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A multiple linear regression model of students' performance in calculus in the new normal

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Abstract

The Philippines launched an educational reform in 2012, adding two years of senior high schools (SHS) with strands that aim to prepare students for work or pursue college degrees. The STEM strand was designed for those wishing to enroll in Science, Technology, Engineering, and Mathematics-related degree programs. This study investigates the performance in Calculus and the University admission examination of a random sample of 234 enrolled students for the First Semester of 2021-2022 at Caraga State University taking Differential Calculus. It tries to identify the socio-economic predictors of students' performance in Calculus. Results revealed that age, gender, SHS strand, enhancement program, and admission scores in English, Mathematics, and Abstract Reasoning correlate with students' Calculus performance. Also, the students who graduated from the SHS strand performed better in Calculus than those who did not. Nonetheless, Calculus student performance is regardless of the type of community, SHS type, and family monthly income. Among the socio-economic correlates, the SHS strand and calculus enhancement program are the main predictors of student performance in Calculus using multiple linear regression. Other significant predictors of Calculus student performance are the students' admission scores in Mathematics and Abstract Reasoning. This means that students who performed well in the Mathematics and Abstract Reasoning admission scores, along with SHS STEM strand enrolment and provision of the Calculus enhancement program, are indicators of students' performance in Calculus, implying the importance of mathematics interventions for the students' performance. Furthermore, an appropriate senior high school strand for college degree program preference is a necessary pre-requisite.

Keywords: Calculus enhancement program, mathematics intervention, STEM strand

Introduction

Background of the study

Mathematics is typically perceived to be difficult (Fritz et al., 2019, pp. 1-6). Nevertheless, mathematics is a gateway to many scientific and technological fields. Leaving it limits students' opportunities to learn a range of essential subjects, thus limiting their future job opportunities and constraining society to a potential pool of quantitatively literate citizens. A study by Rohani Ahmad Tarmizi (2010) pointed out that some students begin to stumble in basic mathematics and will need appropriate help to understand higher mathematics. There were several fields of mathematics students found challenging; one is Calculus. Calculus is complex because it requires hard work; mastery over algebra is more conceptual than introductory mathematics courses and has several highly abstract ideas. Students encounter calculus challenges because it is only sometimes intuitive and demands immense background information.

Based on the 2016 Philippine Statistics Authority report on the overall National Achievement Test (NAT) for the past years, learners still need to meet the standard the country's Department of Education (DepEd) set (Mirabueno & Boyon,2020). They further posited that the school district and its students must complete the standard competency cut-off set by DepEd; thus, teachers must reflect on how to attain better competency ratings. Low performance in NAT for grade 10 indicates that DepEd should continue the existing reviews and reforms to improve SHS program implementation. Also, providing interventions for Mathematical skills development must start from primary to secondary education. Moreover, results reported that Filipino students achieved an average score of 353 points in Mathematical Literacy, significantly lower than the Organization for Economic Co-operation and Development (OECD) average of 489 points (OECD, 2019).

Meanwhile, CARAGA Administrative Region (CARAGA), Philippines, had themes significant percentage of students below Level 1 proficiency at 79.15%. This indicates that students can answer questions involving familiar connections where all relevant learning is present, and the questions are clearly labeled. They can identify data and carry out routine methods concerning direct guidance in precise situations. They can execute operations that are almost always open and follow immediately from the given stimuli. Based on the result, CARAGA sets the lowest proficiency level in Mathematics literacy among 17 regions in the Philippines (Department of Education, 2019).

Regarding implementing K to 12 in the Philippines, curriculum makers argued that only STEM graduates would be accepted in the program for alignment purposes. In other countries, Tan and Dejoras (2019) observed that STEM graduates believe to be more capable in mathematics than non-STEM graduates. Other studies have shown that successfully completing the first year of required STEM courses is vital to retaining post-secondary STEM education; many student programs focus on improving student academic success in the first year. Student success in the college calculus courses required for math-intensive STEM majors, such as engineering, the physical sciences, and mathematics and statistics, is predictive of a student's decision to persist and graduate in a STEM major (Kopparla, 2019).

Recognizing Holes in the Curriculum

Some observable circumstances exist where students enroll in university courses beyond their senior high school track or strand. A concern like this may cause a student to falter in university. Furthermore, these considerable gaps bring into research which math courses

students take after an enhancement. Still, intuition informs that those students who require an enhancement in high school mathematics will not, and most likely should not, seek a degree that requires Calculus or even Pre-calculus. Hence, most students are not majoring in Science, Technology, Engineering, or Mathematics (STEM) disciplines (Allen, 2017). The outlet for most enhancement coursework is the community college, and those four-year colleges and universities that offer enhancement courses usually only provide the Beginning and Intermediate Algebra courses. In many of these institutions, students in enhancement courses must earn a grade of pass/fail course to move to the next level or enroll in the college-level math class required for their degree.

Moreover, emerging into new eras, computers, and digital applications are a part of student's daily life. Properly designed digital educational activities can become a powerful tool for efficient and effective learning. Interactive activities in teaching mathematics may contribute to developing learning stimuli and proper mental development (Zaranis et al., 2013).

Prerogative of the Study

Caraga State University integrated the Enhancement Program for Calculus into the student curricula to assist students who experience difficulties with Calculus 1 subject. The institution takes the initiative to help engineering, mathematics, physics, and chemistry students. The Enhancement Program accommodates students who did not achieve the standard math score during CRSUCAT (Caraga Regional State College Admission Test) and those who are non-STEM graduates during Senior High School. Additionally, the study focused on students' performance in calculus in the new normal utilizing a linear regression model. Adapting digitalization in teaching due to the expanse of the COVID-19 pandemic, Caraga State University shifted its modalities from face-to-face learning to online learning modalities. Conducting asynchronous and synchronous classes during the enhancement was utilized. This adaptation refers to Lavidas et al. (2022), who implicates that online activities for solving problem processes and approaching mathematical concepts should be created and recreated in this context, providing enriched environments with suitable materials for learning mathematics.

Methodology

Research Design

This study employed a causal research design. The study first explored how students' grades in Calculus are distributed across profile variables under study. It tries to identify whether the Calculus performance of students enrolled in the new normal is comparably different across categories of profile variables. The study also wishes to determine whether the pre-identified profile variables, along with the other metrics, are correlated with the students' performance in Calculus. Finally, significant predictor variables are determined to list independent variables that are significantly influencing the students' performance in Calculus.

Respondents of the Study

A random sample of 234 student respondents participated in the study using proportionate stratified random sampling. Since the study focused on determining the predictors of students' performance in Calculus, it targeted those enrolled in the Math 13 classes (Calculus 1) at Caraga State University, Butuan City, Philippines, during the school year 2021-2022. The

sample thus includes those enrolled in a Calculus Enhancement Program (EP) and those not. EP was offered along with the students' enrolment in the Calculus course and given to undergraduate students who graduated from a Non-STEM (Science, Technology, Engineering, and Mathematics) Senior High School (SHS) Strand.

Majority of the students are 18-21 years old (97.01%), females (50.85%), graduated from a public school (78.21%), and are residing from rural communities (52.99%) where internet connectivity is a challenge. On one hand, 50.43% (or 118 of 234) of them come from a poor family, and 30.34% (or 71 of 234) from a low-income class but not poor. The remaining 19.23% (45 of 234) belong to at least lower middle-income class families.

Table 1

Student-participants profile

	f	%
Gender		
Male	115	49.15
Female	119	50.85
Type of Community		
Urban	110	47.01
Rural	124	52.99
Senior High School Type		
Public	183	78.21
Private	51	21.79
Senior High School Strand		
STEM	132	56.41
Non-STEM	102	43.59
Calculus Enhancement Program		
With	112	47.86
Without	122	52.14
Family Monthly Income		
Poor	118	50.43
Low Income Class	71	30.34
At least lower middle-income class	45	19.23

Instrumentation

This study utilized a self-made survey instrument and secondary data from the University's offices. The survey instrument has undergone a series of content validation with the experts. The experts were provided with a questionnaire validation sheet with a scale from 1 (Poor) to 5 (Excellent), which rated the proposed survey instrument with Clarity of Directions and Items (4.50; Excellent), Presentation and Organization of items (4.00; Very Good), Suitability of items (4.00; Very Good), Adequateness of items per category or indicator (5.00; Excellent), Attainment of purpose (5.00; Excellent), Objectivity (5.00; Excellent), and Scale and Evaluation Rating (5.00; Excellent). A pilot testing was done to ensure the observed data's correctness. The survey questionnaire was revised to facilitate the confusion observed in the pilot testing and as recommended by the content validators.

The final survey questionnaire consists of 2 parts. Part 1 covers the demographic profile of the respondents which includes the age (in years), gender (male or female), residential type of community (urban or rural), SHS Strand (STEM or non-STEM), SHS

category (public or private), and family monthly income class). Part 2 includes the Calculus Enhancement Program practices and their encountered challenges of its implementation. Practices include the mode of instruction, frequency of virtual classes and conduct of quizzes, and whether there are feedbacking activities conducted. On the other hand, secondary data such as student grades in Calculus in the First Semester of Academic Year 2021-2022 that ranges from 1.00 (highest) to 5.00 (lowest), EP enrolment (with or without Calculus enhancement program), and admission tests scores for Mathematics, English, and Abstract Reasoning and were collected.

Data Gathering Procedure and Ethical Considerations

The researchers sought permission from the Caraga State University regarding the study targeting the undergraduate students enrolled in a Calculus course at the mentioned University. An approved letter signaled the start of the data gathering. Concerned faculty members of the students were also requested to facilitate the data gathering. The said faculty members provided the number of students per section categorized according to the enrollment in the enhancement program to compute the desired sample size per stratum. Each study participant received a link to the survey in Google form, where they indicated the needed information for the study. The Google form contains a confidentiality clause at the beginning of the survey, assuring the participants that all information gathered would be confidential. The researcher assured that the research would not harm the participants and that their voluntary participation was vital. Study participants who opted not to participate or did not provide complete information were not included in the sample. For example, if a student did not consent to disclose their grades for the study's use, they were excluded from the selection since the grade as the students' performance is the study's dependent variable.

Data Analysis

Frequencies and percentages were calculated to describe the implementation practices of the students' Calculus enhancement program. On one hand, means, standard deviations, and coefficients of variations were computed to compare students' performances in Calculus across the categories of the profile variables.

Spearman Correlation was performed to determine whether students' performance in Calculus correlates with their age, family monthly income, and admission scores in Mathematics, English, and Abstract Reasoning. Moreover, point-biserial correlation was applied to test whether the students' performance in Calculus (numerical grades), and their gender, residential type of community, SHS type, SHS strand, enrolment in the enhancement program were associated. Finally, a multiple linear regression analysis was performed to create a predictive model of students' performance.

Results and Discussions

Calculus Students' Performances in Relation to Profile variables

The shift from high school to college is an adjustment that every student must cope with in pursuing a university education. The sudden change from Face-to-Face classes to online mode adds to the burden that college entrants have encountered. This necessary transformation is where educational interventions should occur so as not to disrupt learning. College education equips a pathway for students to explore their interests and socio-cultural experiences and

builds a more promising career (Garcia & Al-Safadi, 2014). Several empirical studies were conducted to determine whether socio-economic variables contribute to student performance.

Table 2 distinguishes student performances in Calculus across categories of profile variables. As depicted, male students tend to outperform female students with higher mean grades and with less varied responses. The result also compares the mean average of students living in rural or urban communities. Results of Stanley et al. (2007) study, rurality was not significantly related to school adjustment, but rather, the characteristics of individuals living within those communities were. His study indicated that participation in school and non-school activities, the strength of rural schools, can positively affect school adjustment. Given the significant relationships between income and parental education in all school-related variables, a critical long-term strategy may lie in improving the economic atmosphere of rural areas.

Though the study reveals the same mean grade in school type attended, it also displays a lesser proportion of respondents attending public and private schools during their senior high school years. These results support Frenette and Chan (2015) that private schools had higher percentages of students living in two-parent families with biological parents than public school students. Their total parental income was higher, and they tended to live in homes with more books and computers. However, public school students were likelier to live in rural areas, have fewer resources like books and computers, and lower parental income.

Table 2

Students' Calculus performance comparison across profile variables

	Student Performance (Numerical Grade)		
	Mean	SD	CV (in %)
Gender			
Male	2.03	0.83	41.04
Female	2.33	1.03	44.22
Type of Community			
Urban	2.20	1.05	47.69
Rural	2.17	0.85	39.39
Senior High School Type			
Public	2.18	0.98	45.08
Private	2.18	0.82	37.46
Senior High School Strand			
STEM	1.82	0.59	32.60
Non-STEM	2.65	1.11	41.76
Calculus Enhancement Program			
With	2.31	0.87	37.55
Without	2.06	1.00	48.70
Family Monthly Income			
Poor	2.25	0.96	42.80
Low Income Class	2.23	0.96	43.01
At least lower middle-income class	1.91	0.85	44.55

Parents pass their socio-economic drawbacks on to their children in many cases. Most underprivileged children will likely develop a profile where their aspirations, expectations, and actual academic outcomes are misaligned or aligned at the lower end (Khattab, 2015). Furthermore, Padios et al. (2021) assert that lower-income respondents were

more likely to venture into entrepreneurship than a study after senior high school. Compared to the middle-income class, male respondents were more likely to be layout than learning. Regarding gender differences, adolescent males reported more significant uncertainty about their career aspirations than teenage females. Correspondingly, the study took a glimpse at the enhancement program enrolled by the respondents. As presented, enhancement programs transcend without enhancement programs with higher mean grades and less varied values.

Table 3

S*tudents' Calculus performance across age and college entrance admission component scores*

	Student Performance					
	1.00-1.75		2.00-3.00		Below 3.00	
	Mean	SD	Mean	SD	Mean	SD
Age	19	1.24	19	1.28	20	0.68
Mathematics Admission Score	11.28	3.22	9.02	2.68	7.94	3.62
English Admission Score	25.56	4.15	23.97	4.32	23.44	3.76
Abstract Reasoning Admission Score	27.82	3.63	24.68	5.96	22.69	6.98

As presented in the table, a higher admission score means that mathematics, English, and abstract reasoning acquire higher grades of 1.00-1.75. Students with an average mean of 20 in age usually marked a rate of below 3.00. Also, upon examining their admission scores in the three areas, it can be gleaned that students with lower college entrance admission scores obtained a grade below 3.00. This result agrees with Alnahdi (2015) finding that there is consequential literature regarding the relationship between standardized entrance examinations and college performance. For instance, Rigney et al. (2020) found that students with high standardized eligibility scores performed better. Another noteworthy study by Sulphey and Alkahtani (2018) found that based on the thought pattern that learning is an accumulative process, students with higher entry capabilities are better prepared for course content than those with lower capabilities.

Classroom Practices and Challenges Encountered

Face-to-face learning was one of the worst-hit by the COVID-19 pandemic. Thus, institutions scrambled to find solutions for continuous education. In these times and conditions, online learning tools emerged as beneficial. One of these was the conduct of the Enhancement Program in Calculus 1 through an online platform. Although there was easy access to utilizing an online venue, several difficulties needed to be considered. This study analyzes the barriers and challenges encountered by the students during the Enhancement Program in Calculus 1.

Table 4 reveals the mode of instruction instructors utilized during the Calculus enhancement program. As observed, bichronous classes (a combination of asynchronous and synchronous courses) top the most utilized instruction with 49.09%. It is followed by synchronous type by 38.18%. It implies that in most class discussions, students can access the instructional materials each week at any time. Accordingly, instructors virtually meet and conduct quizzes for the students once a week with 63.64% and 83.64%, respectively. Undeniably, 75.45% of the students confirmed that they received immediate instructor feedback. The data imply that students' query about the discussion was answered immediately, ensuring that learning occurs. Study by Al Rawashdeh et.al (2021), the virtual learning method

helps teachers and students access course contents in digital form and share knowledge while making learning more effective with increased interaction among teachers and learners through online forums, and scope sharing. These venues stimulate learning through different features, including developing online courses and evaluating and monitoring activities for students and teachers.

Table 4

Classroom implementation for Calculus enhancement program

	f	%
Mode of Instruction		
Asynchronous	14	12.50
Synchronous	42	37.50
Bichronous	54	48.21
Frequency of Virtual Classes		
Once a Week	70	62.50
Twice a Week	31	27.68
More than twice a week	9	8.04
Frequency of Conduct of Quizzes		
Once a Week	92	82.14
Twice a Week	9	8.04
More than twice a week	9	8.04
Conduct of Immediate formative assessment feedbacking		
Yes	83	74.11
No	27	24.11

Table 5 displays the challenges encountered by the students during the conduct of the Enhancement Program. Students faced several challenges that affected their learning process. One of the top challenges was internet connectivity with 84.55%, conflict with other activities (i.e., house chores, nature of work), and distraction (i.e., noise from the community, social media) with 70.91% and 58.18 %, respectively. It can be observed that the existing health conditions were marked as the lowest challenges of the students, with 18.18% only.

In a corresponding study, Kapasia et al. (2020) analyzed how lockdown influences students' learning performance. Findings disclosed that the lockdown significantly disrupted students' learning experience. The students also noted some challenges that they faced during their online classes. These include poor internet service and an unfavorable home learning environment worsened when students are marginalized and from remote areas.

Moreover, around 41.82% affirmed that students gained instructional support from their parents/guardians, and 38.18% stated that they found support from others. Students pointed out that they used online sources (i.e., YouTube, Google) with 91.82% and downloaded softcopy materials for Calculus 1 with 53.64%. Only 22.73% stated that they had available calculus books at home. Lastly, 62.73% of the students stated that they had a personal learning space during class sessions.

Table 5

Challenges encountered by students in the Calculus enhancement program

Challenges	f	%
Internet Connectivity	93	83.04
Conflict with other activities (i.e, house chore, nature of work)	78	69.64
Distraction (i.e, noise from community, social media)	64	57.14
Difficulty in independent learning	54	48.21
Lack of available gadgets for online class	42	37.50
Existing health condition	20	17.86

This result conforms to the study of Baticulon et al. (2021), which states that the most frequently encountered difficulties are adjusting learning styles, performing duties at home, and poor communication or absence of clear directions from educators. Around two-thirds of the respondents always or often encountered these barriers. Also, it is foreseen that the lack of physical space is a barrier to studying and causes mental health difficulties. The data indicated that speedy and reliable internet connections were more crucial than device privilege. One out of ten students always lacked essential needs such as food, water, medicine, and safety. The study also considered the mode of class instruction utilized during the enhancement program for Calculus 1.

Correlates of Students' Performance in Calculus

This section presents the relationships between students' grades in Calculus 1 based on the first semester of the academic year 2021-2022 and the pre-identified socio-economic variables. As reflected in Table 6, the variables - the type of community, senior high school type, and family monthly income are not significantly correlated with students' performance in Calculus, with p-values of 0.809, 0.987, and 0.076, respectively.

Nonetheless, the socio-economic correlates of students' performance in Calculus are the variables - age, gender, Senior High School Strand, enhancement program (with or without), and admission scores in Mathematics, Abstract Reasoning, and Mathematics, with p-values less than 0.05. These findings suggest that male students tend to have higher Calculus grades than females. Moreover, students who graduated from a STEM strand in their Senior High School and those with a Calculus enhancement program tend to perform better in their college Calculus classes than those who graduated from the non-STEM strands and without the mentioned enhanced program. Based on PISA 2015 by the Ministerio de Educacion Cultura y Deporte (2016), the distinction in mathematics performance between males and females aged 15 is a standard of 8 points in OECD nations where the Philippines belongs and 11 points in the European Union (EU), with boys scoring higher than girls. The present study tries to answer whether there is a distinction in Calculus performance across students' gender.

Table 6

Relationship between student performance in Calculus and socio-economic profile and admission score components

Variable 1	Variable 2	Correlation Coefficient	P-value	Remark
Calculus Performance	Age[a]	0.239	0.000	Significant (Weak)
	Gender[b] *(Male - 1, Female - 0)*	-0.157	0.016	Significant (Very Weak)
	Type of Community[b] *(Urban - 1, Rural - 0)*	-0.016	0.809	Not Significant
	SHS Type[b] *(Public -1, Private - 0)*	-0.001	0.987	Not Significant
	SHS Strand[b] *(STEM -1, Non-STEM - 0)*	-0.435	0.000	Significant (Moderate)
	Enhancement Program[b] *(With - 1, Without - 0)*	-0.135	0.039	Significant (Very Weak)
	Family Monthly Income[a]	-0.116	0.076	Not Significant
	Mathematics Admission Score[a]	-0.356	0.000	Significant (Moderate)
	English Admission Score[a]	-0.174	0.008	Significant (Very Weak)
	Abstract Reasoning Admission Score[a]	-0.316	0.000	Significant (Moderate)

Note. Tested at 0.05 level of significance using Spearman Rho correlation[a] or Point-Biserial Correlation[b]

This result emphasizes the importance of the strand the students chose in senior high school to their college degree, considering that Calculus 1 is one of the pre-requisite subjects needed to pass college engineering, mathematics, physics, and chemistry courses. Hence, aligning strands in senior high school to the mentioned programs greatly benefits the students. As Santos et al. (2019) claimed, students with a strong desire for their career can lead a better pathway in college as they have chosen strands that align with their current college courses. Moreover, it is recommended that incoming senior high school students choose strands related to the career path of their likeness, as it will help them develop their skills.

On the other hand, results also imply that the student's age is weakly correlated with their Calculus performance. Furthermore, the admission scores of the students in terms of Mathematics and Abstract Reasoning are significantly correlated with their performance in Calculus. This result parallels the notion that students with high scores on standardized mastery and achievement tests are most likely to achieve academically; universities and colleges accord considerable importance to it (Bettinger et al., 2013). Better grades in standardized eligibility tests are essential for university programs' admission. This notion is based on the thought pattern that learning is an accumulative process. The student admitted with higher entry qualifications is expected to be better prepared for the course content than those with lower qualifications (Sulphey et al., 2018).

Predictors of Students' Performance in Calculus

Table 7 provides the regression analysis summary for predicting students' performance in Calculus. The model's independent variables –admission scores in Mathematics (*MAS*) and Abstract Reasoning (*ARAS*), enhancement program (EP), and Senior High School strand (SHSS) account for 31.1% of the variation of the student's performance in Calculus. This means that other variables must be further investigated to explain the remaining 68.9% of the variation in the student's performance in Calculus.

The regression model is given by:

$$\boldsymbol{Performance = 4.466 - 0.038(ARAS)^{*} - 0.064(MAS)^{*} - 0.423(EP)^{*} - 0.852(SHSS)}$$

The results of the study explored the factors that predict students' performance in Calculus. The study's findings suggest that the four variables, namely students' admission scores in Mathematics and Abstract Reasoning, an enhancement program, and Senior High School Strand, are significant predictors of students' performance in Calculus, thereby can be used to predict how well a student will perform in college Calculus. The results imply that the mentioned variables strongly impact how well students perform in the course. Specifically, it is noteworthy that an increase of 0.038 units in the Calculus grade can be expected for every unit increase in the Abstract Reasoning admission score. Similarly, a one-point increase in the mathematics admission score is associated with a 0.064 increase in the Calculus grade.

As unveiled from the data, the student's admission score in Mathematics and Abstract Reasoning, participation in an enhancement program intended for the course, and an appropriate Senior High School Strand are the significant predictors of their performance in college Calculus. Nguyen et al. (2019) derived a regression model with the student's performance in admission tests having the highest prediction power regarding academic performance in Mathematics. Reyes (2019) found that admission test results and mathematical performance are related. Anderton et al. (2017) noted the significant contribution of secondary mathematics courses and other courses to first-year university grades.

Table 7

Regression Analysis summary for Calculus student performance predictors

Variable	β Coefficients	Standard Error	$t-$Statistic	P-value*	Remark
Intercept	4.466	0.310	14.41	0.000	Significant
Abstract Reasoning Admission Score (ARAS)	-0.038	0.010	-3.73	0.000	Significant
Mathematics Admission Score (MAS)	-0.064	0.018	-3.59	0.000	Significant
Enhancement Program (EP):	-0.423	0.127	-3.33	0.000	Significant

With - 1, Without - 0					
SHS Strand (SHSS): *STEM -1, Non-STEM - 0*	-0.852	0.129	-6.62	0.000	Significant

Note. R^2=0.311 (n = 234, DF = 4, F = 25.713, p < 0.001). *Tested at 0.05 level of significance

The regression model identified that the two main contributors to the increase in the performance of Calculus are the student's enrollment in the Calculus enhancement program and as a product of a STEM strand in Senior High School. The results indicate that enrollment in the Calculus enhancement program increases the Calculus grade by 0.423 units. The finding suggests that students participating in the program can improve their Calculus skills, positively impacting their overall performance.

Additionally, the results show that graduating from a STEM strand in Senior High School predicts an increase in the Calculus grade by 0.852 units. Students with a strong foundation in STEM subjects are likelier to perform well in Calculus. These findings are consistent with the research conducted by Amanonce (2020), which suggests that students who have exposure to rigorous academic preparation and more instructional exposure to high school mathematics are better prepared for college mathematics. This influence indicates that students with a strong STEM background are more likely to be prepared for college-level Calculus courses. Overall, the results suggest that enrollment in the Calculus enhancement program and having a STEM background in Senior High School are significant factors that can positively impact students' performance in Calculus.

Conclusions and Recommendations

After a thorough analysis, the following are deduced: Students who graduated from the STEM strand in their senior high school performed better in Abstract reasoning, math, and English admission scores than non-STEM students. Moreover, the Enhancement Program in Calculus 1 significantly affected the student's performance in Calculus 1. It further implies that the performance of students enrolled in the enhancement program showed positive development after the program. Consequently, most students who undergo pre-university programs have average passing grades. Accordingly, independent variables such as age, gender, SHS strand, enhancement program, admission score, and pre-university intervention program significantly correlated with students' performance in Calculus 1. While all admission criteria were important variables, only math and abstract reasoning admission scores significantly predicted student performance in Calculus. Also, as the results indicated, the senior high school strand and enhancement program predict future calculus performance.

The study then recommends that students are encouraged to enroll in college courses related to their SHS strand. During Senior High School, students will acquire the necessary skills for their future professions. These skills equip them to perform their work better. The researcher also suggests that it would be helpful for senior high school students to enroll in a course they are genuinely interested in college. Enrolling in a school specializing in their skillfully inclined studies would benefit students. The researcher believes that students will perform better and be more motivated in college in a course they like. In addition, senior high school students proposed to build a solid academic foundation and develop critical thinking skills, especially in the competencies in mathematics.

It would be suitable for teachers to focus on teaching the learning competencies found difficult by students. Also, it would be helpful for teachers to strengthen the mathematical foundation of the students before moving them to higher education. Students need a solid basis, especially in pursuing math-related courses in higher education. It would be favorable for instructors in enhancement programs to focus on teaching the learning competencies found difficult by students. Also, curriculum developers from the K-12 and higher education sectors may consider preparing students for college and continue to think innovatively about this relatively recent enhancement program. Also, it would be advantageous to revisit the syllabus utilized by the enhancement program for better-expected students' success.

It would also be good practice for classroom implementers to provide insight to policy-making bodies on how the Enhancement Program for Calculus 1 has been performing. Also, it would be helpful for the administrators to consider the admission standards for incoming college students. It may be beneficial to see those students taking engineering courses, physics, chemistry, and mathematics to view admission scores in mathematics and abstract reasoning. It would be helpful if mathematics instructors modified their strategies and instructional materials for students who experienced difficulties in Calculus 1. Most specifically, those students experience challenges with online class instruction. Finally, future researchers are encouraged to explore other predictors that influence the students' performance in Calculus 1. More variables must be dealt with for more precise results.

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