On The Performance of First Year Engineering Students in Mathematics. (A Case Study of University Of Mines and Technology (UMaT), Tarkwa).

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Abstract

Engineering as a profession, requires a clear understanding of mathematics. It is therefore vital that engineering students acquire both abstract and an empirical understanding of Mathematics. This paper examines and analysis the level of mathematical knowledge of first year engineering students in UMaT. The data on scores of students in the courses 'Linear Algebra and Trigonometry' and 'Calculus' were analyzed from six departments: Electrical and Electronics Engineering Department, Mechanical Engineering Department, Geomatics Engineering Department, Geological Engineering Department, Mining Engineering Department and Mineral Engineering Department. The findings from the study revealed that majority of the students performed well. Approximately 7% (i.e. 6.93) of the students failed the course Linear Algebra and Trigonometry while 11.26% failed Calculus. Amongst the departments, students in the Mining Engineering Department performed best in the course Linear Algebra and Trigonometry while, for the course Calculus, the students of the Mechanical Engineering Department performed best over the periods of study. The students under UMaT performed well by the help of the marks adjusting model. Furthermore, the grades obtained by the students depicts that the students in the academic years 2000-2004 performed better than the students in the academic years 2005-2008.

Key Words:

Performance, first year engineering students, mathematics, Calculus, University of Mines and Technology; (UMaT), Linear Algebra and Trigonometry, Kwame Nkrumah University of Science and Technology, (KNUST).

Introduction

Mathematics has been vital to the development of civilization. From ancient to modern times mathematics has been fundamental to advances in Science, Engineering and Philosophy. Mathematics will continue to take pre-eminence in the society and at all level of the educational strata; because of the importance of mathematics and the prime of place it occupies in our society and on the curricular of the primary, secondary and tertiary levels of educational in Ghana (Adetunde, 2010). Engineering as a profession requires a clear understanding of mathematics, science and technology (Pyle, 2001). (Sazhin, 1998) said that mathematics for the engineering student should be regarded as a language of expressing physical, chemical and engineering laws. In the same paper he emphasized that in engineering, mathematical and scientific theories and principles are applied to real life situations and used to develop economical solutions to technical problems. Algebra and analysis, probability and discrete mathematics are part of a large common core. It is vital therefore, that the engineering graduate acquires not only an empirical but also abstract understanding of mathematics. (Searl, 1997) said that thinking mathematically in a scientific and engineering context however requires knowledge and skills that will make the knowing efficient and effective. For many engineering students, the lack of this coherent knowledge base is affecting their ability to obtain an empirical and abstract understanding of mathematics, (Sarah Williamson 2003). Sarah Williamson from UK point of view, emphasised it categorically that " the past decade has seen a serious decline in students' basic mathematical skill and level of preparation on entry into higher education in the UK, causing many students to embark on engineering degree programmes without the necessary mathematics skills required for the course". She further said that unfortunately, the "mathematics problem" is unlikely to be resolved at school level, at least in the medium term, and so the responsibility lies with Universities to combat this issue. Evidently, (Sutherland and Pozzi; 1995) supported the argument of Sarah Williamson by saying that over the last ten years, Engineering Institutions in London have been facing growing challenges of undergraduates being accepted for degree courses with relatively low mathematics qualifications.

From Australia point of view on mathematics, **(**Janet A Taylor and David Mander 2004) from the University of Southern Queensland in their paper titled "managing diversity in first year service mathematics course": intersection of effective numeracy teaching principles and management theory. Their own emphasizes is that first year service courses in mathematics are faced with numerous challenges as a result of the increasing diversity of student populations and the hierarchical nature of knowledge within mathematics.

Mathematics has now entered into the field of studies which were thought to be non-mathematics in the past. Mathematics is now seen as the point on which all other subjects revolve. Because of the importance of mathematics, most Institutions of higher learning all over the world often require candidates who are offered admission to read various courses by these institutions to have at least a credit grade in mathematics in SSCE/WASCE before they are registered for such courses.

Mathematics is the key to all subjects be it the Sciences, Technology, Accounting and Social Sciences or even Law. In addition to these, the overall national development of any nation and building of a healthy, happy and prosperous society or nation cannot be successfully achieved without mathematics. The pursuit of mathematics is therefore, vital and imperative for any society or community or nation in order to maintain its independence and ensure increased prosperity and keep its place amongst the civilized nations of the world in this era of technology. The rich and more advanced countries of the world have attained their affluence through advancement which they made in mathematics which links sciences and technology. This implies that mathematics education is a very important input in the scientific and technological development of any society. It is now obvious that mathematics subject is a tool for science and technology (Adetunde, 2009).

Mathematics has been playing very important role in the development of human beings. Human beings cannot do away with the use of mathematics in our life by applying it in our daily activities. We benefit from the results of mathematical research every day. The fibre-optic network carrying our telephone conversations was designed with the help of mathematics. There is no controversy about the claim that mathematics makes unparalleled positive contributions to the development of computer science and technology. Our computers are the result of millions of hours of mathematical analysis. Weather predictions, the design of fuel-efficient automobiles and airplanes, traffic control, and medical imaging depends upon mathematical analysis. For the most part, mathematics remains behind the scenes. We use the end results without really thinking about the complexity underlying the technology in our lives. But the phenomenal advances in technology over the last 100 years parallel the rise of mathematics as an independent scientific discipline. The uses of numbers, the habit of counting and recording and checking mathematically have influenced many aspects of our daily life. This is very much pronounced in the areas of buying and selling, calculating our profits and losses, business understandings and running governmental affairs. Government involvement in keeping records of taxes and man power for administrative purposes actually said the advent of arithmetic which has served as a tool to management and decision making.

Furthermore, there are nationally recognised and well documented deficiencies in mathematics teaching in some schools, which in turn produce students who are ill equipped for the demands of higher education mathematics courses. Several investigations have concerned themselves with the problems of this mathematics; notable among them are; Adetunde, I.A. (2007), Adetunde, I.A. (2009)**,** Yara, P.O. (2009), Zainuri, N.A., Nopiah, Z.M., Asshaari, I. and Yaacob, N.R. (2009), Tang, H.E., Voon, L.L. and Julaihi, N.H. (2009), Lee D. (1990), Linn L S (1965), Anderson RC (1942), Akpan SM (1989), Bandura, A. (1971), Lafortune, L. (1989), Kaiser-Messmer, G. (1994), Winjstra, J.M. (1988), Ethington, C.A. and Wolfe, L.M. (1984), Johnson, S. (1987), Fennema E, Sherman J (1977), Leder, G. (1987), Leder, G. (1990), Becker, J. (1981), Eshiwani, G. (1983), Boswell, S. (1985), Fennema, E. (1990)

Students of UMaT need to acquire a solid knowledge in mathematics to become valuable engineers but the present state of performance of the students in Linear Algebra and Trigonometry and Calculus which are University mathematics courses have not been quite good. Several students have been observed to have failed these courses since time memorial. Because of the fear of low performance, these courses have been perceived to be very difficult to understand and excel left alone its application in their various fields of study.

The objectives of this study are:

- Analysing the performance of students in the first year mathematics courses: Linear Algebra and Trigonometry course and Calculus course.
- Compare the scores of students who were under KNUST (academic years 2000-2004) with the scores of students under UMaT (academic years 2005-2008).

Materials And Methods

Scope Of Study

This study investigates the level of mathematical knowledge among first year engineering students in the University of Mines and Technology (UMaT). UMaT is located at Tarkwa in the Western Region of Ghana. UMaT previously affiliated to Kwame Nkrumah University of Science and Technology (KNUST) School of Mines called the Western University of College of KNUST Tarkwa was elevated to the status of a University in the year 2004 to train high level personnel in mining and allied engineering disciplines. The scope of study is limited to UMaT, and considering the scores obtained by students in the two mathematical courses: Linear algebra and Trigonometry course and Calculus course for the following departments; Electrical and Electronic Engineering Department and Mechanical Engineering Department which are under the Faculty of Engineering and Geomatics Engineering Department, Geological Engineering Department, Mining Engineering Department and Mineral Engineering Department which are also under the Faculty of Mineral Resource and Technology.

Grading System

The academic year of the University of Mines and Technology is made up of two semesters, the first semester and the second semester. At the beginning of the semester, the various courses the student needs to study are registered for that semester. In the cause of the semester, series of assignments, quizzes, tests, attendance and contributions of students at lectures which serve as marks together constitute the class assessment mark. At the end of each semester, the final examination is taken for the various courses registered and this constitutes the examination mark. In all, the class assessment mark and the final examination mark are added to make a total percentage of 100. Knowing the percentage obtained by the student represents the score of the student and indicates the grade of the student.

In the first semester, all first year students are required to register for the course Linear Algebra and Trigonometry and in the second semester the first year student register for the course Calculus. The data collected indicates the percentage scores obtained by each student in the courses mentioned above. The performance of the students based on the examination results is indicated by the help of the grading system of the institution. The grading system model came to existence as a result of the changes that took place when UMaT changed the grading pattern from that of KNUST.

The Grading System For The 2000-2004 Academic Years

During these years 2000-2004, the "University of Mines and Technology" (UMaT) was under the mother university Kwame Nkrumah University of Science and Technology, Kumasi (KNUST) and therefore the institution was using the grading system of KNUST. For this system, the class assessment constitutes 30 marks and the final examination marks constitutes 70 marks making the total of 100. The students are graded in ranges as follows: 70-100 gives an A (High Distinction), 60-69 for a B (Distinction), 50-59 giving a C (Credit average), the range 40-49 gives a D (Pass) and 0-39 give an F (Fail).

The Grading System For The 2005-2008 Academic Years

During the years 2005-2008, the grading system was different from that of the previous years. The first set of graduate students was produced using the updated grading system. For this system, the class assessment constitutes 40 marks and the final examination marks constitutes 60 making the total of 100%. After the original marks are obtained, these marks are channelled through a model (named by students "Agatha Curve") to rescale the performance of the class in the various courses and the results that come out of the model serves the results of the student. These scores are used in the grading of students as follows: 80-100 gives and A (High Distinction), 70-79 for a B (Distinction), 60-69 giving a C (Credit average), 50-59 as a D indicating Pass mark and lastly the range 0-49 giving an F (Fail).

The University's Marks Adjusting Model

This model is aimed at rescaling the marks of students. In the model, the boundaries is set such that 23% of the students offering the course obtain an "A" grade (i.e. 80 and above) and that most below 7% of the students obtain an "F" grade (i.e. obtaining below the 50 mark). In the end, the marks of students are adjusted to better the performance of the whole class to suit the cut off percentages. In achieving this, some assumptions are made. Since the statistical distribution of the marks is unknown, the model assumes that the marks is normally distributed with mean μ_0 and variance $\sigma_o^2 X_n \sim (\mu_o , \sigma_o^2)$ and that of the adjusted marks to be found is also assumed to be normally distributed with mean μ_n and variance σ_n^2 ,$X_n \sim (\mu_n , \sigma_n^2)$. The desire is to map the marks from X_o to X_n. The marks are then adjusted by the model $X_n = aX_o + \mu_n$, where a= σ_n^2 / σ_0^2.Xn are the adjusted marks, Xo are the marks obtained, and μ is the accepted mean. This model is being used if and only if the performance of the class is poor and that the class mean is less than the adjusted mean. When adjusting the scores of students, the program adjusted mark of a student does not exceed a 96 mark. Also in the case where an adjusted mark is less than the original mark, the original mark of the student is obtained. In all, the modelled class mean of the adjusted mark is expected to be near 72 and the standard deviation of the modelled marks is expected to be around 12.5.

Mathematics Performance Using The Examination Results

For the first semester course "Linear Algebra and Trigonometry", the participants of this study comprises of 1962 first year students in total; 1765 males and 197 females UMaT students. The examination results for these students were collected from the various departmental examination officers for the academic years 2000 to 2008. From the Electrical and Electronic Engineering Department, we have 363 students, from the Mechanical Engineering Department; we have 340 students, 327 students from the Mining Engineering Department, 311 students from the Mineral Engineering Departments, 327 students from the Geological Engineering Department, and 294 from the Geomatics Engineering Department.

For the second semester course "Calculus", the participants of this study comprises of 1919 first year students in total; 1727 males and 197 females UMaT students. Likewise the examination results for these students were collected from the various departmental examination officers for the academic years 2000 to 2008. From the Electrical Electronic Engineering Department, we have 353 students; from the Mechanical Engineering Department we have 331 students, 321 students from the Mining Engineering Department, 302 students from the Mineral Engineering Departments, 322 students from the Geological Engineering Department, and 290 from the Geomatics Engineering Department.

For Mathematics Department, the examination scores of 66 students for the courses Trigonometry and Coordinate Geometry, Vector Analysis, Basic Linear Algebra which are first semester courses and the examination scores for 74 students for the courses Discrete Mathematics, Calculus of a Single Variable, Higher Linear Algebra, Probability and Statistics 1, and Vector Applications which are second semester courses were collected for the years 2006, 2007, and 2008. These results were analysed separately from the other Department.

Together for the first semester, the examination scores for 2058 students were obtained and for the second semester, the examination scores for 2030 students were collected. The account of decrease in number of students may be as a result of student(s) been expelled from the school, or student(s) deferring the course and not registering or student(s) abandoning the course.

Data Processing Procedure

The data collected from the examination officers on the scores of students on the two mathematical courses were analysed using quantitative methods. Descriptive statistics such as mean, variance, and percentages were used to describe the performance of students and the level of knowledge developed in the two mathematical courses. Tables were used to represent the results. By the help of these mathematical procedures, the comparison of scores for Electrical and Electronic Engineering Department Students, Mechanical Engineering Students, Mining Engineering Students, Mineral Engineering Students, Geological Engineering Students and Geomatics Engineering Students were strategically done since students of these departments offer the two mathematics courses in the same semester. Secondly the comparison was done on the students having the same academic year group in the various departments.

RESULTS ANALYSIS AND INTERPRETATION OF THE MARKS OBTAINED BY THE YEAR ONE STUDENTS OF UMAT FROM 2000 – 2009

In this section, the findings are presented in the form of tables and in narrative. In the narrative the percentage figures refers to "rounded up" values to two decimal figures. The analysis of the results regarding the performance of first year students of UMaT in the mathematical courses "Linear Algebra and Trigonometry" and "Calculus" for the academic years 2000 - 2008 are presented. Tables 1 to Table 13 show the statistical analyses with their headings.

Table 1: Population size of students examined in the course linear algebra and trigonometry for the 2000-2008 academic years

DEPARTMENTS	Total
Electrical and Electronics (EL)	363
Mechanical Engineering (MC)	340
Mining Engineering (MN)	327
Mineral Engineering (MR)	311
Geological Engineering (GL)	327
Geomatics Engineering (GM)	294
TOTAL	1962

Table 2: Population size of students examined in the course calculus for the 2000 - 2008 academic years

DEPARTMENTS	Total
Electrical and Electronics (EL)	353
Mechanical Engineering (MC)	331
Mining Engineering (MN)	321
Mineral Engineering (MR)	302
Geological Engineering (GL)	322
Geomatics Engineering (GM)	290
TOTAL	**1919**

Table 3: Population of male and female students

DEPARTMENT	MALES	FEMALES	% OF MALES IN DEPATMENTS	% 0F FEMALES IN DEPARTMENTS	TOTAL	% TOTAL
ELECTRICAL	328	35	90.36	9.64	363	18.50
MECHANICAL	325	15	95.59	4.41	340	17.33
MINING	297	30	90.83	9.17	327	16.67
MINERAL	270	41	86.82	13.18	311	15.85
GEOLOGY	285	42	87.16	12.84	327	16.67
GEOMATIC	260	34	88.44	11.56	294	14.98
TOTAL	**1765**	**197**	89.96	10.04	**1962**	**100**

Table 4: Performance of students in Linear Algebra and Trigonometry for the years 2000-2004

GRADE	EL	MC	MN	MR	GL	GM	TOTAL	% TOTAL
A	114	51	80	57	61	42	405	40.70
B	39	35	43	43	50	39	249	25.03
C	21	32	28	25	32	27	165	16.58
D	24	41	10	15	19	29	138	13.87
F	2	10	4	11	3	8	38	3.82
TOTAL	200	169	165	151	165	145	995	100

Table 5: Performance of students in Linear Algebra and Trigonometry for the years 2005 - 2008

PERFORMANCE OF STUDENTS IN LINEAR ALGEBRA AND TRIGONOMETRY FOR THE YEARS 2005-2008								
GRADE	**EL**	**MC**	**MN**	**MR**	**GL**	**GM**	**TOTAL**	**% TOTAL**
A	39	22	53	46	41	37	238	24.61
B	31	37	51	49	41	36	245	25.34
C	42	43	45	38	54	39	261	26.10
D	19	33	9	21	19	24	125	12.93
F	32	36	4	6	7	13	98	10.13
TOTAL	163	171	162	160	162	149	967	100

Table 6: Performance of students in Calculus for the years 2000-2004

PERFORMANCE OF STUDENTS IN CALCULUS FOR THE YEARS 2000-2004								
GRADE	**EL**	**MC**	**MN**	**MR**	**GL**	**GM**	**TOTAL**	**% TOTAL**
A	67	69	65	30	43	38	312	32.03
B	39	41	32	35	28	28	203	20.84
C	38	26	29	31	36	28	188	19.30
D	39	20	22	24	34	32	171	17.56
F	12	11	12	26	21	18	100	10.27
TOTAL	195	167	160	146	162	144	974	100

Table 7 Performance of students in calculus for the years 2005-2008

PERFOMANCE OF STUDENTS IN CALCULUS FOR THE YEARS 2005-2008								
GRADE	**EL**	**MC**	**MN**	**MR**	**GL**	**GM**	**TOTAL**	**% TOTAL**
A	48	41	41	31	53	36	250	26.46
B	31	41	32	34	35	35	208	22.01
C	32	41	45	47	23	37	225	23.81
D	34	32	20	23	16	21	146	15.45
F	13	9	23	21	33	17	116	12.28
TOTAL	158	164	161	156	160	146	945	100

Table8: Number of students in each department obtaining specific grades in Linear Algebra and Trigonometry

GRADE	**DEPARTMENTS**							
	EL	**MC**	**MN**	**MR**	**GL**	**GM**	**Total**	**% of Total**
A	153	73	133	103	102	79	643	**32.77**
B	70	72	94	92	91	75	494	**25.18**
C	63	75	73	63	86	66	426	**21.71**
D	43	74	19	36	38	53	263	**13.41**
F	34	46	8	17	10	21	136	**6.93**
TOTAL	**363**	**340**	**327**	**311**	**327**	**294**	**1962**	**100**

Table 9: Number of students in each department obtaining specific grades in Calculus

GRADE	DEPARTMENTS							
	EL	**MC**	**MN**	**MR**	**GL**	**GM**	**Total**	**% Total**
A	115	110	106	61	96	74	562	29.29
B	70	82	64	69	63	63	411	21.42
C	70	67	74	78	59	65	413	21.52
D	73	52	42	47	50	53	317	16.52
F	25	20	35	47	54	35	216	11.26
Total	**353**	**331**	**321**	**302**	**322**	**290**	**1919**	**100**

THE USE OF ANALYSIS OF VARIANCE TO TEST FOR THE LEVEL OF SIGNIFICANCE OF PERFORMANCE OF STUDENTS IN THE TWO MATHEMATICAL COURSES

	Year	Treatment One : Linear Algebra and Trigonometry	Treatment Two : Calculus
1	2000	66.87	61.86
2	2001	64.11	64.65
3	2002	63.74	62.08
4	2003	66.21	62.79
5	2004	61.08	49.72
6	2005	63.45	50.32
7	2006	67.80	71.31
8	2007	69.90	73.50
9	2008	71.58	70.56

TABLE 10: Average scores of students for Linear Algebra and Trigonometry course and Calculus course

HYPOTHESIS TESTING BETWEEN THE MEANS

H_0: There is no significant difference between the average marks obtained by the students in the courses Linear Algebra and Trigonometry and the marks obtained by students in the course Calculus.($\mu_{\text{linear algebra and trigonometry}} = \mu_{\text{calculus}}$)

H_1: There exists a significant difference between the average marks obtained by students, hence the average marks obtained by students in the course Linear Algebra and Trigonometry is significantly affected by programme of study by students. ($\mu_{\text{linear algebra and trigonometry}} \neq \mu_{\text{calculus}}$)

ANALYSIS OF VARIANCE TABLE (ANOVA TABLE)

Sources of Variation	Degrees of freedom	Sum of Squares	Expected means	F – value
Treatment	1	43.35	43.35	1.04
Residue/Error	16	668.28	41.77	
Total Variation	17	711.62		

Table 11: ANOVA

Decision Rule: We accept H_0 if Calculated F value is less than Table F value.

The Calculated Value = 1.04

The Table Value: F becomes

$\mathbf{F_{1, 16, 0.05} = 4.49,}$

This implies that, at a 5% level of significance, Calculated F < Table F hence we accept H_0 and reject H_1. Concluding that there exists no significant difference between the scores obtained by students in the course Linear Algebra and Trigonometry and the course Calculus.

THE USE OF ANALYSIS OF VARIANCE ONTHE PROGRAMME OF STUDY OF STUDENT AND THE PERFORMANCE OF STUDENTS IN THE COURSE LINEAR ALGEBRA AND TRIGONOMETRY

	ELECTRICAL	MECHANICAL	MINING	MINERAL	GEOLOGY	GEOMATICS
2000	71.18	66.83	70.65	64.00	64.73	63.83
2001	65.30	66.54	65.64	60.88	64.53	61.79
2002	75.51	50.46	71.06	66.42	66.86	52.11
2003	66.23	60.32	69.32	67.71	66.56	67.11
2004	64.36	55.34	63.72	59.74	61.77	61.52
2005	55.81	56.23	71.24	65.06	69.42	62.94
2006	62.94	60.61	72.84	71.08	70.05	69.29
2007	64.37	55.22	76.33	75.80	73.64	74.05
2008	75.61	71.62	73.83	73.24	67.57	67.59

Table 12: Average marks obtained by students in the various departments for Linear Algebra and Trigonometry

H_0: There is no significant difference between the average marks obtained by the students in the course Linear Algebra and Trigonometry irrespective of Department the student belongs. This implying that the average marks of students is not affected by the programme of study of the student. ($\mu_{electrical} = \mu_{mechanical} = \mu_{mining} = \mu_{mineral} = \mu_{geology} = \mu_{geomatics}$)

H_1: There exists a significant difference between the average marks obtained by students, hence the average marks obtained by students in the course Linear Algebra and Trigonometry is significantly affected by programme of study by students. ($\mu_{electrical} \neq \mu_{mechanical} \neq \mu_{mining} \neq \mu_{mineral} \neq \mu_{geology} \neq \mu_{geomatics}$)

Below is the analysis of variance table for the above data.

Performance	**ANOVA TABLE**				
Sources of Variation	Sum of Squares	d.f	Mean Square	F	Sig.
Students (Department)	240.589	5	48.118	1.329	0.268
Error	1737.729	48	36.203		
Total	1978.318	53			

Table 13: Analysis of Variance Table

Decision Rule: We accept H_0 if Calculated F value is less than Table F value.

The Calculated Value = 1.329

The Table Value: $F_{(t-1), (r-1), \alpha}$, = $F_{5, 48, 0.05}$ = 2.40,

This implies that, Calculated F < Table F we accept H_0 and reject H_1 , then concluding that there exists no significant difference between the average marks obtained by students in the course Linear Algebra and Trigonometry, irrespective of department students belong to. Hence the performance and scores obtained by students in the course Linear Algebra and Trigonometry is independent on the programme of study of student.

THE USE OF ANALYSIS OF VARIANCE ON THE PROGRAMME OF STUDY OF STUDENT AND THE PERFORMANCE OF STUDENTS IN THE COURSE CALCULUS

	ELECTRICAL	MECHANICAL	MINING	MINERAL	GEOLOGY	GEOMATIC
2000	69.15	70.61	59.26	55.41	56.14	60.58
2001	68.19	64.54	67.14	58.92	65.73	63.41
2002	53.60	66.85	67.03	62.03	62.34	60.62
2003	61.51	62.79	66.17	62.25	61.07	62.96
2004	55.85	62.03	53.22	42.70	42.03	42.52
2005	58.07	60.43	50.58	49.20	34.47	49.16
2006	76.65	70.91	68.06	66.03	77.95	68.29
2007	74.03	76.36	72.46	69.70	76.89	71.56
2008	68.83	67.90	73.25	71.63	66.02	75.75

Table 14: AVERAGE MARKS OBTAINED BY STUDENTS IN THE VARIOUS DEPARTMENTS FOR CALCULUS

Ho: There is no significant difference between the average marks obtained by the students in the course Calculus irrespective of Department the student belongs. This implying that the average marks of students is not affected by the programme of study of the student. ($\mu_{electrical} = \mu_{mechanical} = \mu_{mining} = \mu_{mineral} = \mu_{geology} = \mu_{geomatics}$)

H_1: There exists a significant difference between the average marks obtained by students, hence the average marks obtained by students in the course Calculus, irrespective of department students belong to. That is the course Calculus is significantly affected by programme of study by students. ($\mu_{electrical} \neq \mu_{mechanical} \neq \mu_{mining} \neq \mu_{mineral} \neq \mu_{geology} \neq \mu_{geomatics}$)

Below is the analysis of variance table for the data above.

ANOVA

Sources of Variation	Sum of Squares	d.f	Mean Square	F
Students (Departments)	366.994	5	73.399	0.781
Error	4512.155	48	94.003	
Total	4879.148	53		

Table 15: Analysis of Variance Table

The Calculated Value = 0.568

The Table Value: $F_{(t-1), (r-1), \alpha}$

$F_{5, 48, 0.025} = 2.40$,

We accept H_0 and reject H_1, and conclude that there exists no significant difference between the average marks obtained by students in the course Calculus irrespective of the programme the student is doing. Hence the scores obtained by students in the course Calculus is independent on the programme of study of student.

Conclusions

The concluding remarks are:

- Majority of the students performed well. Approximately 7% (i.e. 6.93) of the students failed the course Linear Algebra and Trigonometry while 11.26% failed Calculus. This can be seen in Table 8 and Table 9 respectively.
- Amongst the departments, students in the Mining Engineering Department performed best in the course Linear Algebra and Trigonometry over the periods of study. The students had an average mark of 70.51 over the periods of study. It was also observed that Mining Engineering Students came second to Electrical and Electronic Engineering Students in terms of the distinction grades; only 8 students failed the Linear Algebra and Trigonometry course compared to 34 students who failed in the Electrical and Electronic Engineering Department. The average score

of students in the Electrical and Electronic Engineering Department was 66.81. This can be seen in Table 8.

- For the course Calculus, the students of the Mechanical Engineering Department performed best with an average score of 66.94. This can be seen in Table 9, even though from this table, it was observed that the students in the Electrical and Electronic Engineering Department had 115 students obtaining distinction compared to 110 from the Mechanical Engineering Students, most of the students had grade B with 20 students failing in Mechanical Engineering Department, compared with the 25 students that failed in the Electrical and Electronic Departments. On the average the score of the Electrical and Electronic Engineering Students was 65.10.
- In general the performance of students in the Linear Algebra and Trigonometry course is better than in Calculus course.
- Students under KNUST for the years 2000-2004 performed better than students under UMaT for the years 2005-2008 in the first year mathematics courses (i.e. Linear Algebra and Trigonometry and Calculus). The University's marks adjusting model betters the scores of the UMaT Students, but at the end the percentages, it was noted that, students under UMaT failing the first year mathematics courses greater than the students under KNUST, using their grading system.

Recommendations

It is recommended that students take mathematics very seriously since it is the back bone to engineering and economic growth.

In addition, we suggest that mathematics taught to engineering students should be related to practical problems. This is particularly important in the motivation of the engineering students.

Acknowledgement

The authors are thankful to various heads of departments as well as various departmental examinations officers for providing the results for carrying out this research.

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