

## A MULTIVARIATE ANALYSIS ON THE FACTORS AFFECTING THE STUDENTS' MATHEMATICS PERFORMANCE IN A MODULAR APPROACH OF DISTANCE LEARNING

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### Abstract

This study sought to examine the factors affecting the Science, Technology, Engineering and Mathematics (STEM) students' Mathematics performance in a modular distance learning at Notre Dame Village National High School (NDVNHS). In particular, the researcher was interested to determine if these factors had a significant effect on the students' Pre-Calculus and General Mathematics performance considering the number of hours spent in modular learning. The period covered by the study was during the first semester of the school year 2020-2021. The respondents were all 67 Grade 11 STEM students of NDVNHS. A quantitative research design was utilized particularly using Multivariate Analysis of Covariance (MANCOVA). The findings of the study revealed that majority of the STEM students had a good performance in their Mathematics subjects for the first semester. Also, the factors specifically type of motivation (intrinsic or extrinsic) and support system (parents, siblings, relatives, friends, or classmates) had statistically significant effect on their mathematics performance in the new normal considering the amount of time they spent in learning using modules. Moreover, there were statistically significant differences in both Pre-Calculus and General Mathematics performances between the type of motivation and support system when adjusted for the number of hours spent in modular learning. Based on the findings, the study concluded that the students' motivation and support system can greatly affect their mathematics performance when controlling for the allocated time in modular learning. Especially in Pre-Calculus and General Mathematics, motivation and support system are important factors in learning using modules. In the new normal education, the students should increase their level of motivation as well as exposure in self-learning and be given full support towards the processes in the modular approach of distance learning.

**Keywords:** *Modular Distance Learning, Significant Effect, Multivariate Analysis of Covariance*

### INTRODUCTION

Educational institutions have been providing distance learning programs for traditional and nontraditional learners for several years. With the recent coronavirus disease 2019 (COVID-19) pandemic which affected the entire education system, it brought a new phase in education which strengthened the idea of distance education particularly under basic education programs (Elumalai, et al., 2020). "Distance education is any educational process in which all or most of the teachings are conducted by someone geographically removed from the learner, with all or most of the communication between teachers and learners being conducted through electronic or print mediums" (UNESCO, 2006).

“As Philippines continues to confront different issues brought about by the COVID-19 pandemic, the Department of Education (DepEd) is addressing the challenges in the basic education for the school year 2020-2021 through its Basic Education-Learning Continuity Plan” (BE-LCP) under DepEd Order No. 012, s. 2020. As indicated, there are different learning delivery modalities that schools can adopt depending on the local health conditions, the availability of resources and the context of the learners in the school or locality. One of these is distance learning which refers to a modality where learning takes place between the teacher and the learners who are geographically remote from each other during instruction. This modality has three types, namely: Modular Distance Learning, Online Distance Learning and Television/Radio-Based Instruction.

Every Grade 11 student, both public and private, is required to take Pre-Calculus as one of the mathematics specialized subjects and General Mathematics as one of the mathematics core subjects offered in the Senior High School (SHS) program. The said subjects are studied in the first semester every school year. Many studies have demonstrated that students’ difficulty in understanding Calculus and this is caused by their weak understanding of functions which is studied in the contents of General Mathematics (Parrot & Kwan Eu, 2018). Since there was an educational practice shift from face to face to distance education, these subjects are now taught using modular distance learning especially in public schools. In the modular approach of distance learning, Self-Learning Modules (SLM) are provided to the students. According to Daries (1981) as cited by Sadiq & Zamir (2014), a module has placidly defined objectives preferably in behavioral form. A module covers either a single element of subject matter content or a group of content elements composing a discrete unit of subject matter or area of adeptness.

Due to the sudden change to this mode of learning delivery, students were not ready and consequently, experienced a lot of challenges in the teaching-learning process. It is now very evident that distance learning has started to play an important role in teaching and learning. Because of this, the researcher wanted to examine the factors affecting the Science, Technology, Engineering and Mathematics (STEM) students’ Mathematics performance in the new normal education at Notre Dame Village National High School (NDVNHS). In particular, the researcher was interested to determine if the identified predictors had significant effect on Mathematics performance considering the amount of time spent in modular distance learning.

## **METHODS**

### **Research Design**

Quantitative research design was utilized particularly using Multivariate Analysis of Covariance (MANCOVA). The respondents of the study were all 67 Grade 11 Science, Technology, Engineering and Mathematics (STEM) students of Notre Dame Village National High School (NDVNHS) who were officially enrolled in the first semester of the school year 2020-2021. Survey questionnaire as well as the requested grades were used in data analysis. For the data gathering procedure, the researcher sent a letter to the principal of NDVNHS to allow the conduct of the study. Then, the Pre-Calculus and General Mathematics grades were gathered and the survey was conducted through a Google Form. Finally, the researcher used Jeffreys’s Amazing Statistics Program (JASP) for statistical analysis.

Using 0.05 level of significance, the variables were determined as significant or not. For the decision of the significance, it was based on the generated p-value using JASP that if p-value is less than  $\alpha$ , where  $\alpha = 0.05$ , then, it is significant.

**RESULTS and DISCUSSION**

**Table 1**

*Performance of STEM Students in Pre-Calculus and General Mathematics (n = 67)*

Range of Grades	Performance in Pre - Calculus		Performance in General Mathematics	
	<i>f</i>	<i>f</i> %	<i>f</i>	<i>f</i> %
90 - 100	16	23.9	31	46.2
85 - 89	21	31.3	14	20.9
80 - 84	8	12.0	8	12.0
75 - 79	22	32.8	14	20.9
74 and below	0	0.0	0	0.0
	=	84.03	=	87.10
	=	5.954	=	6.569
<b>Total</b>	<b>67</b>	<b>100.0</b>	<b>67</b>	<b>100.0</b>

Note:

Range of Grades	Description
90 - 100	Outstanding
85 - 89	Very Satisfactory
80 - 84	Satisfactory
75 - 79	Fairly Satisfactory
74 and below	Did Not Meet Expectations

As presented in Table 1, the mean performance for Pre-Calculus was 84.03 with the standard deviation of 5.954 which can be described as satisfactory. On the other hand, the mean performance for General Mathematics was 87.10 with the standard deviation of 6.569 which can be described as very satisfactory. The result shows that 45 or 67.2% of the STEM students got a grade of at least 80% in Pre-Calculus while in General Mathematics, 53 or 79.1% of them got a grade of at least 80%. This further implies that majority of the STEM students had at least good performance in their Mathematics subjects in a modular distance learning as the mode of learning delivery.

**Table 2**

*Significant Factors Affecting the Students' Mathematics Performance (n = 67)*

Compared Variables		Wilks' Lambda (- sss)	p-value	Partial	Interpretation
Mathematics Performance	Sex	0.801	0.460*	0.063	Not Significant
	Age	0.610	0.765*	0.092	Not Significant
	School Graduated	0.663	0.524*	0.052	Not Significant
	Type of Motivation	4.170	0.028*	0.258	Significant
	Support System	2.615	0.018*	0.304	Significant
	Internet Access	1.979	0.160*	0.142	Not Significant

Note: \* $p < 0.05$ , significant at 0.05 level (two-tailed), covariate = hours spent in modular learning

Table 2 revealed significant difference in Mathematics performance (response) of the STEM students based on the type of motivation and the support system (factors) after controlling for the number of hours spent in modular learning (covariate),  $F = 4.170, p = 0.028 < 0.05$ , partial  $\eta^2 = 0.258$  and  $F = 2.615, p = 0.018 < 0.05$ , partial  $\eta^2 = 0.304$ , respectively. This means that the corresponding null hypotheses for these compared variables were rejected. However, the null

hypotheses were accepted for the performance and sex; performance and age; performance and school graduated; and performance and internet access, respectively. The result implies that the students' mathematics performance was significantly dependent on the type of their motivation and the support system they received while considering the amount of time spent in learning modules. In other words, the factors specifically type of motivation and support system had statistically significant effect on their mathematics performance in the new normal considering the time spent in modular distance learning.

Students' self-perceptions about their academic abilities are vital in their effort to adjust with their school tasks and responsibilities because these perceptions could influence the extent of efforts students exert for their school tasks (Farrington et al., 2012; Pajares & Schunk, 2001 as cited by Peteros, et al., 2019). As Hsu and Shiue (2005) cited by Chang (2011) noted, "In the distance learning environment, learners must be motivated to direct their own learning process because the teachers and students are physically separated." According to Smith (2004) as cited by Michael (2015), family background influences student performance in mathematics, and it is identified that students' cultural backgrounds differ and can affect students' influences to study mathematics.

**Table 3**

*Post-Hoc Test on the Significant Factors Affecting the Students' Mathematics Performance (n = 67)*

Compared Variables		Wilks' Lambda ( - sss)	p-value	Partial	Interpretation
Pre-Calculus Performance	Type of Motivation	8.238	0.008*	0.248	Significant
	Support System	5.440	0.003*	0.465	Significant
General Mathematics Performance	Type of Motivation	6.515	0.017*	0.207	Significant
	Support System	4.419	0.008*	0.414	Significant

*Note: \*  $p \leq 0.05$ , significant at 0.05 level (two-tailed), covariate = hours spent in modular learning*

As shown in Table 3, there were significant differences both in Pre-Calculus and General Mathematics performances (response) of the STEM students based on the type of motivation and support system (factors) after controlling for the number of hours spent in modular learning (covariate),  $p - \text{values} < 0.05$ . The result implies that students' Pre-Calculus and General Mathematics performances were significantly dependent on the type of their motivation and the support system they received when adjusted for time spent in learning modules. The result further emphasizes type of motivation and support system as important factors that have significant effect on students' mathematics performance while considering their time spent in modular distance learning.

Baynton (1992) introduced a theoretical construct about distance education which supports the findings of the study. According to her, the concept of control is defined by independence, competence, and support. She notes that control is more than independence. It requires striking a balance among three factors: a learner's independence (the opportunity to make choices), competence (ability and skill) and support (both human and material). Baynton's factor analysis confirms the significance of these three factors and suggests other factors that may affect the concept of control and which should be examined to portray accurately the complex interaction between teacher and learner in the distance learning setting.

## CONCLUSIONS

Based on the findings of the study, it is concluded that even in a distance learning, there are significant factors that can affect the performance of students in a particular set of subjects. In Mathematics, the students' motivation and support system can greatly affect their performance when controlling for the allocated time in modular learning. Especially in Pre-Calculus and General Mathematics, motivation and support system are important factors in learning using modules. In a new normal education, students should increase their level of motivation as well as exposure in self-learning and be given full support towards the processes in the modular approach of distance learning.

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