Linear Algebra and Discrete Mathematics in a single first semester as introductory courses to the Applied Mathematics degree undergraduate programme. Calculus and Linear Algebra are also offered as service courses to the Departments of

Physics and Computer Science). Widening the enrolment spectrum entails offering places to high school students with very low points, some with as low as three points. Though, the general regulation stipulates that any students with two “A” level passes is eligible for university, it does not seem to be appropriate for Applied Mathematics Degree programmes. Good mathematics background is perceived to make a better applied mathematics prospective student.

It is observed that ever since the enrolment increment, first year students’ performance in Pure Mathematics performance has been on a declining trend, especially Discrete Mathematics. The Department used to have a cut- off point for admission before the 2012 review, that is, a minimum of 7 “A” level points for boys and a minimum of 6 “A” level points for girls. Now, with this widened enrolment, the Department has to enrol students with at least two “A” level passes including mathematics regardless of the quality of the passes so as to reach the maximum number of students required per intake. Sometimes, the Department is instructed to surpass the stipulated maximum enrolment figure. Some students with an “E” symbol at “A” level mathematics (based on the University of Cambridge grading system), qualified for admission into the Applied Mathematics degree programmes. Figure 1 below shows the decline in first year pure mathematics performance. Of interest, might be the highest percentage of failures in 2009.

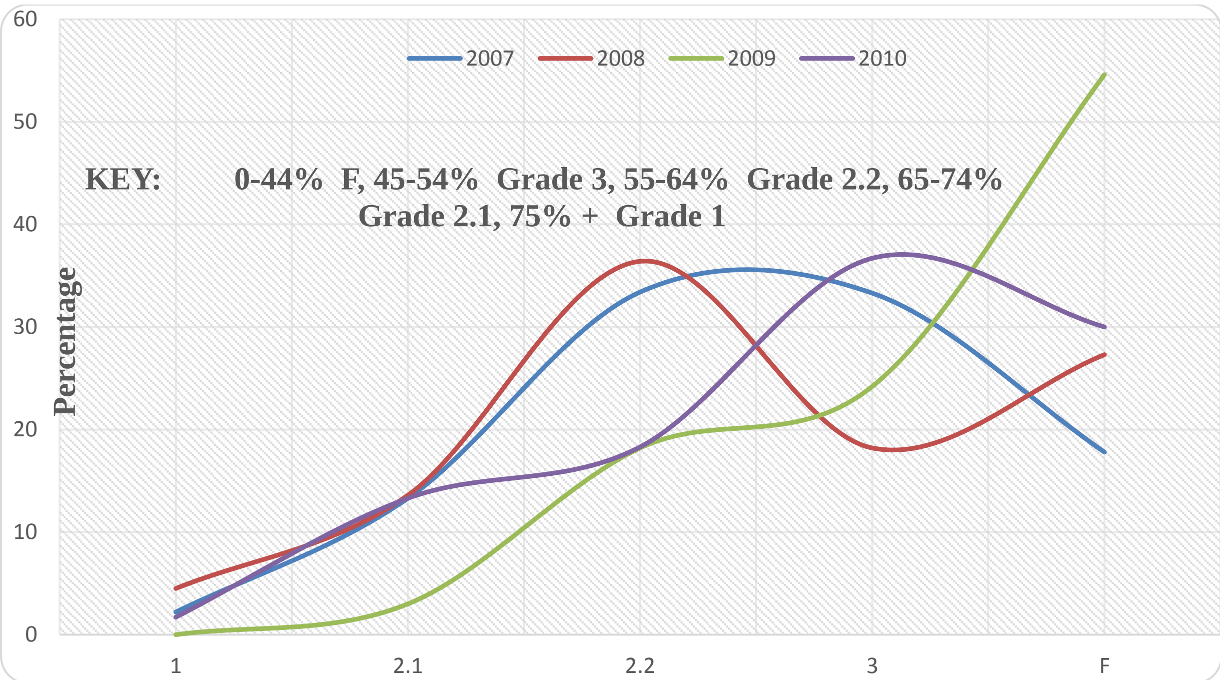

Figure 2: First year pure mathematics performance

The performance of these students on Discrete Mathematics, calculus and linear Algebra is a great cause of concern in the Department and the Faculty of Applied Sciences as a whole. It is noted that the performance is even worse for those doing BSc Operations Research and statistics especially from the parallel programme classes. This is a programme on which those who did commercial and/ or technical subjects at "A" level are eligible for the degree programme as long as they have an "A" level pass in mathematics. This has resulted in a number of postulates being put forward to try and explain the real cause of the failure rate.

2. Literature Review

In general, academic performance is affected by a number of factors including admission points, social economic status and school background (Kirsten & Robert, 2001, Messinis & Peter, 2015). (Culperrer *et al*., 2010, and Whannell, Whannell, & Allen, 2012) found out that positive progression to mathematics and math classes was significantly predicted by high school course selection. This means that students will more likely to pursue mathematics degrees or degrees with some significant mathematical content. If they happen to do some pure math's courses in their degree programmes then they also have high chances of passing the courses without many difficulties. Many studies point to admission points as a major determinant of academic performance (McDonald *et al*., 2001; Staffolani & Bratti, 2002; Kirsten & Robert, 2001; Messinis & Peter, 2015). However, academic performance can also be affected by variables such as the university facilities and the quality of lecturers, social and economic background (Kirsten & Robert, 2001; Messinis & Peter, 2015). Determinants of mathematics performance at higher institutions have been identified by several scholars. The contributing factors to mathematics performances were found to be attitude (Chepete, 2008; Saritas & Akdemir, 2009), parents' education (Chepete, 2008; Campbell & Mazzeo, 2000**),** gender (Yazici & Ertekin, 2010; Niederle & Vesterlund, 2010), instructional strategies and methods (Hyde & Lanon, 1990; Granstrom, 2006) and teacher competency in math education (Grossman, Wilson, & Shulman, 1989). In a case study done in Morawaka Educational Zone a logistic regression model was fitted and three contributory factors of tuition classes, early preparation for examination and father's education level suggested were found to be significant. The well preparedness of a student was so much significant in such a way that the student excelled five-fold higher than a student who did not. However, (Saritas & Akdemir, 2009) highlighted that results have demonstrated that teacher competency in math education, instructional strategies and methods and motivation or concentration were the three most influential factors that should be considered when designing decisions in mathematics education at tertiary level. These factors were also pointed out by (Samuelsson, 2010) when he said that the student's opportunity classroom.

In this study, determinants of mathematical performance of first year undergraduate students at the university are therefore explored. The study concentrates on overall points at “A” level, “A” level mathematics points, gender and academic year, on Calculus, Linear Algebra and Discrete Mathematics courses offered in the first year. Academic year represents the lecturer.

Our study also explores the effects of subject combination at “A” level on performance. We wanted to establish whether or not a student with pure science subjects at “A” level can outperform other students with a combination of an “A” level mathematics and any other subjects.

3. Methodology

3.1 Data Collection

A mixed research design (that is, both quantitative and qualitative) was adopted in this study. “A” level results of students offered places in the department as from the year 2007 up to 2011 were collected from students personal files and counter checked against a computer printout from admissions and students records. The same students whom their entry profile was collected had their results for first year in Calculus, Discrete Maths and Linear Algebra collected again. No sampling was done but students with missing results in at least one of the first year mathematics courses under study were omitted. In other words, secondary data was gathered from already existing published results in the Applied Mathematics Department database. The Admissions Department database provided us with the high school results. Two main groups of the students used in the study were BSc Applied Mathematics and BSc OR and Statistics (convectional and parallel) student’s performances. The data included the following variables:-

- Sex of each student admitted (qualitative);
- Subject combination (Coded 1 to 5), (qualitative);
- “A” level symbol in Mathematics (Points in “A” Level Mathematics if any) (quantitative); and
- Total points attained at “A” level (quantitative).

Performance as measured by the overall mark attained in each of course under study was determined for each student using marks from University senate published results kept by the Department in which the concerned students are registered in. The final data analysed covered a period of 5 years that is 2007 to 2011 inclusively.

3.2 Unbalanced Factorial Experimental Design

We identify *“A” Level Mathematics result* and *Total Points Scored at “A” level* to be the main factors that may affect the performance of first year students in pure Mathematics courses. These students would have written the same examination set by country's Examination Council. As a result, in this study, we consider that the students are homogenous with respect to each of the two factors. In addition, in order for us to calculate the *Total Points Scored* we would have added the points obtained from the *"A" Level Mathematics* result. This means that there would be a need of also studying the effects of the combination of the levels of the two factors on the first year pure Mathematics performance. Most authors highlight that in such a study factorial designs are most efficient. All possible combinations of the levels of factors are investigated. That is, the introduction of possible interaction effects. *"A" Level Mathematics* result has got 5 levels and *Total Points Scored* at *"A"* level has 10 levels.

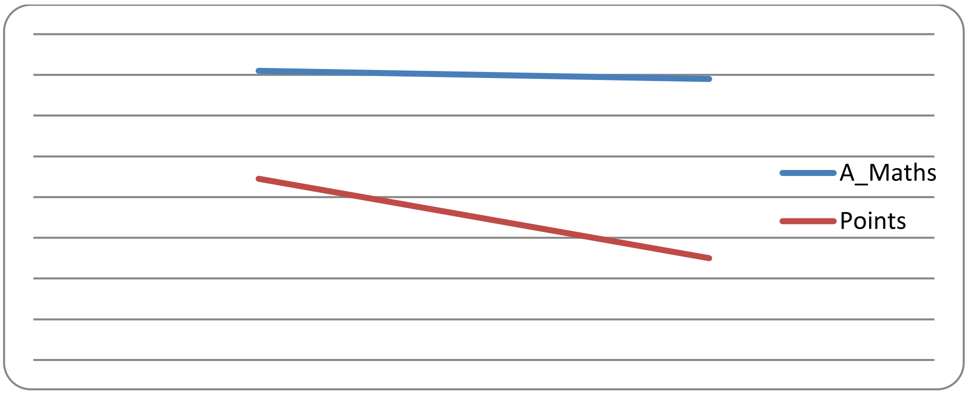

Figure 3: "A" level mathematics *total points interaction plot

Levels 4 and 5 points are common to both factors. As a result, we use them to investigate existence of interaction effects just as illustrated in figure 2. The curves of the two factors are not parallel which suggests the presence of the *"A" Level Mathematics* by *Total Points Scored* at *"A" level* interaction effects. This means that the interaction term in the above model is justified.

We have other two factors that are worth to study. We may group the students according to their *"A" Level Subject Combination* for example, science combination, and commercial combination and so on. That is, students are considered heterogeneous with respect to subject combination at "A" level. There is this perception, especially from scientist, that students who do science combination of subjects at "A" level are better Mathematics or science degree candidates. We might have to investigate that perception. The other factor is the *Lecturer.* Each lecturer has a different method, style, and approach and so on to lecturing (teaching). This difference might cause variations in the performance of students. The *Lecturer* becomes an external variable that may influence the performance of students in their first year pure Mathematics courses. It is noted that lecturer effect is imbedded in the year-by-year variation, as a result, in this study we cannot analyse its effect separately. From literature, we discovered that there are so many factors that may cause year by year variations in first year pure Mathematics courses which include country's socio-economic as well as political infrastructure. To guide us in the analysis following assertions or hypothesis were formulated:-

- H0: Points scored in "A" level Mathematics have no significant effect on the performance of students in the three first year pure Mathematics courses
- H1: Points scored in "A" level Mathematics have a significant effect on the performance of students in the three first year pure Mathematics courses.
- H0: Total Points scored at "A" level have no significant effect on the performance of students in the three first year pure mathematics courses.
- H1: Total Points at "A" level have a significant effect on the performance of students in the three first year pure Mathematics courses.
- H0: Subject combination at "A" level does not have a significant effect on the performance of students in the three first year pure Mathematics courses.
- H1: Subject combination at "A" level has a significant effect on the performance of students in the three first year pure mathematics courses.
- H0: Year by year variations have no significant effect on the performance of students in the three first year pure Mathematics courses
- H1: Year by year variations have a significant effect on the performance of students in the three first year pure Mathematics courses.

An Unbalanced Factorial Analysis of Variance was then performed followed by (Bonferron and Duncan) multiple comparisons to answer all of the above assertions.

4.0 Results

Partial correlation was used to explore the relationship between overall performance in pure mathematics undergraduate courses and advanced mathematics points attained at high school.

Table 1: Partial correlation between A level mathematics points attained and overall performance in pure performance whilst controlling for year of study

Control Variables			Performance	A level Mathematics points
Year	Performance		1.000	**.171**
		Significance (2-tailed)	.	**.000**
		Degrees of freedom		702

Table 1 above shows the correlation between “A” level mathematics points obtained and the overall performance in pure mathematics. A significant positive partial correlation of 0.17 (p-value=0.00), suggests that the number of A level mathematics points influence performance in pure mathematics. This might explain why the University has a cut-off point system, where by the higher the points the higher priority a candidate will have during admission. However, this cut-off point system was relaxed to allow the University to raise money through the self-funding programmes hence, his might explain one the causes of higher failure rates now recorded.

Table2: Levene’s Test of Equality of Error Variances

F	df1	df2	Sig.
1.178	195	509	1.79

Fisher’s Analysis of variance model diagnostic checks was performed (Refer table 2 above) to test for the homoscedasticity assumption. Since p-value=1.79 (>0.05) we can conclude that, the data collected did not violate the constant variance assumption. We thus proceeded to run an analysis of variance using SPSS, the results are summarised in the table 3 below.

Table3: Summary results of between subjects effects test (Significance level $\alpha = 0.05$)

Statistically Significant Factors	P-value	Statistically non-significant Factors	P-value
Maths points	0.031^{*}	Course	0.152^{ns}
Year	0.002^{*}	Combination	0.332^{ns}
Total A Level points	0.000^{*}	Total A level points * combination	0.07^{ns}
Total points * Year	0.018^{*}	Sex	0.058^{ns}
Maths points * Combination	0.003^{*}	**KEY**	
Maths points * Year	0.006^{*}	P-value*	Statistically significant factor at 5%
Course * Year	0.025^{*}	P-value^{ns}	Statistically non-significant factor at 5%

Dependent variable: Performance in the three first year pure Mathematics courses

The number of points at “A” level scored by a student significantly affects his/her subsequent performance in the three courses as shown by the results in the table 3 above. Other factors are also shown in the table above. It is however worth mentioning that whether a student did commercials or sciences is statistically insignificant in determining performance in the courses under study. Furthermore, gender was not found to be a significant factor on first year pure Mathematics performance.

To explore the impact of the widely talked about brain drain where highly experienced teachers and Lecturers migrate to neighbouring countries mainly South Africa and Botswana due to economic hardships, we performed a pairwise comparison using Duncan's post hoc method for years. The purpose was to establish whether students who did their studies in a certain year are better than some from a different year. The results are shown in table 4 below:

Table 4: Year by Year Pair wise comparison using Duncan's Multiple Range Test

Year	Sample size (n)	Subset	
		1	2
2007	135		54.25
2008	66		53.48
2009	99	45.40	
2010	180		52.08
2011	225		53.48

Table 4 above shows the impact of "A" level completion year on the performance. In 2009 students performed badly in all the three courses with an average course mark of 45.40%. Of importance to note here is that students performed very well in 2007 since these were students who graduated from "A" level in 2006 possible before the serious economy crisis in the country. We deduce two important issues from the results above. Firstly, there is a link between economic performance of a country and education performance. Secondly and more importantly, the quality of teaching staff in terms of their qualifications and experience are strong determinants of student's performance.

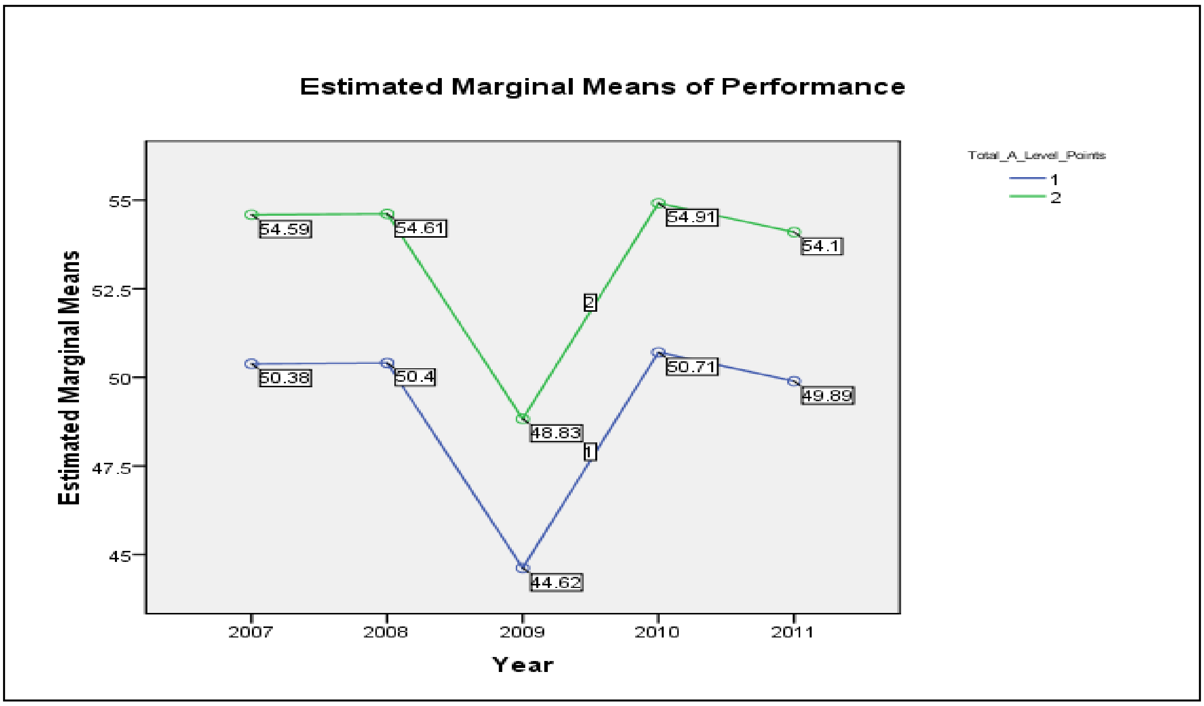

Figure 3: Graph of marginal means

The graph of marginal means above (Figure 3) shows that performance is direct proportional to the number of points a student scores at advance level. The higher the "A" level points the higher the performance. 1 represents students with 0-7 points and 2 represent those with 8 and above. It is praiseworthy to note that those with 8 points and above have a marginal mean performance ranging from 47.5 to 52.5, contrary to that of the other group that ranges between 42.5 to 48.6. The same can be said for the number of points scored in Mathematics at "A" level (Figure 4). Though sounding hypothetical, the drop in marginal means in 2009 symbolises the impact of brain drain on the quality of high school graduates. The 2009 pupils are those who did their Advanced level in 2007 and 2008. Most likely these pupils were taught by less qualified more specifically Teachers Awaiting Training (ATA) as there are commonly known. The results are that these are pupils who failed to appreciate the subject and lacked what is required to proceed with Mathematics at such a level of learning.

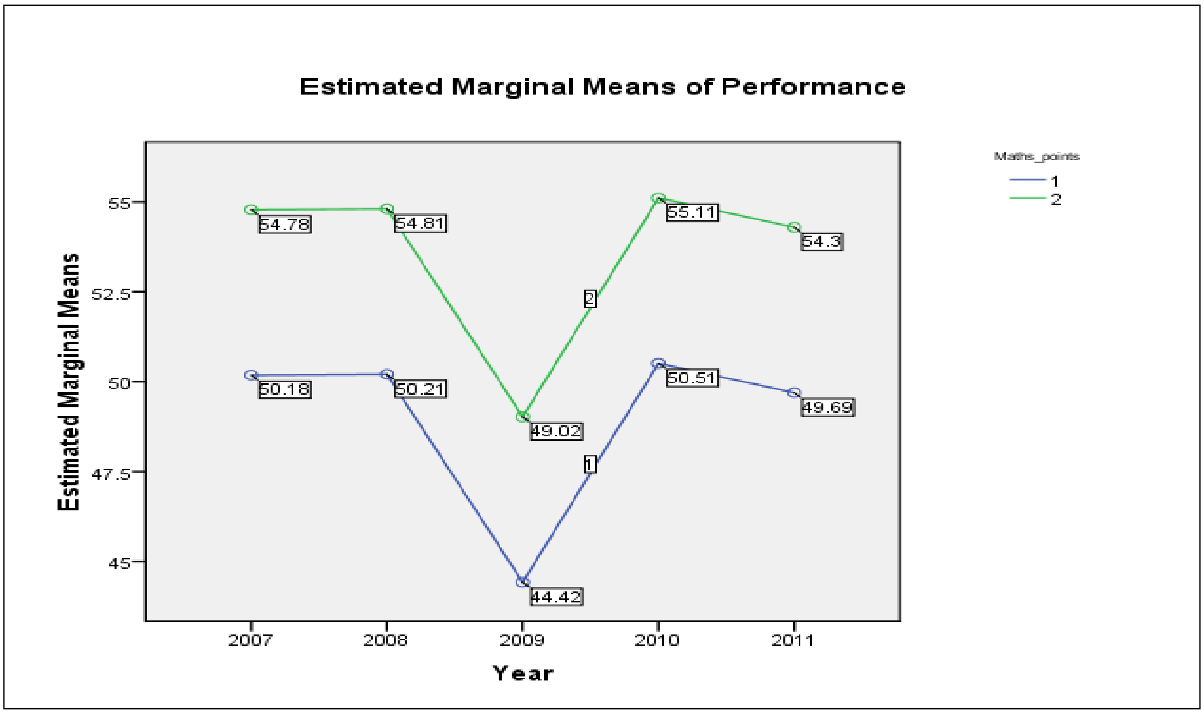

Figure 4: Marginal means of performance: "A" level mathematics points

We found out that 14 pointers were the best performers with an average of 69 and 3 pointers are the worst performers with an average of 38 marks as shown in table 5. All the homogeneous sub-groups are statistically significant at 10%. 3 pointers up to 6 pointers are statistically the same in terms of their performance as there are in the same homogenous group 1. However, 3 pointers fail to qualify in group 2 with 4 pointers qualifying in group 3. Based on the results shown in table 4, one would suggest that the University should admit only 10 pointers, 11 pointers, 12 pointers and 14 pointers if their primary goal is to have students who can perform well in pure mathematics courses in their first year of study. The exclusion of 13 pointers in the last homogeneous group warrant the need for some further investigation before conclusive remarks can be profaned.

Table 5: Total Points Pair Wise Comparison using Duncan's Multiple Range Test

"A" level	N	Subset			
		1	2	3	4
3	2	38.00			
4	12	49.25	49.25	49.25	
5	28	44.93	44.93		
6	25	46.52	46.52		
7	39		52.23	52.23	
8	39		53.49	53.49	
9	44		53.20	53.20	
10	28		56.82	56.82	56.82
11	8		58.00	58.00	58.00
12	4			61.75	61.75
13	5		54.40	54.40	
14	2				69.00
Sig.		0.075^{w}	0.055^{w}	0.064^{w}	0.053^{w}

Key: A^{w}**-** p-value for testing within group difference, for example p-value=0.053 for group 4 homogeneous means implying that the means are not statistical significant different at 5 %. However all group means are different at 10% level of significance.

5.0 Discussions

We can quickly highlight the convention on gender equality as far as first year pure mathematics performance is concerned. Girls equally perform as boys agreeing with the convention but contradicting what other authors like (Hyde & Mertz, 2009; Ellison & Swanson, 2009 and Niederle & Vesterlund, 2010) concluded. Probably, the educational set ups, policies and everything else that has to do with mathematics education in their geographical areas of study is different from the Zimbabwean educational environment. In Zimbabwe, it is expected that girls perform equally as boys that is maybe why sex has not been a significant factor on first year pure mathematics performance.

A clear distinction between 0-7 pointers and 8+ pointers was observed. This agrees with findings from other researchers who pointed out that an admission point is a determinant of mathematics performance (McDonald, Newton, Whetton, & Benefiel, 2001; Staffolani & Bratti, 2002; Kirsten &

Robert, 2001; Messinis & Peter, 2015). We also found out that high entry points are associated with better performance as was also obtained by (Kirsten & Robert, 2001; Messinis & Peter, 2015; Swart, 1999; Geiser & Satelices, 2007). It is observed that academic performance can also be affected by variables such as the university facilities and the quality of lectures in terms of teaching experience, a result obtained by several researchers (Acata, 2006), social and economic background of students (Kirsten & Robert, 2001; Messinis & Peter, 2015), "A" level subject combination was also found to be statistically insignificant a result which is in contrast with the result of (Chisholm, Carter, & Ames, 1995). Whether a student did commercials, sciences or other combination was found to be immaterial. This result defeats the perception some mathematicians and statisticians have. They think that students with a good science background only, are the ones who perform well in pure mathematics courses. From this study it is found that pure mathematics performance is not affected at all by subject combination as long as the student has a good "A" level mathematics result and total number of points. What is important is for the student to have done mathematics and passed it well. Whether the student had a science, commercial or even arts combination does not have any bearing on first year pure mathematics courses' performance. This result on subject combination at high school agrees with the results obtained on Mpumalanga study done by Maree *et al*. (2006). They found a correlation coefficient of 0.26 between science subjects' combination at high school and mathematics performance at university level. Which clearly indicated that subject combination at high school is not correlated (or does not affect) with mathematics performance at university level.

Year-by-year variation was found to be statistically significant (P =0.006), refer to table 3 above. This can be attributed to the Lecturer, with differing approaches to lecturing which also has a bearing on pupil performance. However, the constant assumption of other external factors can be an oversight such that "competencies" of a lecturer as the only source of year-by-year variation has to be analysed together with other external factors such as political environment, country's social economic status. Examination papers, though standardised by an external examiner (such a control does not guarantee uniformity) thus another factor that may cause the year by year performance variation. So many things can happen within a year that can affect the year-by-year variation in pure mathematics performance that includes the socio-economic environment in the country, political environment, university's infrastructure (availability of enough lecture rooms, proper white/black boards, electricity etc.), provision of tutorials, remedial activities etc. As a result, just taking the lecturer as the only source of year-by-year variation can be an oversight. Further research can be done exploring all other sources of pure mathematics variation within the year (in the lecture room).

Results shown on Table 3 play a pivotal role in showing that tertiary institutions are also affected by how students are taught at high school level, by who and under what conditions. If students fail to appreciate the mathematics at high school level then chances are high that there will sit for their first semester examinations before they fully appreciate the mathematics thereby poor performance in pure mathematics courses. The department of Applied Mathematics at NUST through NUST Schools Enrichment Programme (NUSTSEP) is somehow addressing this problem at grass root level.

6.0 Conclusions

We conclude that students with high points in "A" level mathematics perform well in all the three pure maths courses at university level. In addition, it is important that first year students have scored high (in total) at "A" level in order to expect good performance in pure mathematics courses. Though "A" level mathematics performance had an interaction effect with "A" level subject combination, the subject combination on its own does not have any impact on the performance of students in university pure mathematics courses. What is important is for the student to have passed "A" level mathematics. Apart from academic factors, changes in lecturers for the course as well as conditions in high schools which vary year by year can have a significant bearing on student performance in university pure mathematics courses. The convention that a lecturer should teach a course for a period of at least three years before another one comes in should be strictly followed. In addition, the previous lecturer should work with the new lecturer for at least a year, sharing ideas and materials. It is very important to identify students in need of short bridging or refresher courses because it has been found that some students may qualify for Applied Mathematics degree programmes but missing adequate mathematics background needed.

7.0 Acknowledgements

Acknowledgements are made to the staff at National University of Science and Technology in the Admissions Department for their great assistance on data collection support they gave on this study.

References

Acata, Y. (2006). *Quality assurance vital. New vision university guide 2006/2007.* Georgia: New Vision University.

Angus, M., Paul, N., Chris, W., & Pauline, B. (2001). *Aptitude testing for university entrance: A literature review.* Upton, United Kingdom: National Foundation for Educational Research. Retrieved from: https://www.nfer.ac.uk/publications/APL01

Campbell, J., & Mazzeo, J. (2000). *NAEP 1999 trends in academic progress: Three decades of students performance.* Washington DC: National Center for Education Statistics.

Chepete, P. (2008). *Modelling of the factors affecting mathematical achievement of form 1 students in Botswana based on tyhe 2003 trends in international mathematics and science study.* Bloomington, IN: UMI-Published PhD thesis, Indiana University.

Chisholm, K., Carter, M.C., & Ames, E.W. (1995). *Attachment security and indiscriminately friendly behavior in children adopted from Romanian orphanages. Development and Psychopathology*. Cambridge: Cambridge University Press.

Culperrer, B., Ferguson, C., Lanning, J., & Perkins, A. (2010). Understanding the transition between high school and college mathematics and science. *The Journal of Mathematics and Science: Collaborative Explorations*, 157-167.

Ellison, G., & Swanson, A. (2010, August). The gender gap in secondary school mathematics at high achievement levels: Evidence from the American mathematics competitions. *Journal of Economic Perpectives, 24*(2), 109-128. Retrieved from www.economics.mit.edu

Geiser, S., & Satelices, V. (2007, February 8). *Validity of high school grades in predicting students success beyond the freshmean year*. Retrieved from Center for studies in higher Education, University of Califonia: http://cshe.berkeley.edu/publications/docs/ROPS.GEISER_SAT_6.16.07.pdf

Granstrom, K. (2006). Group phenomena and classroom management. A swedish perspective. In C. Evertson (Ed.), *Handbook for classroom management: Research practice, and contemporary issues* (pp. 1141-1160). New York: Erlbaum.

Grossman, P., Wilson, S., & Shulman, L. (1989). Teachers of substance: Subject matter for teaching in Knowledge Base for the Beginning Teacher. New York: Perganon.

Hyde, J., & Lanon, S. (1990). Gender differences in mathematics performance: A meta-analysis. *Psychological Bulletin, 107*(2), 139-155.

Hyde, J., & Mertz, J. (2009). Gender, culture and mathematics perfomance. *PNAS, 106*(22), 5501-8807.

Kirsten, V., & Robert, S. (2001). Who succeds at University? Factors predicting academic performance in fisrt year Australian university students. *Higher education Research and Development, 20*(1), 21-33. doi:10.1080/07924360120043621

Kun, G. (2007, August 22). *What student engagement data tell us about college readiness*. Retrieved from Pathwas to college online library at American institute for research: http://www.pathwaylibrary.org/UserSearch.aspx?v=Description&s

Maree, K., Swanepoel, A.H., & Van der Linde, M. (2006). Predictors of learner performance in mathematics and science according to a large-scale study in Mpumalanga. *South African Journal of Education, 26*(2), 229-252.

Messinis, G., & Peter, S. (2015). *The academic performance of first year students at Victoria University by entry score and SES.* Victoria University. Retrieved October 1, 2016, from https://www.vu.edu.au/sites/default/files/cses/pdfs/the-academic-performance-of-first-year-students-at-VU-by-entry-score-and-SES-2009-2013.pdf

Niederle, M., & Vesterlund, L. (2010). Explaining the gender gap in math test scores: The role of competition. *Journal of Economic Perspective, 24*(2), 129-144.

Samuelsson, J. (2010). The impact of teaching approaches on students' mathematics proficiency in Sweden. *International Electronic Journal of Mathematics Education, 5*(2), 6178.

Saritas, T., & Akdemir, O. (2009, December 06). *Identifying factors affecting the mathematics achievement of students for better instructional design*. Retrieved from International Journal of Instructional Technology and Distance Learning: http://itdl.org/journal/Dec 09/article03.htm

Staffolani, S., & Bratti, M. (2002, June 08). *Student time allocation and education production functions*. Retrieved 14 May, 2012, from Ideas:
http://ideas.repec.org/p/wpa/wuwphe/0207001.html-16k

Swart, A. (1999, February 14). *Evaluation of the assessment strategy for admission at Pretoria University*. Retrieved June 14, 2010, from University of Pretoria:
http://hagar.up.ac.za/learner/andres/assess.html

University of Rahuna. (2010, July 12). Retrieved from Library University of Ruhuna:
http://www.lib.ruh.ac.lk/RohanaJ/index.php?option=com_content&view=article&id=52&Itemid=27

Whannell, P., Whannell, R., & Allen, B. (2012, April). Investigating the influence of teacher strategies on academic self-efficacy and study behaviour of students in a tertiary bridging program. *Australian Journal of Adult Learning, 52*(1).

Yazici, E., & Ertekin, E. (2010). Gender differences of elementary prospective teachers in mathe matics beliefs and mathematics teaching anxiety. *International Journal of Human and Social Sciences, 26*(2), 610-613.