Journal of Education and Practice
ISSN 2222-1735 (Paper) ISSN 2222-288X (Online)
Vol.6, No.9, 2015

An Assessment of Different Educational Background of Students Performance in Engineering Mathematics and on the Class of Award obtained at the Higher National Diploma (HND) Level at Cape Coast Polytechnic, Ghana.

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ABSTRACT
The purpose of this research article is to find out an assessment of different educational background of students performance in engineering mathematics and on the class of award obtained at the Higher National Diploma (HND) level at Cape Coast Polytechnic. A descriptive survey was conducted on students of the Electricals/Electronics Department who graduated in each year from 2007 to 2011. A sample of ten (10) students was randomly selected from those who graduated with SSS, and ten (10) from Non-SSS background, constituting a total of twenty (20) students from each graduation year. In all, one hundred (100) graduated students were selected from 2007 to 2011 for the study. A secondary data consisted of information on student's Department entry requirement, class assessment result, end-of-semester examination result for engineering mathematics and the class of award obtained were collected from the department. Correlation coefficient (Pearson's product moment) was used for the analysis. The study revealed that the students' educational background of study has effect on their performance in Engineering Mathematics, and also on the class of award obtained.

Key words: Correlation coefficient, Higher National Diploma (HND), Performance in Engineering Mathematics.

1.0 Introduction

The Polytechnics in Ghana were to complement the role of the universities to increase access to tertiary education for the training of middle and higher level manpower for the country. In view of this, the Polytechnics accept applicants with either Senior Secondary School Certificate Examination (SSSCE) result of aggregate 24 or better, or West Africa Senior Secondary School Examination (WASSCE) result of aggregate 36 or better, and other equivalents, as the minimum requirement for admission to study various 3-year higher national diploma (HND) programmes. Apart from the Polytechnic's general minimum requirement for admission, the schools in the polytechnic have their specific departmental admission requirement, which they normally call "cut-off-point" to read specific programmes in the departments of the various schools.

The Department of Electronics/Electrical Engineering started as Electrical Department in 1985, and was mandated to run technician programmes i.e. Electrical Engineering Technician Part-one (EET 1) and Part-Two (EET 2) Power Option. The Department now runs the EET 2 (Electronics Option). In 1994, the HND programme in Electrical/Electronic Engineering was started with the power supply and distribution option. So far four out of the five HND specializations are being offered in addition to the two technician programmes in this department, to supply the middle level labour force required to support engineers in industry. Programmes offered and specialties for the HND Electrical/Electronic Engineering specialties include (1) Power Supply and Distribution, (2) Computer Operating Systems/Digital Computer Design, (3) Electronics and Telecommunication, and (4) Instrumentation and Control.
The Department of Electrical/Electronic like all other departments in the School of Engineering admits two categories of students to offer the HND programmes and specialties. These are (1) SSS Graduates and (2) Non-SSS Graduates. The entry requirements are as follows:

(1) SSS Graduates

An aggregate of 24 or better with passes in three (3) core subjects including English Language, Mathematics and Integrated Science in addition to three (3) passes in relevant elective subjects like Physics, Chemistry, Mathematics, Technical Drawing, Engineering Science, Applied Electricity and Electronics for Senior Secondary School Certificate Examination (SSSCE) and/or an aggregate 36 or better with same subjects as above for West Africa Senior Secondary School Examination (WASSCE).

(2) Non-SSS Graduates

EET Part III or Telecoms Part III or EET Part II with passes in all course plus credit passes in English, Mathematics, Physics and any other two (2) subjects at 'O' Level or its equivalent. Or EET part I with passes in all three (3) subjects plus passes in five (5) relevant subjects including English Language and core Mathematics at SSSCE/WASSCE Level. Or Part I & II or Part I, II & III Technicians Certificate (EET) with three (3) passes in each. Or Ordinary Technicians Diploma (OTD) in Electrical/Electronic Engineering, or Two (2) GCE 'A' Level passes in Mathematics/Statistics, Physics, Chemistry and any other science subject AND five (5) credit passes at 'O' Level including English Language, Modern Mathematics, Additional Modern Mathematics, Physics and any other two subjects at the 'O' Level.

Interestingly, these categories of students with various education backgrounds do the same Engineering Mathematics course content for the first four semesters i.e. first two years of the three-year programme.

Mathematics has been the impediment or hindrance to the progress of many students, out of all the subjects in the school curriculum it is mathematics that records the most woeful and heart-rending results in publicly-conducted examination. This disappointingly poor performance of students in mathematics year-in-year-out has been a constant source of concern, worry and anxiety to all stakeholders in the educational sector-governments, educationists, proprietors, principals, teachers, guardians etc. (Rowe, 2003).

Electrical/Electronic Engineering students admitted from different backgrounds at Cape Coast Polytechnic are no exception of this canker. Most of the students perform woefully in class assessment, especially end-of-semester examinations. It raises the question of whether some students with one educational background (SSS) perform better in Engineering Mathematics than their counterpart (Non-SSS).
In order to find answers to these speculations, the study aims at investigating whether students' background is independent of their performance. Or is there any association between students' performance and the class student obtained after their 3- year study.

Table 1 and 2, shows summary of interpreted grading system and the classification of the HND awards based on the cumulated grade point average (CGPA) at the end of the 3-year programme of study.

Table 1: Summary of Interpreted Grading System

SCORE RANGE	GRADE AWARDED
100 – 80	A
79 – 70	B
69 – 60	C
59 – 50	E
Below 50	D

Table 2: Interpretation of the Classes Awarded

CUMULATED GPA	CLASS OF AWARD
4.00 – 5.00	First Class
3.00 – 3.99	Second Class Upper Division
2.00 – 2.99	Second Class Lower Division
1.55 – 1.9	Pass
Below 1.50	Fail

Students tend to follow and contribute immensely to only some aspects of the course content in Mathematics class. This problem is mostly exhibited in students' class assessment homework and the end of semester examinations. When the students were answering questions they tend to consider only the elementary functions and transformations of the course content and ignore others such as calculus, vectors, and mechanics. It is against this background that this study is being conducted to critically examine the impact of SSSCE/WASSCE and non-SSSCE/WASSCE backgrounds on performance in engineering mathematics and the class awards the students obtain at the end of the 3-year programme.

1.1 Statement of the Problem

The authors observed poor performance in Engineering Mathematics by the Engineering students who were admitted with different second cycle educational backgrounds. Students tend to follow and contribute immensely to only some aspects of the course content in class. This problem is mostly exhibited in students' class

assessment homework and the end of semester examinations. When the students were answering questions they tend to consider only the elementary functions and transformations of the course content and ignore others such as calculus, vectors, and mechanics. It is against this background that this study is being conducted to critically examine the impact of SSSCE/WASSCE and non-SSSCE/WASSCE backgrounds on performance in engineering mathematics and the class awards the students obtain at the end of the 3-year programme.

1.3 Objective of the Study

There are three main objectives of the research. These are:

1. To determine whether the students' background of study (SSS or Non-SSS) has effect on their performance in Engineering Mathematics.
2. To determine whether the students' background of study (SSS or Non-SSS) has effect on their class of awards.
3. To determine whether there is an association between the class of awards students obtained and the students' performance in Engineering Mathematics.

1.4 Research Questions

In view of the above objectives, the following research questions guided the study:

1. How does the background of students (SSS or Non-SSS) influence their performance in Engineering Mathematics?
2. How does the students' background influence their class of awards obtained?
3. How are the class of awards students obtained and the students' achievement in Engineering Mathematics associated?

2.0 Methods

2.1 Research Design

Research design is the overall plan for collecting and analyzing data including measures to enhance both internal and external validity. It is the term used to describe a number of decisions which used to be taken regarding the collection of data even before embarking upon the data collection process. It specifies how data relating to a given problem should be collected and analyzed. It provides a procedural outline for the conduct of any investigation. The objective of the study is to investigate the relationship between students' Engineering Mathematics achievement and their background (SSS or Non-SSS), Engineering Mathematics achievement versus class of award (HND). Finally, it is to ascertain whether or not the Engineering Mathematics achievement can be used to predict the class of award.

2.2 Population/Sample

The study was conducted with a population of Electrical/Electronic Engineering department in Cape Coast Polytechnic in the Central Region of Ghana. It involves all the students who graduated at Cape Coast Polytechnic in the years 2007 to 2011. A sample of 100 students selected from the Electrical/Electronic Engineering department of the School of Engineering at Cape Coast polytechnic, from 2007 to 22011 graduation years was used for the study. In each of the five consecutive years (from 2007 to 2011), ten (10) students were randomly selected from students who graduated with SSS background and ten (10) students were randomly selected from those who graduated with Non-SSS background, constituting a total of twenty (20) students from each graduation. In all, a total of hundred (100) graduated students were selected from 2007 to 2011 for the study.

2.3 Research Instrument/Data Analysis Procedure

The data for the study were secondary data obtained from Electrical/Electronic Engineering department of the Cape Coast Polytechnic. The data consisted of the information on students' Department entry requirement, class assessment result, end-of-semester examination result for Engineering Mathematics and the class of awards obtained. The years that were considered for the study are 2007, 2008, 2009, 2010 and 2011 graduations. Data analysis can be described as orderly and structuring of data to produce knowledge. The knowledge gathered gives meaning to the data collected. It is said to be the mechanism for reducing and organizing the bulk data to produce findings. These findings ultimately aid researchers in the interpretation of their work. After instruments have been administered, and data have also been tabulated, the next step in data analysis was to describe it in summary fashion one or more descriptive statistics. In this type of research where raw data was used, the entire process of analysis consisted of computing and then interpreting such statistics. And so, the statistical methods for analysis of the data obtained included descriptive statistics, distribution tables and graphs, percentages, means (Opoku, 2005).

2.4 Correlation Analysis

Correlation analysis was used to determine whether there is an association between Engineering Mathematics (variable x) and Classes of award (variable y). It was also used to assess the strength of the linear relationship between the two variables. The correction coefficient which is also referred to as the Pearson's product-moment, denoted by the letter *r*, was used to assess the strength of the linear relationship between the Engineering Mathematics and the Classes of awards. (Gordor and Howard, 2000)

3.0 Results and Discussion

Table 3 depicts that, out of 100 students sample graduated over the five consecutive years, nine (9) had First Class, three (3) had Pass, forty (40) had Second Class (upper division) and forty-eight (48) had Second Class (lower division). No First Class was recorded in 2008. It is worth noting that four First Classes were recorded in 2011 alone. It can also be seen that 10 out of 20 students who graduated in 2009 had second class upper, and 12 out of 20 students had second class lower in 2008.

Table 3: Classes obtained by Students from 2007-2011

Years	First Class	Second Class		Pass	Total
		Upper division	Lower division		
2007	1	8	10	1	20
2008	0	8	12	0	20
2009	2	10	8	0	20
2010	2	8	9	1	20
2011	4	6	9	1	20
Total	9	40	48	3	100

It can be observed that among the five year groups (2007 to 2011), the 2009 batch students performed well recording the highest number of students passing with First and Second Class (Upper Division) whiles a few with Second Class (lower division) and none had a Pass. The 2008 batch students performed averagely as all the students passed with Second Class (Upper & Lower Divisions), and no records for both First Class and Pass.

Table 4 presents a summary of the average scores obtained by 20 students over the first two years, that From Table 4, out of a sample of 20 students selected from those who graduated in 2007 (10 from each group of Non-SSS and SSS), Non-SSS recorded 1 grade A, 6 grade B, 3 grade C, and no records for grades D nor E, as against 1 grade A, 1 grade B, 6 grade C, 2 grade D and no grade E for SSS.

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From Table 5, with respect to the year 2010, Non-SSS had 1 (10%) each of First Class and Second Class (upper division), 8 (80%) Second Class (lower division), as against SSS recording 1 (10%) each of First Class, Second Class (lower division) and Pass, 7 (70%) had Second Class (upper division). It could be concluded that SSS students perform better than Non-SSS students in terms of Cass of Awards. It can be observed further from Table 5, that Non-SSS 4 (8%) had First Class, 17 (34%) obtained Second Class (upper division), 28 (56%) obtained Second Class (lower division) and 1 (2%) obtained a Pass.

Table 4: Average Scores in Engineering Mathematics obtained by students (2007-2011)

Year/Background	N	0-49 (E)	50-59 (D)	60-69 (C)	70-79 (B)	80-100 (A)	Total
2007	20						
Non-SSS		0	0	3	6	1	10
SSS		0	2	6	1	1	10
2008	20						
Non-SSS		0	3	3	4	0	10
SSS		0	1	4	4	1	10
2009	20						
Non-SSS		3	2	4	1	0	10
SSS		0	1	4	4	1	10
2010	20						
Non-SSS		0	6	3	1	0	10
SSS		0	2	2	3	3	10
2010	20						
Non-SSS		0	3	3	3	1	10
SSS		1	3	3	0	3	10
Average Score (2007-2011)	100						
Non-SSS		3	14	16	15	2	50
SSS		1	9	19	12	9	50

As compared to SSS with 5 (10%) First Class, 23 (46%) Second Class (upper division), 20 (40%) Second Class (lower division) and 3 (6%) Pass. On the whole, it could be concluded that SSS students perform better than Non-SSS students in terms of Cass of Awards.

The observations made in Table 4 and 5 respectively need to be tested further. For instance, it was observed that students with SSS background recorded more grades A's and C's in the Engineering Mathematics assessment than their counterpart with Non-SSS background whiles Non-SSS had more grades B's and D's than the SSS. It was also observed that more students with SSS background graduated with First Class and Second Class (upper division) than those with Non-SSS background whiles more students with Non-SSS background graduated with Second Class (lower division) than their colleagues with SSS background.

These calls for further tests to determine whether the classes of award students obtained and their performance in Engineering Mathematics are independent or not. It is therefore necessary to subject these interesting results to further testing. In this chapter, means calculation from distribution tables determine whether or not the background has effect on Engineering Mathematics performance and the class of awards the obtained, the Spearman's Product Moment test of independence shall be used to determine whether there is a correlation (an association) between the classes of award students obtained and their performance in Engineering Mathematics.

Table 5: Classes obtained by Students in the Department (2007-2011)

Year/Background	N	First Class	Second Class		Pass	Total
			Upper division	Lower division		
2007	20					
Non-SSS		1	5	3	1	10
SSS		0	3	7	0	10
2008	20					
Non-SSS		0	2	8	0	10
SSS		0	6	4	0	10
2009	20					
Non-SSS		0	6	4	0	10
SSS		2	4	4	0	10
2010	20					
Non-SSS		1	1	8	0	10
SSS		1	7	1	1	10
2011	20					
Non-SSS		2	3	5	0	10
SSS		2	3	4	1	10
Average Score (2007-2011)	100					
Non-SSS		4	17	28	1	50
SSS		5	23	20	2	50

In table 6, Non-SSS recorded an average Engineering Mathematics score of 72.40 whiles the SSS had 65.95 in the 2007 graduation year. From 2008 to 2010, SSS recorded average Engineering Mathematics score of 70.78, 70.20 and 71.57 respectively as against Non-SSS average score of 64.41, 60.00 and 61.43.

Table 6: Mean Distribution of Engineering Mathematics Assessment

Year	**Background**	
	Non - SSS	**SSSS**
2007	72.40	65.95
2008	64.41	70.78
2009	60.00	70.20
2010	61.43	71.57
2011	66.60	66.20

In 2011, Non-SSS again recorded 66.60 as SSS had 66.20. Over the five-year period for the study, it shows that SSS background perform better in Engineering Mathematics than Non-SSS.

Table 7: Mean Distribution of Classes of Awards

Year	**Background**	
	Non - SSS	**SSSS**
2007	3.1	2.8
2008	2.7	3.1
2009	3.1	3.3
2010	2.8	3.3
2011	3.2	3.1

In table 7, Non-SSS recorded an average Classes of award value of 3.1 whiles the SSS had 2.8 in the 2007 graduation year. From 2008 to 2010, SSS recorded average Classes of award value of 3.1, 3.3 and 3.3 respectively as against Non-SSS average value of 2.7, 3.1 and 2.8. In 2011, Non-SSS again recorded 3.2 as SSS had 3.1. Over the five-year period of the study, it could be concluded that SSS students perform better in the Classes of Awards than the Non-SSS students.

Table 8: Frequency Distribution of Performance in Engineering Mathematics by Non-SSS Students

Class interval	Class Mark (x)	No. of students (f)	fx
40 – 49	44.5	3	133.5
50 – 59	54.5	14	763
60 – 69	64.5	16	1032
70 – 79	74.5	15	1117.5
80 – 89	84.5	2	169

$\sum f = 50$, $\sum fx = 3215$, $\bar{x} = \frac{\sum fx}{\sum f} = \frac{3215}{50} = 64.3$

Table 9: Frequency Distribution of Performance in Engineering Mathematics by SSS Students

Class interval	Class Mark (x)	No. of students (f)	fx
40 – 49	44.5	1	44.5
50 – 59	54.5	9	490.5
60 – 69	64.5	19	1225.5
70 – 79	74.5	12	894
80 – 89	84.5	9	760.5

$\sum f = 50$ $\sum fx = 3415$, $\bar{x} = \frac{\sum fx}{\sum f} = \frac{3415}{50} = 68.3$

From tables 8 and 9, calculations shows that students with the Non-SSS background had mean Engineering

Mathematics performance of 64.3 whiles their counterpart from SSS had 68.3. From the above computations, SSS students perform better in Engineering Mathematics than Non-SSS students.

Table 10: Frequency Distribution of Classes of Awards by Non-SSS students

Class interval	Class Mark (x)	No. of students (f)	fx
1.00 – 1.99	1.5	1	1.5
2.00 – 2.99	2.5	28	70.0
3.00 – 3.99	3.5	17	59.5
4.00– 4.99	4.5	4	18.0

$\sum f = 50$, $\sum fx = 149$, $\bar{x} = \frac{\sum fx}{\sum f} = \frac{149}{50} = 2.98$

Table 11: Frequency Distribution of Classes of Awards by SSS students

Class interval	Class Mark (x)	No. of students (f)	fx
1.00 – 1.99	1.5	2	3.0
2.00 – 2.99	2.5	20	50.0
3.00 – 3.99	3.5	23	80.5
4.00 – 4.99	4.5	5	22.5

$\sum f = 50$, $\sum fx = 156$, $\bar{x} = \frac{\sum fx}{\sum f} = \frac{156}{50} = 3.12$

From tables 20 and 21, calculations shows that students with the Non-SSS background had mean Classes of Award of 2.98 whiles their counterpart from SSS had 3.12. From the above computations, SSS perform better in Classes of Awards than Non-SSS.

Table 12: Mean Distribution of Engineering Mathematics and Classes of Awards

Engineering Mathematics (x)	Class of Award (y)
72.40	3.1
64.41	2.7
60.00	3.1
61.43	2.8
66.60	3.2
65.95	2.8
70.78	3.1
70.20	3.3
71.57	3.3
66.20	3.1

The correlation coefficient is given by

$$r = \frac{n\sum xy - \sum x \sum y}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}}$$

Computations

Table 13: Extended form of Table 22

x	y	x^2	y^2	xy
72.40	3.1	5241.76	9.61	224.44
64.41	2.7	4148.65	7.29	173.907
60.00	3.1	3600.00	9.61	186
61.43	2.8	3773.64	7.84	172.004
66.60	3.2	4435.56	10.24	213.12
65.95	2.8	4349.40	7.84	184.66
70.78	3.1	5009.81	9.61	219.418
70.20	3.3	4928.04	10.89	231.66
71.57	3.3	5122.26	10.89	236.181
66.20	3.1	4382.44	9.61	205.22

$$n = 10,\ \ \sum x = 669.54,\ \ \sum y = 30.5,\ \ \sum x^2 = 44991.57,\ \ \sum y^2 = 93.43, \sum xy = 2046.61$$

From the relation above,

$$r = \frac{10(2046.61) - 669.54(30.5)}{\sqrt{[10(44991.57) - (669.54)^2][10(93.43 - (30.5)^2)]}} r = \frac{45.13}{\sqrt{(1631.8884)(4.05)}} r = \frac{45.13}{81.30} r \approx 0.6$$

The value of *r* being positive indicates that there is a direct relationship between the Engineering Mathematics achievement and the Classes of Awards student obtained. The value of *r* (i.e. r = 0.6) indicates that there is a moderately strong association between the Mathematics achievement and the Award a student obtained. This means one can rely entirely on the Engineering Mathematics achievement to predict the Class of Award a student obtains at the end of the three-year HND programme if further test is conducted using regression analysis.

4.0 Conclusions

Based on the findings and discussions from the tables, graphs and computations so far, it could be concluded that a student's background of study (SSS or Non-SSS) has effect on his/her Engineering Mathematics achievement, and on the class of award the student obtained; there is an association between classes of awards students obtained and the Engineering Mathematics achievement. Thus, a student with SSS background would perform better than one with Non-SSS in Engineering Mathematics; a student with SSS background would have a better

class of award as compared to one with Non-SSS; a student with good Engineering Mathematics achievement would have a good class of award.

Acknowledgment
We are indebted to Mr. Frank B. K. Twenefour of the Department of Mathematics and Statistics, Takoradi Polytechnic for his encouragement and support during the preparation of this paper. We say God bless you!!

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