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COMPARISON OF THE CALCULUS 1 PERFORMANCE OF ENGINEERING STUDENTS FROM STEM AND NON-STEM SHS STRANDS

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Abstract

The study aimed to compare the Calculus 1 performance of engineering students from STEM and non-STEM SHS strands. A total of 486 engineering students comprise the respondents of the study. Of the 486 respondents, 466 students were from STEM SHS strand and 20 students were from non-STEM SHS strand. Data were collected using the (1) Midterm Departmental Exam (MDE), (2) Final Departmental Exam (FDE), and (3) Final Grade. The results revealed that engineering students performed poorly in Calculus 1. Moreover, a significant difference between the performance of engineering students from STEM and non-STEM SHS strands in finding derivatives was found. This showed that engineering students from STEM strand performed better in finding derivatives than the engineering students from the non-STEM strand. Similarly, a significant difference was found between the performance of engineering students from STEM and non-STEM strands in the applications of derivatives. This indicated that engineering students from STEM strand have a better performance in the applications of derivatives than the engineering students from the non-STEM strand. In regard to the Calculus 1 performance of engineering *students from STEM and non-STEM strands, a significant difference was also found. The result revealed that engineering students from STEM strand outperformed the engineering students from the non-STEM strand in Calculus 1. The study recommended further investigation of the possible causes of students' poor performance in Calculus 1 which include revisiting both the SHS and engineering curriculums.*

Keywords

Calculus 1 Performance, Engineering Students, SHS Strands, STEM, Non-STEM

1. Introduction

Calculus 1 is a Commission on Higher Education (CHED) mandated technical course for engineering students under the revised engineering programs effective AY 2018-2019. It is a 3-unit introductory course that covers the core concepts of limits, continuity, and differentiability of functions involving one or more variables. It also includes the application of differential calculations in solving problems on optimization, rates of change, related rates, tangents and normal, and approximations; partial differentiation and transcendental curve tracing. (CMO no. 101, s. 2017)

Aside from being one of the CHED's mandated technical courses, Calculus 1 is regarded as one of the fundamental courses for all engineering programs at the tertiary level. Indeed, most of the higher engineering courses are calculus-based. Thus, a solid foundation in Calculus 1 is deemed necessary for engineering students.

In the old curriculum, Calculus 1 was called Differential Calculus. It was a 4-unit course offered to second-year engineering students every first semester. Before taking Differential Calculus, engineering students should have passed the prerequisite courses such as College Algebra, Plane and Spherical Trigonometry, Advanced Algebra, Solid Mensuration, and Analytic Geometry (CMO no. 29, s. 2007). These prerequisite courses served as the critical filter to many engineering students.

However, due to the implementation of the K to 12 curriculum, Calculus 1 is offered to first-year engineering students every first semester. It is the first math subject to be taken by the engineering students. With K to 12, students are expected to be better prepared in Calculus 1. This is due to the inclusion of the prerequisite courses from the old tertiary level curriculum to the senior high school (SHS) curriculum (Congress of the Philippines, 2013). Moreover, this makes the offering of the prerequisite courses in the old curriculum no longer relevant to the present university students (Cruz, 2014) especially in Calculus 1.

Though taking Calculus 1 does not require any prerequisite courses, university professors considered students' level of preparation in taking this course as a great deal of concern. A study revealed that deficiencies in Algebra and Pre-calculus skills continue to adversely impact university students when they take their Calculus course (Agustin & Agustin, 2009). Accordingly, students' knowledge of Algebra and understanding of Trigonometry has a significant impact on their performance in Calculus (Ferrer, 2017). This clearly shows that engineering students should possess the basic math skills required for Calculus 1.

However, these basic math skills are only evident to SHS students who took the Science, Technology, Engineering, and Mathematics (STEM) strand. Since, from among the SHS strands, Pre-calculus and Basic Calculus were only taken by STEM students, as parts of their specialized subjects (DepEd, 2014). Undeniably, the Basic Calculus offered in SHS is not the kind of Calculus meant for a two-semester course for engineering students in college (Cruz, 2014). Nonetheless, STEM students are presumed to be more literate in mathematics. And, therefore, capable of undertaking advanced mathematics courses like Calculus 1.

Initially, in the last two years of the K-12 curriculum, students are required to choose from four SHS tracks. These tracks are specific areas of study much like college courses: Academic, Technical-Vocational-Livelihood (TVL), Sports, and Arts and Design. These will equip students with the competencies and advanced skills required to better prepare them in higher education (college) or TECH-VOC education (skills' development), in employment, in entrepreneurship, and, most important, in life (Banal-Formoso, 2016). Majority of the students who choose academic tracks is those who plan to proceed to college (Sarmiento & Orale, 2016). The Academic track has four strands: Accountancy, Business, and Management (ABM); Science, Technology, Engineering, and Mathematics (STEM); Humanities and Social Sciences (HUMSS); and General Academic Strand (GAS). Students who wished to pursue engineering programs in college should take STEM strand.

However, last December 29, 2017, CHED released a memorandum order on the policy on the admission of SHS graduates to the higher education institutions (HEIs). It is indicated in the CMO that all Grade 12 graduates beginning AY 2017-2018 are eligible to enter college regardless of the track or strand taken in SHS. Moreover, applicant grade 12 graduates may enroll in any higher education program subject to the admission requirements of the admitting HEI (CMO no.105 s. 2017).

Consequently, the first batch of SHS graduates who have not taken the STEM strand is also allowed to pursue engineering programs. However, these students are facing the challenges of learning Calculus 1 due to the lack of basic math skills necessary for the course. As a solution to these challenges, the admitting HEI has the option to give the students a bridging program (Casiple, 2018). The bridging program is intended for the students with insufficient mathematics preparation such as students from the non-STEM strand. Other HEIs, however, choose not to offer a bridging program.

To address this issue, the researcher opted to conduct a study to compare the Calculus 1 performance of engineering students from STEM and non-STEM SHS strands. So, the researcher can provide baseline data that can be utilized to improve the education system.

2. Methodology

2.1 Research Design

A descriptive-comparative research design was employed in this study. The descriptive design was carried out to describe the current status of the students. The comparative design, on the other hand, was utilized to compare two or more groups of students with a view of discovering something about them. In this study, the students were grouped as: from STEM SHS Strand and non-STEM SHS Strand.

2.2 Respondents of the Study

The researcher considered the entire population of first-year engineering students who were enrolled in Calculus 1 course for the 1st semester, AY 2018-2019. However, those students who dropped from the course were removed from the respondents. Thus, a total of 486 first-year engineering students were considered respondents of the study. The respondents were divided into two groups: the STEM SHS Strand with 466 students and non-STEM SHS Strand with 20 students. Students from non-STEM SHS strand consist of 5 students from ABM strand, 3 students from HUMSS strand, 4 students from GAS, and 8 students from TVL track.

2.3 Research Instruments

To assess the students' performance in finding derivatives and performance in the applications of derivatives, two instruments were utilized. These instruments were the two departmental examinations, which were required to take part in the students' semester course. The two departmental examinations were (1) the midterm departmental exam (MDE) and the final departmental exam (FDE). The scores obtained by the students in the MDE were used to determine their performance in finding derivatives while the scores they obtained in the FDE were used to determine their performance in the applications of derivatives. Both examinations were made by the researcher, and the other assigned faculty members of the mathematics department. Both exams underwent face validation to ensure that the exams measure what they intend to measure. Face validation was done by the other faculty members of the mathematics department who were not among those assigned to create the exams. Furthermore, the MDE and FDE were approved and endorsed by the mathematics department chairperson.

The MDE and the FDE were both multiple-choice type of tests that consist of 40 items with each item having four answer choices. The items of the MDE were divided as follows: finding the derivative of a function using the first nine basic differentiation formulas (11 items), using the differentiation formulas of trigonometric functions (5 items), using the differentiation formulas of inverse trigonometric functions (5 items), using the differentiation formulas of exponential functions (5 items), using the differentiation formulas of logarithmic functions (5 items), and using the differentiation formulas of hyperbolic functions (5 items). It also includes 2 items of implicit differentiation and 2 items of finding the higher-order derivative of a function.

Whereas, FDE's items were divided as follows: finding the slopes and equations of tangent and normal lines (10 items); finding the angle of intersection between two given curves (4 items); determining the critical points, maximum and minimum points, points of inflection of a function and whether a function is increasing or decreasing (8 items), solving problems which involve the applications of maxima and minima (6 items), solving related rates problems (6 items), and finding the first and higher-order partial derivatives of a function (6 items).

Regarding students' Calculus 1 performance, the students' final grades in Calculus 1 were utilized. The final grade was based on the midterm exam (20%), final exam (20%) and class standing (60%).

2.4 Data Gathering Procedure

The MDE and the FDE were administered to the entire population of engineering students who were taking Calculus 1 course on their assigned examination schedule during the midterm examination week and the final examination week, respectively. The students' scores in the MDE and FDE and their final grades in Calculus 1 were collected during and after the deadline of posting or submission of students' final grades. These data were collected from the students' respective professors.

2.5 Statistical Analysis

In determining the statistical tools to be used in this study, the normality test Kolmogorov-Smirnov Test was first carried out. Kolmogorov-Smirnov test was used to determine whether students' performance in finding derivatives, performance in the applications of derivatives, and performance in Calculus 1 do not significantly differ in a normal population. The results showed that the *p*–values of the three performances are less than 0.05 (see Appendix, Table 11). Thus, the distribution of the students in the three performances is significantly different from the normal population. Hence, non-parametric tests must be used in statistical analysis.

The following statistical tools were utilized by the researcher: (1) The Kruskal-Wallis H test, to determine if significant differences exist among the performance in finding derivatives, performance in the applications of derivatives, and Calculus 1 performance of engineering students from different SHS strands/track. And (2) The Mann-Whitney U test, to determine if a significant difference exists between the performance in finding derivatives, performance in the applications of derivatives, and Calculus 1 performance of engineering students from STEM and non-STEM SHS strands. It was also used as a post hoc test for Kruskal-Wallis H test.

3. Results and Discussions

3.1 Comparison of the Performance of Engineering Students from different SHS Strands/Track in Finding Derivatives

As shown in Table 1, the engineering students from STEM strand got the highest mean rank of 239.07 in their performance in finding derivatives. The second highest mean rank was obtained by the engineering students from the HUMSS strand (mean rank = 244.50). The third and fourth mean ranks were obtained by the engineering students from GAS (mean rank = 314.75) and ABM (mean rank = 361. 02) strands, respectively. While the lowest mean rank was obtained by the engineering students from TVL track (mean rank = 392.06). It can be observed that the mean ranks of the performances of the engineering students from different SHS strands/track in finding derivatives were extremely far from the overall highest rank of 1.50 (see Appendix, Table 8). Moreover, the overall mean rank performance of the engineering students in finding derivatives was 243.50 with a standard deviation of 140.184 (see Appendix, Table 7). This only showed that the performances of engineering students from different SHS strands/track and their overall performance in finding derivatives was poor.

Students' poor performance in finding derivatives was also evident in the students who participated in the study of Pyzdrowski, et al. (2013). In their study, students suggested logarithms as difficult topics. However, the instructors who participated in the study described students' difficulty with exponential functions, implicit differentiation, and trigonometry.

Table 1 also shows the Kruskal-Wallis H value of 14.009 and the *p*-value of 0.007 which is less than 0.01. This revealed that there were significant differences in the performances of engineering students from different SHS strands/track in finding derivatives.

Table 1: *Comparison of the Performance of Engineering Students from different SHS Strands/Track in Finding Derivatives*

SHS Strands/Track	*n*	Mean Rank	Kruskal-Wallis H	*p*-value	Interpretation
STEM	466	239.07	14.009**	0.007	significant
ABM	5	361.02			
HUMSS	3	244.50			
GAS	4	314.75			
TVL	8	392.06			
Total	486				

**significant at $p < 0.01$

To confirm where the significant differences in the performance in finding derivatives occurred among SHS strands/track, the post hoc test, Mann-Whitney U, as shown in Table 1.a was performed. As can be gleaned in the table, a significant difference in the performance in finding derivatives exists between engineering students from STEM strand and TVL track (Mann-Whitney U = 694.000, $p = 0.002 < 0.01$). This specified that engineering students from STEM strand performed better in finding derivatives (mean rank = 234.99) than engineering students from TVL track (mean rank = 383.75).

Table 1a: *Post Hoc Test on the Comparison on the Performance of Engineering Students from different SHS Strands/Track in Finding Derivatives*

SHS Strands/Track	Mean Rank	Mann-Whitney U	*p*-value	Interpretation
STEM ABM	234.74 353.10	579.500	0.053	not significant
STEM HUMSS	234.97 240.33	683.000	0.945	not significant
STEM GAS	234.87 308.88	638.500	0.277	not significant
STEM TVL	234.99 383.75	694.000**	0.002	significant
ABM HUMSS	5.30 3.17	3.500	0.230	not significant
ABM GAS	5.60 4.25	7.000	0.459	not significant
ABM TVL	6.20 7.50	16.000	0.555	not significant
HUMSS GAS	3.50 4.38	4.500	0.593	not significant
HUMSS TVL	3.50 6.94	4.500	0.124	not significant
GAS TVL	4.75 7.38	9.000	0.232	not significant

**significant at $p < 0.01$

The low performance of engineering students from TVL track as compared to engineering students from STEM strand was possibly due to their lack of mathematics subjects or any academic subjects during their senior high school years. TVL students invest primarily on skills that can gain them requisite COCs (Certificates of Competency) and NCs (National Certifications) which would be essential when looking for better career opportunities in agriculture, electronics, and trade as well as when applying abroad (Edukasyon.ph). Thus, no academic subjects were prescribed to them.

3.2 Comparison of the Performance of Engineering Students from STEM and non-STEM SHS Strands in Finding Derivatives

The result presented in Table 2 showed a significant difference between the performance of engineering students from STEM and non-STEM SHS strands in finding derivatives (Mann-Whitney U = 2595.000, $p = 0.001 < 0.01$). Moreover, the result showed that engineering students from STEM strand (mean rank = 239.07) outperformed the engineering students from non-STEM strand (mean rank = 346.75) in finding derivatives.

Table 2: *Comparison of the Performance of Engineering Students from STEM and non-STEM SHS Strands in Finding Derivatives*

SHS Strands/Track	*n*	Mean Rank	Mann-Whitney U	*p*-value	Interpretation
STEM	466	239.07	2595.000**	0.001	significant
non-STEM	20	346.75			
Total	486				

**significant at p < 0.01

This finding was similar to that of Olivarez (2012). In his study, STEM group outperformed the non-STEM group concerning achievement in mathematics.

3.3 Comparison of the Performance of Engineering Students from different SHS Strands/Track in the Applications of Derivatives

As depicted in Table 3, surprisingly, the engineering students from the HUMSS strand got the highest mean rank of 196.83 in their performance in the applications of derivatives. The second and third mean ranks were obtained by the engineering students from STEM (mean rank = 240.22) and GAS (mean rank = 280.13) strands, respectively. The fourth mean rank was obtained by the engineering students from TVL track (mean rank = 308.50). While the lowest mean rank was obtained by the engineering students from ABM strand (mean rank = 444.10). It was also revealed that the mean ranks of the performances of the engineering students from different SHS strands/track in the applications of derivatives were again extremely far from the overall highest rank of 1.00 (see Appendix, Table 9). Moreover, the overall mean rank performance of the engineering students in the applications of derivatives is 243.50 with a standard deviation of 140.222 (see Appendix, Table 7). This indicated that the performance of engineering students from different SHS strands/track, as well as their overall performance in the applications of derivatives, was also poor.

The remarkable result of having the engineering students from HUMSS on the highest rank was supported by the findings of Carlson, Madison, and West (2015). They found out that many students are succeeding in Calculus without the prerequisite knowledge. However, the poor performance of the engineering students in the applications of derivatives was clarified by Constantinou (2014). She pointed out that students have trouble correctly answering derivative application questions because they do not fully understand the concept of a derivative. Moreover, Pyzdrowski, et al. (2013) indicated that students have difficulty on related rates and word problems.

Accordingly, as can be gleaned in Table 3, there are significant differences in the performances of engineering students from different SHS strands/track in the applications of derivatives (Kruskal-Wallis H = 12.812, p-value = 0.012 < 0.05).

Table 3: *Comparison of the Performance of Engineering Students from different SHS Strands/Track in the Applications of Derivatives*

SHS Strands/Track	***n***	**Mean Rank**	**Kruskal-Wallis H**	***p*-value**	**Interpretation**
STEM	466	240.22	12.812*	0.012	significant
ABM	5	444.10			
HUMSS	3	196.83			
GAS	4	280.13			
TECH-VOC	8	308.50			
Total	486				

*significant at $p < 0.05$

Table 3a shows the result of the post hoc test, Mann-Whitney U, to determine which engineering students from different SHS strands/track differ from each other in terms of their performances in the applications of derivatives. As shown in the table, significant differences occurred in the performance in the applications of derivatives between engineering students from STEM and ABM strands (Mann-Whitney U = 189.500, p-value = 0.001 < 0.01), and between engineering students from ABM and TVL strands (Mann-Whitney U = 4.000, p-value = 0.019 < 0.05). The result also showed that engineering students from STEM strand (mean rank = 233.91) performed better than engineering students from ABM strand (mean rank = 431.10) in the applications of derivatives. Moreover, engineering students from TVL track (mean rank = 5.00) have better performance in the applications of derivatives than engineering students from ABM strand (mean rank = 10.20).

Table 3a: *Post Hoc Test on the Comparison on the Performance of Engineering Students from different SHS Strands/Track in the Applications of Derivatives*

SHS Strands/Track	Mean Rank	Mann-Whitney U	*p*-value	Interpretation
STEM ABM	233.91 431.10	189.500**	0.001	significant
STEM HUMSS	235.27 193.00	573.000	0.590	not significant
STEM GAS	235.18 273.25	781.000	0.576	not significant
STEM TVL	236.36 303.63	1335.000	0.168	not significant
ABM HUMSS	5.80 2.33	1.000	0.053	not significant
ABM GAS	6.00 3.75	5.000	0.221	not significant
ABM TVL	10.20 5.00	4.000*	0.019	significant
HUMSS GAS	3.33 4.50	4.000	0.480	not significant
HUMSS TVL	4.17 6.69	6.500	0.251	not significant
GAS TVL	6.13 6.69	14.500	0.797	not significant

*significant at $p < 0.05$, **significant at $p < 0.01$

As noted earlier, engineering students from TVL track do not have any academic subjects. Thus, made them fall behind students from STEM strand in terms of their performance in the applications of derivatives. On the other hand, though students from ABM strand have academic subjects during their SHS years, however, pre-calculus and basic calculus subjects were not among them (DepEd, 2014). For this reason, they also did not perform well in the applications of derivatives. Nonetheless, it is unforeseen that engineering students from TVL outperformed them. Moreover, the lack of a strong foundation in pre-requisite knowledge in Calculus resulted in the difficulties encountered by the students in using their knowledge about derivative to solve applied problems (Firouzian, n.d.).

3.4 Comparison of the Performance of Engineering Students from STEM and non-STEM SHS Strands in the Applications of Derivatives

As shown in Table 4, a significant difference was found in the performance of engineering students from STEM and non-STEM strands in the applications of derivatives (Mann-Whitney U = 3130.500, *p*-value = 0.013 < 0.05). This further showed that the engineering students from STEM strand (mean rank = 240.22) have better performance than the engineering students from non-STEM strand (mean rank = 319.98) in the applications of derivatives.

Table 4: *Comparison of the Performance of Engineering Students from STEM andnon-STEM SHS Strands in the Applications of Derivatives*

SHS Strands/Track	*n*	Mean Rank	Mann-Whitney U	*p*-value	Interpretation
STEM	466	240.22	3130.500*	0.013	significant
Non-STEM	20	319.98			
Total	486				

*significant at p < 0.05

This finding was explained by Sadler and Sonnert (2016). They indicated that those who were ill-prepared for the rigors of calculus often perform poorly in the class. They further emphasized that among the students in the introductory college calculus classes, those who have taken high school calculus earned a grade half a letter higher, on average, compared with students with a similar pre-calculus preparation, but without a high school calculus course.

3.5 Comparison of the Calculus 1 Performance of Engineering Students from different SHS Strands/Track

As presented in Table 5, the engineering students from STEM strand got the highest mean rank of 240.80 in their Calculus 1 performance. The second highest mean rank was obtained by the engineering students from GAS (mean rank = 244.50). The third and fourth mean ranks were obtained by the engineering students from HUMSS strand (mean rank = 247.33) and TVL track (mean rank = 318.69), respectively. While the lowest mean rank was obtained by the engineering students from ABM strand (mean rank = 372.10). It can be noted that the mean ranks of the

Calculus 1 performances of the engineering students from different SHS strands/track were also extremely far from the overall highest rank of 1.00 (see Appendix, Table 10). Moreover, the overall Calculus 1 performance mean rank of the engineering students is 243.50 with a standard deviation of 136.384 (see Appendix, Table 7). This clearly showed that the Calculus 1 performance of engineering students from different SHS strands/Track, as well as their overall Calculus 1 performance, was poor.

This poor Calculus 1 performance of engineering students from different SHS strands/track was possibly due to their weak foundation in the basic skills necessary in Calculus 1. Severe weaknesses in students' foundational knowledge and reasoning abilities for learning calculus was revealed by Carlson, Madison, and West (2015).

Result of the comparison on the Calculus 1 performance of engineering students from different SHS strands/track is also shown in Table 5. Based on the table, there were no significant differences in the Calculus 1 performances of engineering students from different SHS strands/track (Kruskal-Wallis H = 7.063, p-value = 0.133 > 0.05). This revealed that engineering students from different SHS strands were comparable in terms of their Calculus 1 performance.

Table 5: *Comparison of the Calculus 1 Performance of Engineering Students from different SHS Strands/Track*

SHS Strands/Track	*n*	Mean Rank	Kruskal-Wallis H	*p*-value	Interpretation
STEM	466	240.80	7.063	0.133	not significant
ABM	5	372.10			
HUMSS	3	247.33			
GAS	4	244.50			
TVL	8	318.69			
Total	486				

It is imperative to note that though STEM students have taken subjects that were pre-requisites of Calculus 1 during their SHS years, their performance in the course was still comparable to the other SHS strands/track. This result suggests a need for higher standards for curriculum and courses before calculus. This could support students' development of fundamental reasoning abilities and understandings essential for learning calculus (Carlson, Madison, & West, 2015).

3.6 Comparison of the Calculus 1 Performance of Engineering Students from STEM and non-STEM SHS Strands

Regarding the comparison of the Calculus 1 performance of engineering students from STEM and non-STEM SHS strands, as shown in Table 6, a significant difference was found (Mann-Whitney U = 3400.00, *p*-value = 0.035 < 0.05). The result revealed that engineering students from STEM strand (mean rank = 240.80) outperformed the engineering students from non-STEM strand (mean rank = 306.50) in Calculus 1. Furthermore, the overall mean rank in Calculus 1 performance of the engineering students is 243.50 with a standard deviation of 136.384 (see Appendix, Table 7). This result revealed that engineering students, both from STEM and non-STEM SHS strands, performed poorly in Calculus 1.

Table 6: *Comparison of the Calculus 1 Performance of Engineering Students from STEM and non-STEM SHS Strands*

SHS Strands	*n*	Mean Rank	Mann-Whitney U	*p*-value	Interpretation
STEM	466	240.80	3400.00*	0.035	significant
Non-STEM	20	306.50			
Total	486				

*significant at p < 0.05

This agreed with the findings of Nicholas, et al. (2015). They found that students who have taken higher-level mathematics, Basic Calculus, in senior secondary school outperformed their peers who are mathematically under-prepared. They also indicated that the higher levels of mathematics taken in senior secondary school are strong predictors of success in Differential Calculus.

Regarding the poor performance of the engineering students in Calculus 1, the study made by Islam & Al-Ghassani (2015) showed a different finding. They found that students from the College of Engineering showed the best Calculus 1 performance (GPA = 2.35) than any other college. Though, the performance was fairly satisfactory.

4. Conclusions

Engineering students performed poorly in finding derivatives, in the applications of derivatives, and in Calculus 1.

The results indicated that there were significant differences in the performances of engineering students from different SHS strands/track in finding derivatives. Accordingly, the significant difference exists between engineering students from STEM strand and TVL track. Consequently, engineering students from STEM strand performed better in finding derivatives than engineering students from TVL track. Similarly, a significant difference between the performance of engineering students from STEM and non-STEM SHS strands in finding derivatives was found. The result showed that engineering students from STEM strand outperformed the engineering students from the non-STEM strand in finding derivatives.

With regard to the applications of derivatives, significant differences among the performances of engineering students from different SHS strands/track was also found. Subsequently, the significant differences occurred in the performances in the applications of derivatives between engineering students from STEM and ABM strands, and between engineering students from ABM and TVL strands. The result further showed that engineering students from STEM strand performed better than engineering students from ABM strand in the applications of derivatives. Moreover, engineering students from TVL track have a better performance in the applications of derivatives than engineering students from ABM strand. Likewise, a significant difference was found in the performance of engineering students from STEM and non-STEM strands in the applications of derivatives. This indicated that engineering students from STEM strand have better performance in the applications of derivatives than the engineering students from the non-STEM strand.

Finally, regarding the Calculus 1 performances of engineering students from different SHS strands/track, no significant difference was found. This showed that engineering students from different SHS strands/track were comparable in terms of their Calculus 1 performance. On the contrary, a significant difference was found in the Calculus 1 performance between engineering students from STEM and non-STEM strands. The result revealed that engineering students from STEM strand outperformed the engineering students from the non-STEM strand in Calculus 1.

5. Recommendations

Based on the conclusions, the following are hereby recommended as the scope of future research. First, use the result of this study to further investigate the possible causes of students' poor performance in Calculus 1. This may include revisiting the both SHS and engineering curriculums. Second, develop methods to improve students' Calculus 1 performance. Consider offering bridging programs for the students from the non-STEM strand and giving supplementary or enhancement activities for students from STEM strand. Third, consider a comparison on the Calculus 1 performance of the engineering students from non-STEM strands with bridging course and without bridging course. Fourth, increase the sample size and use the research to other groups or disciplines. Last, consider a replication of this study in different areas of mathematics and other academic courses.

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Appendix

Table 7: *Overall Mean Ranks of the Engineering Students*

	n	Mean Rank	Std. Deviation
Performance in Finding Derivatives	486	243.50	140.184
Performance in the Applications of Derivatives	486	243.50	140.222
Calculus 1 Performance	486	243.50	136.384

Table 8: *Distribution of Ranks of Engineering Students' Performance in Finding Derivatives*

		Frequency	Percent
Valid	1.500	2	.4
	4.000	3	.6
	6.000	1	.2
	7.500	2	.4
	9.500	2	.4
	11.500	2	.4
	16.000	7	1.4
	24.500	10	2.1
	33.500	8	1.6
	44.500	14	2.9
	63.000	23	4.7
	84.500	20	4.1
	102.000	15	3.1
	120.000	21	4.3
	145.000	29	6.0
	175.500	32	6.6
	209.500	36	7.4
	243.500	32	6.6
	281.500	44	9.1
	319.000	31	6.4
	356.000	43	8.8
	390.000	25	5.1
	414.500	24	4.9
	439.000	25	5.1
	458.000	13	2.7
	471.500	14	2.9
	479.500	2	.4
	481.500	2	.4
	483.500	2	.4

	485.500	2	.4
	Total	486	100.0

Table 9: *Distribution of Ranks of Engineering Students' Performance in the Applications of Derivatives*

		Frequency	Percent
Valid	1.000	1	.2
	2.500	2	.4
	5.500	4	.8
	10.500	6	1.2
	15.000	3	.6
	17.500	2	.4
	19.000	1	.2
	23.500	8	1.6
	34.000	13	2.7
	47.000	13	2.7
	60.000	13	2.7
	76.000	19	3.9
	91.500	12	2.5
	109.500	24	4.9
	131.000	19	3.9
	155.500	30	6.2
	181.500	22	4.5
	204.000	23	4.7
	228.500	26	5.3
	257.000	31	6.4
	295.000	45	9.3
	332.000	29	6.0
	365.000	37	7.6
	401.000	35	7.2
	428.000	19	3.9
	445.500	16	3.3
	460.500	14	2.9
	471.000	7	1.4
	478.500	8	1.6
	484.000	3	.6
	486.000	1	.2
	Total	486	100.0

Table 10: *Distribution of Ranks of Engineering Students' Calculus 1 Performance*

		Frequency	Percent
Valid	1.00	1	.2
	3.50	4	.8
	9.00	7	1.4
	25.50	26	5.3
	55.50	34	7.0
	96.50	48	9.9
	165.00	89	18.3
	289.00	159	32.7
	427.50	118	24.3
	Total	486	100.0

Table 11: *Test for Normality*

	Kolmogorov-Smirnov[a]		
	Statistic	df	Sig.
Performance in Finding Derivatives	.082	486	.000
Performance in the Applications of Derivatives	.101	486	.000
Calculus 1 Performance	.352	486	.000