GLOBUS

Globus Journal of Progressive Education
A Refereed Research Journal
Vol 11 / No 2 / Jul-Dec 2021 ISSN: 2231-1335

PREPAREDNESS TO ENGINEERING PROGRAMS AND ACADEMIC PERFORMANCE IN MATHEMATICS OF GRADE 12 SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS (STEM) STUDENTS

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Paper Received: 11.09.2021 / **Paper Accepted**: 07.10.2021 / **Paper Published**: 11.10.2021

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Abstract

This descriptive-comparative study investigated the mathematics performance of the outgoing Grade 12 students of a university in Bacolod City and their preparation to tackle the mathematics of the engineering programs in college. A 30-item researcher-made questionnaire based on the subjects, pre-calculus and basic calculus was validated by three subject experts and reliability tested by Grade 12 students who were not part of the study. Stratified proportionate random sampling was used to the 137 respondents under the engineering cluster for the academic year 2019-2020. Mean, standard deviation, t-test for independent samples, one-way analysis of variance and Post Hoc Analysis were the statistical tools used to analyze the results. It was found out that preparedness of the students to engineering Mathematics was not at the expected level although their academic performance was very satisfactory. Results showed that students were not that prepared to the mathematics of the college engineering programs. Those students whose grades were 85 and above in their mathematics subjects during their Grade 10 were more prepared to mathematics engineering programs than those with grades below 85. Thus, it is necessary that students should really be mathematically-prepared if they want to take up engineering programs in college.

Keywords: Mathematics Performance, Academic Performance, Preparedness of Students, Mathematics of Engineering Programs.

Introduction

The basic education system prepares the students for their chosen path when they get to college. The Department of Education has been doing its purpose to ensure quality basic education throughout the country. This shows one of the salient features of the Department of Education which is nurturing the holistically developed Filipino, that is, college and livelihood readiness, 21st Century Skills [12]. Through this, the Department of Education is ensuring that the students are ready for the challenges of tertiary education and the standards of Higher Education Institutions. The education system here in the Philippines four years ago has fewer number of years compared to our neighbors here in South East Asia and the rest of the world. Before the implementation of the new basic education curriculum, the Philippines was one of the three remaining countries whose basic education has only a 10-year cycle [8], but with the new curriculum, students would benefit with the advanced courses and discipline concentrated curriculum.

To catch up with the global demand for education and professionals, R.A. 10533, an act enhancing the Philippine basic education system by strengthening its curriculum and increasing the number of years for basic education, appropriating funds therefore and for other purposes, was approved by the House of Representatives. This act stipulated the adding of two more years to secondary education which is known as the Senior High [12].

One purpose of this is to have work opportunities for those unable to proceed to college through technical vocation track. Workforce is in a demand and graduates under the K-12 education system are expected to be equipped and ready for the workforce.

The Department of Education worked in unison with the Commission on Higher Education and the Technical Education and Skills Development Authority in the curriculum development ensuring that both the higher education and the basic education is synchronized [12]. One result is that most subjects or courses in college are incorporated in the senior high level. Statistics and probability,

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Pre-Calculus, Basic Calculus and sciences subjects are few examples [4]. These subjects offered in the senior high school may no longer be present in college or may be of higher level of applications will be discussed in college. But as a requirement for engineering programs, Applied Mathematics subjects are still taught. In line with this, a question may be raised as to how ready the students are from the Science, Technology, Engineering and Mathematics strand for the engineering programs in college. One major concern that is present in different studies about the new basic education curriculum is on human resource capability of the teachers handling STEM classes [1].

Hence, this study is determined to investigate on the preparedness and the academic performance of the Grade 12 senior high-school Science, Technology, Engineering and Mathematics students.

Statement of the Problem

The main focus of this study was to determine the preparedness and the academic performance of the Grade 12 senior high-school Science, Technology, Engineering and Mathematics students in one of the private schools in Bacolod City for 2019-2020 to engineering programs of the higher education institutions.

Specifically, the aim of this research was to answer the following questions:

1. What is the level of preparedness of the students to engineering programs when they are taken as a whole and grouped according to a) target engineering program and b) Grade 10 mathematics grade?
2. What is the level of academic performance of the students when they are taken as a whole and grouped according to the aforementioned variables?
3. Is there a significant difference in the preparedness of the students when they are grouped according to the aforementioned variables?
4. Is there a significant difference in the academic performance of the students when they are grouped according to the aforementioned variables?

Hypotheses

The following are the presumptions for the preparedness of the Grade 12 STEM students to engineering programs in college.

1. There is no significant difference in the preparedness of the students when they are grouped according to a) target engineering program and b) Grade 10 Mathematics grade.
2. There is no significant difference in the academic performance of the students when they are grouped according to the aforementioned variables.

Methods

Respondents of the Study

The participants of the study were the 137 out of 207 Grade 12 STEM students out of 207 in one of the private schools in Bacolod City for Academic year 2019-2020 under the engineering cluster who were randomly selected through the use of stratified proportionate random sampling.

Table 1 presents the distribution of participants.

Table 1: Distribution of Participants

Grouping Variable	f	%
A. Entire Group	137	100
B. Engineering Program		
Civil Engineering	41	29.92
Mechanical Engineering	13	9.49
Chemical Engineering	7	5.11
Electrical Engineering	8	5.84
Computer Engineering	22	16.06
Undecided	46	33.58
C. Grade 10 Mathematics Grade		
Below 85	25	18.25
85 and above	112	81.75

Research Design

This research utilized a descriptive-comparative research design to determine the preparedness of the Grade 12 STEM students to the engineering programs offered in the Higher Education Institutions of Bacolod City and their academic performance in Mathematics.

Statistical Treatment

The following statistical tools were used to answer the questions presented in this study:

For objectives 1 and 2, mean and standard deviation were used.

For objectives 3 and 4, t-test for independent samples was utilized to determine whether a significant difference in the preparedness and academic performance was present when the students were grouped according to their grade 10 Mathematics grade. One-way analysis of variance was utilized to ascertain if there was variability in the preparedness and academic performance of the students when they were taken according to their target engineering program and Post Hoc analysis to determine where the significant difference occurred.

Data were analyzed at 5% level of significance using computer-generated software.

Results and Discussion

Level of Preparedness of the Grade 12 STEM Students to the Different Engineering Programs in College

Table 2 presents the level of preparedness of the grade 12 stem students to the different engineering programs in college.

Table 2: Level of Preparedness of the Grade 12 STEM Students to Engineering Mathematics When Grouped According to Target Engineering Program and Grade 10 Mathematics Grade

Grouping Variable	Mean	Verbal Interpretation	Standard Deviation
A. Entire Group	10.31	Low Preparation	3.13
B. Engineering Programs			
Civil Engineering	11.56	Low Preparation	3.10
Mechanical Engineering	9.46	Low Preparation	4.05
Chemical Engineering	11.29	Low Preparation	2.29
Electrical Engineering	8.75	Low Preparation	1.83
Computer Engineering	10.18	Low Preparation	3.32
Undecided	9.61	Low Preparation	2.75
C. Grade 10 Mathematics Grade			
Below 85	9.36	Low Preparation	2.31
85 and above	10.52	Low Preparation	3.25

Note: 0 – 5.99- Very Low Preparation; 6 – 11.99- Low Preparation; 12 – 17.99- Moderately Prepared; 18 – 23.99- Highly Prepared; 24 – 30- Very Highly Prepared

Table 2 shows that the result of the level of preparedness of the Grade 12 STEM students when taken as a whole was Low (M =10.31, SD = 3.13). When the students were grouped according to engineering programs and Grade 10 grade, the results showed that their preparedness to the different engineering programs was low with means ranging from 8.75 to 11.56. The standard deviations ranging from 1.83 to 4.05 showed that there was homogeneity in their responses.

Level of Academic Performance of the Grade 12 students in Senior High School Mathematics

Table 3: Level of Academic Performance of the Grade 12 STEM Students When Taken as a Whole and Grouped according to Target Engineering Program and Grade 10 Mathematics Grade

Grouping Variable	Mean	Verbal Interpretation	Standard Deviation
A. Entire Group	88.08	Very Satisfactory	5.42
B. Engineering Program			
Civil Engineering	88.62	Very Satisfactory	5.38
Mechanical Engineering	89.29	Very Satisfactory	4.15
Chemical Engineering	88.32	Very Satisfactory	7.05
Electrical Engineering	86.72	Very Satisfactory	5.09
Computer Engineering	86.31	Very Satisfactory	5.52

Undecided	88.30	Very Satisfactory	5.55
C. Grade 10 Mathematics Grade			
Below 85	82.55	Satisfactory	4.44
85 and above	89.32	Very Satisfactory	4.82

Note: 90 – 100 – Outstanding; 85 – 99 – Very Satisfactory; 80 – 84 - Satisfactory;
75 – 79 – Fairly Satisfactory; Below 75 - Did Not Meet Expectations

In Table 3, the level of academic performance of the Grade 12 STEM students when taken as a whole (*M* = 88.08, *SD* = 5.42) was Very Satisfactory. When grouped according to engineering programs, the means range from 86.31 to 89.29 was interpreted as Very Satisfactory.

However, when grouped according to Grade 10 Mathematics grade, those who belong to below 85 (*M* = 82.55, *SD* = 4.44) showed a Satisfactory result and Very Satisfactory for those with grades above 85 (*M* = 89.32, *SD* = 4.82). Likewise, there was homogeneity in their responses based on the results in the standard deviations ranging from 4.44 to 7.05. Their academic performance in the grade 10 Mathematics was carried on to their performance in the senior high school Mathematics. Students who had a grade above 85 in grade 10 Mathematics continued to thrive showing a very satisfactory performance. Students who had a grade below 85 in grade 10 Mathematics reflected the same performance in senior high school Mathematics.

Difference in the Level of Preparedness of the Grade 12 STEM Students to Engineering Mathematics

Table 4: Analysis of Variance Result for the Difference in the Level of Preparedness of the Grade 12 STEM Students to Engineering Mathematics when Grouped According to Target Engineering Program

Grouping Variable	Sum of Squares	df	Mean Square	*F*-ratio	*p*
Between Groups	122.638	5	24.528	2.663*	.025
Within Groups	1206.486	131	9.210		
Total	1329.124	136			

$* p < 0.05$

Table 4 shows that there is a significant difference ($F\ (5,131) = 2.663, p = 0.025$) in the preparedness of the Grade 12 students to the different engineering programs when they are grouped according to their target engineering program,

To further test as to where the significant difference occurred, a Post Hoc Analysis using Least Square Difference was used. Table 5 shows the result of the said analysis.

The result of the Post Hoc analysis showed that there was a significant difference ($MD = 1.952$, $p = 0.038$) between the students who preferred to take civil engineering and those who have not yet decided which course to take in college.

Table 5: Post Hoc Analysis for the Significant Difference in the Level of Preparedness of the Grade 12 STEM Students to Engineering Mathematics When Grouped According to their Target Engineering Program

Engineering Program	Engineering Program	Mean Difference	*p*
Civil Engineering	Electrical Engineering	2.811	.165
	Mechanical Engineering	2.099	.257
	Computer Engineering	1.379	.521
	Chemical Engineering	.275	1.000
	Undecided	1.952*	.038
Electrical Engineering	Mechanical Engineering	-.712	.165
	Computer Engineering	-1.432	.863

	Chemical Engineering	-2.536	.591
	Undecided	-.859	1.163
Mechanical Engineering	Computer Engineering	-.720	.984
	Chemical Engineering	-1.824	.794
	Undecided	-.147	1.000
Computer Engineering	Chemical Engineering	-1.104	.960
	Undecided	.573	.978
Chemical Engineering	Undecided	1.677	.749

$* p < 0.05$

This implies that those who were undecided to which engineering program they intend to take were really unprepared than those who were certain to take up Civil Engineering. The rest of the students had the same preparedness of Engineering Mathematics.

Table 6: t-test Result for the Significant Difference in the Level of Preparedness of the Grade 12 STEM Students to Engineering Mathematics When Grouped According Their Grade 10 Mathematics Grade

Grouping Variable	Mean	SD	df	*t*-ratio	*p*
Below 85	9.36	2.307	47.97	-2.088*	0.040
85 and above	10.52	3.252			

$*p < 0.05$

Table 6 shows that there was a significant difference $(t(47.97) = -2.088, p = 0.040)$ in the preparedness of the Grade 12 STEM students when grouped according to their Grade 10 Mathematics grade.

It implies that the Grade 10 grade of the Grade 12 STEM students did matter in their preparedness to Engineering mathematics. Students whose Grade 10 Mathematics grade are 85 and above were mathematically prepared compared to those whose Grade 10 Mathematics grade was below 85.

Difference in the Academic performance of the Grade 12 STEM Students

Table 7: Analysis of Variance Result for the Difference in the Academic Performance of the Grade 12 STEM Students When Grouped According to Target Engineering Program

Grouping Variable	Sum of Squares	df	Mean Square	*F*-ratio	*p*
Between Groups	117.746	5	23.549	0.797	0.554
Within Groups	3871.246	131	29.551		
Total	3988.992	136			

The results showed that there was no significant difference (F (5,131)= 0.797, p = 0.554) in the academic performance of the Grade 12 students when grouped according to their target engineering programs.

It implies that the students have the same academic performance even if their target engineering programs are different from one another.

Table 8: t-test Results for the Significant Difference in the Academic Performance of the Grade 12 STEM Students When Grouped According to Grade 10 Mathematics Grade

Grouping Variable	Mean	SD	df	*t*-ratio	*p*
Below 85	82.55	4.44	135	-6.430**	.000
85 and above	89.32	4.82			

$** p < 0.01$

The t-test result showed that there was a significant difference (t (135) = -6.430, p < 0.001) in the academic performance of the Grade 12 STEM students when they were grouped according to their Grade 10 Mathematics grade.

Those students whose grades were 85 and above had really better academic performance than those whose grades were below 85. This shows that one of the groups performed better than the other.

Conclusion

Based on the results of the objective of this study, it was found that the level of preparedness of the Grade 12 students to college engineering Mathematics had been consistent to have low preparation and was homogenous regardless of the group they belong to. Thus, retention of the Mathematics topics taught to them was insufficient and was evident as the academic performance was above the level expected however the level of preparedness was in contrast.

The academic performance of the Grade 12 STEM students was very satisfactory. However, when grouped according to their Grade 10 Mathematics grade, students whose grades were below 85 showed a satisfactory academic performance. The students had the needed competence for the Mathematics in the senior high school curriculum. Their grade in junior high school Mathematics was a predictor for their performance in the senior high school Mathematics as this competence was carried on to the senior high school where the students had satisfactory and very satisfactory grades in the Mathematics subjects.

There was a significant difference in the level of preparedness of the Grade 12 STEM students to engineering Mathematics when grouped according to target engineering program and Grade 10 Mathematics grade. This was seen between the groups who intend to proceed to civil engineering and those who were undecided yet and those whose Grade 10 Mathematics grade were 85 and above and those whose Grade 10 Mathematics grade were below 85. Students who were decided to take up civil engineering were mathematically prepared for their targeted engineering program than those who were still undecided. Likewise, those whose Grade 10 Mathematics grades were 85 and above were more mathematically prepared compared to those whose Grade 10 Mathematics grades were below 85.

It showed that the Grade 12 STEM students had homogenous academic performance in the senior high school Mathematics. However, it was notable that the significant difference occurred when they were grouped according to their Grade 10 Mathematics grade which showed that their performance in Grade 10 Mathematics reflected their performance in senior high school Mathematics. The students had the same academic performance regardless of their target engineering program in college.

Conflict of Interest

There is no conflict of interest between the authors in this manuscript.

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