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THE EFFECT OF Z-SCORE ON YEAR GRADE POINT AVERAGE (YGPA) AND FINAL GRADE POINT AVERAGE (FGPA) IN FACULTY OF ENGINEERING, GENERAL SIR JOHN KOTELAWALA DEFENCE UNIVERSITY (KDU)

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ABSTRACT

A collection of 182 Intake 35 day scholar undergraduates who had followed the Local GCE Advanced Level examination from the Faculty of Engineering, General Sir John Kotelawala Defence University (KDU), was selected. Data was collected from the several departments and units of KDU. The Grade Point Average (GPA) was considered the scale of a student's academic performance in the study. A descriptive analysis was performed to differentiate the configuration of the data and the relationship between the Year Grade Point Average (YGPA), and Final Grade Point Average (FGPA) variables with the Z-Score. Spearman and Kendall rank correlation tests were performed in the analysis. The results indicated that the Z-score has a comparatively strong positive relationship with student's performance at the university in their first year and the class selection.

KEYWORDS: *FGPA, Student's performance, YGPA, Z-Score*

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1. INTRODUCTION

Higher education grants a society robust financial capability by producing a powerful labor force. University graduates have significant roles in government and private-sector employment in Sri Lanka. Thus, the student's educational performance is a more acceptable indication of the country's prospective development.

The academic performance of undergraduates may depend on various factors, including the institution's facilities, the students' backgrounds, their prior academic success, their mental and physical wellness, and the institution's social influence. It might change for various reasons during various student life phases. Previous research (McKenzie & Schweitzer, 2001) indicates that previous school achievement significantly predicts university student performance.

After high school, a student's performance in Sri Lanka is assessed based on their grade point average (GPA) during their university education. As a result, this study concentrated on the effect of students' GCE Advanced Level Z-score on year-wise and final GPAs.

This study aimed to determine the effect of standardized secondary educational achievement on GPA in the Faculty of Engineering, General Sir John Kotelawala Defence University (KDU). Since the students' academic performance changes periodically, administrative bodies must identify the effects of previous educational performance on an undergraduate's GPA. Accordingly, the investigation aims to determine whether there is an effect on students' secondary education performances (GCE A/L) on the Grade Point Average value throughout their university years.There are eleven faculties in the General Sir John Kotelawala Defence University (KDU): Faculty of Engineering, Faculty of Medicine, Faculty of Computing, Faculty of Management, Social Sciences and Humanities, Faculty of Defence and Strategic Studies, Faculty of Law, Faculty of Allied Health Science, Faculty of Built Environment and Spatial Sciences, Faculty of Technology, Faculty of Criminal Justice, and Faculty of Graduate studies.

The Faculty of Engineering has the highest student population at General Sir John Kotelawala Defence University. The faculty's six departments of study, i.e., Department of Aeronautical Engineering, Marine Engineering, Mechanical Engineering, Civil Engineering, Electrical Electronic & Telecommunication Engineering, and Mathematics, offer B.Sc. in Engineering (Hons) degree programs in nine disciplines.

The students are selected for the university based on the results of their secondary education, GCE Advanced Level examination Local, Cambridge, and Edexcel. The undergraduates follow a set of standard modules in their first semester. They are selected for the respective discipline at the beginning of the second semester based on their preference. Academic performance is evaluated using the Grade Point Average (GPA) value. GPA is computed for each semester (SGPA), for each year (YGPA) separately, and calculated for the entire degree program (FGPA). The classes are determined according to the Final Grade Point Average (FGPA) value.

Calculation of Grade Point Average value

The GPA value is computed by dividing the total credits weighted on grade point values by the total number of credits. Their GPA determines the student's academic performance based on the final grades, computed using semester-end examination marks and continuous assessment grades. The university calculates the GPA based on the grades obtained by students and relevant point values, as shown in Table 1.

The GPA is calculated by dividing the total credit-weighted score by the total number of credits as follows.

$$GPA = \frac{\sum X_i Y_i}{\sum Y_i}$$

where,

Xi= Grade point value of the i^{th} course unit

Y_i = Number of credits in the i^{th} course unit

Table 1: Grade and relevant point values for students' final marks

Range of Marks	Grade	Point Value
100-85	A+	4.2
84-75	A	4.0
74-70	A-	3.7
69-65	B+	3.3
64-60	B	3.0
59-55	B-	2.7
54-50	C+	2.3
49-45	C	2.0
44-40	C-	1.7
39-35	D+	1.3
ES<35	IE	0.0
CAS<35	IA	0.0
ES<35 & CAS<35	IB	0.0

Background

Most educational academies consider the productivity of graduates that they will contribute to the community. Since university students' productivity is reliant on their academic success, most researchers have considered students' grade point average (GPA) as an ascertaining feature for their research investigations (McKenzie & Schweitzer, 2001; Erdem et al., 2007; Mushtaq & Khan, 2012). Even though the number of graduates in the labor market is increasing, finding appropriate employment with mere knowledge is difficult. Employers prefer professionals with a higher cumulative GPA (Erdem et al., 2007). Ali et al. (2009) state that a country's social and economic growth affects students' academic performance.

Evidently, a country's well-educated human resources ensure a more promising future. McKenzie and Schweitzer (2001) discovered that prior academic performance impacted pupils' undergraduate academic success. The study examined the academic, psychological, cognitive, and demographic factors of first-year university students' academic performance. The study's conclusions are based on 197 students from a large metropolitan computer-based university's Science and Information Technology faculties. To determine the significant effect of the aspects, a descriptive analysis, standard regression models, and analysis of variance tables (ANOVA) were used. Erdem et al. (2007) used cumulative grade point averages to indicate student performance at Turkey's Gasiosmanpasa University. This research was conducted to identify the socio-economic and demographic characteristics that affect academic achievement. Even though previous academic performance and the nationwide university admission test (OSS) scores were evaluated in the study, they were irrelevant to the analysis. Martha (2009) investigated the determinants influencing undergraduate academic achievement at Uganda Cristian University for her Master of Arts dissertation. This study examined factors connected to academic performance in 340 undergraduates at Uganda Christian University. Admission points for advanced level and diploma programs, parents' socioeconomic status, and previous school experience have all been found to influence academic achievement. Chathuranga, C.D. (2016) investigated the effect of Past Education Performance on Grade Point averages in the Faculty of Social Sciences, University of Kelaniya, Sri Lanka, using a sample of 274 undergraduates. This study has determined that, except for the Grade 5 scholarship examination results, both the results of the GCE O/L and GCE A/L have a positive association with student's performance at the university.

Abdelfattah et al. investigated how entrance scores relate to short-term and long-term success in Engineering Education. They found that high school coursework, general ability, and achievement tests significantly correlated with preparatory year GPA, while first to third-year GPAs were predictive of cumulative GPAs at graduation. Lawal et al. similarly examined the predictive validity of first-year GPA on final-year degree classification for management and social science students in a Nigerian University. They discovered a significant, albeit negative, correlation between first-year GPA and final-year CGPA among management science graduates. Kennedy and Ebuwa explored how University entry scores (UTME) and Post Unified Tertiary Matriculation Examination (PUTME) predict undergraduate final-year CGPA in Nigeria. Despite analyzing data from 436 undergraduate

students across four departments, they found that combined UTME and PUTME scores did not significantly predict final-year CGPA. Oguntunde et al. investigated the relationship between first-year results and final graduating grades in a Nigerian University. They developed a model that accurately predicts final year CGPA based on first-year results through correlation and regression analysis, indicating a robust linear relationship between GPAs and academic progression.

Nurudeen et al. delved into the practical implications of the predictive power of first-year GPA on final-year CGPA and the influence of demographic attributes on academic achievement. Their findings, which emphasized the strong positive relationship between first-year GPA and final-year CGPA and the lack of significant correlation between demographic characteristics and final-year CGPA, provide valuable insights for educators and policymakers in enhancing academic success.

Several diverse studies, including those by Abdelfattah et al., Abdulkadir and Ogwueleka, Lawal et al., Debaliz et al., and Oguntunde et al., have all concluded that there is a robust linear relationship between Grade Point Average and Cumulative Grade Point Average, influencing students' academic achievement. This wide range of research demonstrates the comprehensive exploration of this topic.

2. METHODOLOGY

Selection of Subjects

The students from intake 35 who graduated in 2022 were selected for this study. The number of students in the faculty was obtained from the Dean's office of the Faculty of Engineering, KDU. According to that data, 201 engineering day scholars were in intake 35, while the total number of engineering students (Officer Cadets and Day scholars) in intake 35 was 246. Since the Z-score is not calculated for the GCE Advanced Level offered by Cambridge and Edexcel, 182 day scholars who completed the Local GCE Advanced level examination were selected for the study, as shown in Table 2.

Table 2: Number of engineering undergraduates in intake 35

Discipline	Number of Students (Officer Cadets + Day scholars)	No. of day scholars	No. of day scholars selected for the study
Aeronautical Engineering (AE)	15	7	7
Aircraft Maintenance Engineering (AME)	7	5	5
Biomedical Engineering (BM)	14	10	6
Civil Engineering (CE)	55	51	47
Electrical and Electronic Engineering (EE)	53	44	42
Electronic and Telecommunication Engineering (ET)	31	29	28
Marine Engineering (MR)	10	-	-
Mechanical Engineering (ME)	28	24	24
Mechatronics Engineering (MC)	33	31	23

Collection of Data

The list of Engineering undergraduates of intake 35 with their secondary education performance (Z-score) was obtained from the Enlistment Department of KDU. Undergraduate student performance data, such as year-wise grade point average and final GPA values, was collected from the Examination Department, KDU.

The dataset was developed by integrating the components collected from the respective departments. The data set consisted of six continuous variables; Z-score, 1st year YGPA, 2nd year YGPA, 3rd year YGPA, 4th year YGPA and FGPA of students and four string type variables; Discipline, Registration number, Name, and Class.

Analysis of Data

The dataset was uploaded into the R studio for analysis.

Histograms and box charts were plotted for the six continuous variables. Once the outliers were identified, data was cleaned for the six continuous variables by withdrawing them. Then the analysis was executed on the cleaned dataset.

Since the Z-Score was considered the response variable, the normality was checked for the remaining variables, GPAs. The histogram, density plot, and quantile-quantile plot were plotted for the GPAs. Then the skewness and kurtosis were calculated to check the normality of the continuous variables.

The tests of Shapiro-Wilk and Kolmogorov-Smirnov were used to conduct a normality test.

The following hypotheses were tested in normality tests.

H_0: The data come from a normally distributed population.

Versus

H_1: The data come from a population that is not normally distributed.

If the test is significant, reject the normality assumption for the distribution.

Since the normality assumption was not satisfied, nonparametric tests were used to analyze the data. A suitable nonparametric test called the distribution-free test, i.e., Spearman rank correlation test, and Kendall's tau-c Rank correlation, have been considered for the study.

The tests of Spearman Rank Correlation test and Kendall Rank Correlation were used to test for the associations between Z-score and GPAs.

The following hypotheses were tested.

H_o: There is no association between two continuous variables.

Versus

H_1: There is an association between two continuous variables.

If the test is significant, reject the null hypothesis.

3. RESULTS AND DISCUSSION

Preliminary Analysis

A preliminary analysis was conducted to identify the outliers. Histograms and box plots were plotted for the six continuous variables.

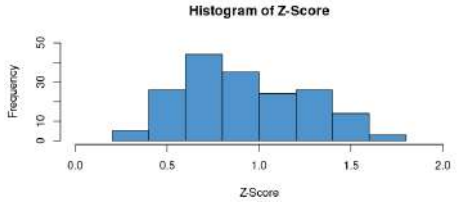

Figure 1: Histogram of Z-Score

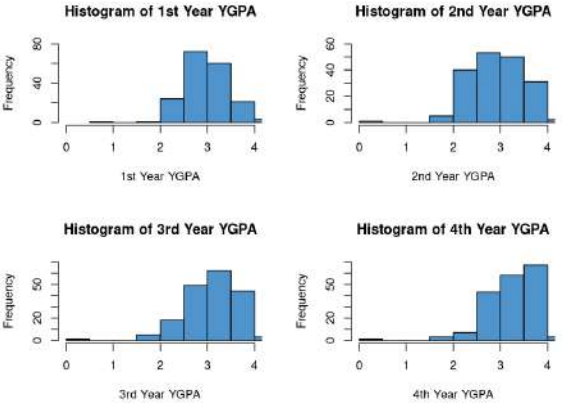

Figure 2: Histograms of 1st, 2nd, 3rd and 4th Year YGPA

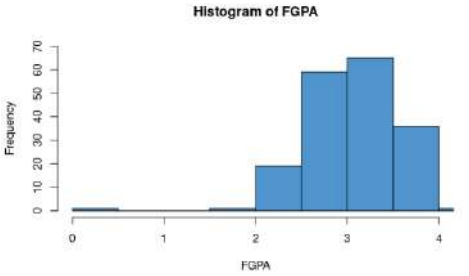

Figure 3: Histogram of FGPA

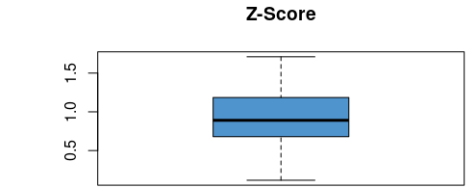

Figure 4: Box plot of Z-Score

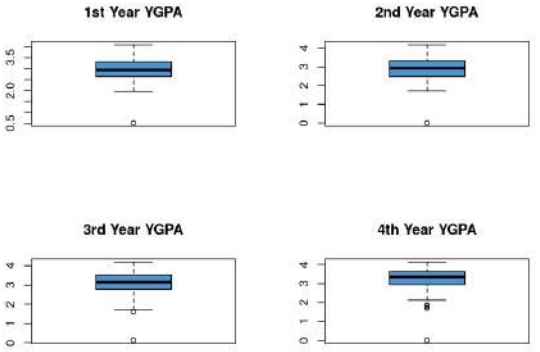

Figure 5: Box plots of 1st, 2nd, 3rd and 4th Year YGPA

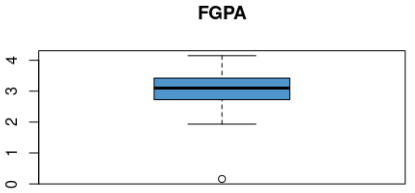

Figure 6: Box plot of FGPA

Data Cleaning

The number of outliers in each variable is represented in Table 3.

Table 3: Outliers

Variable	Number of Outliers
Z-score	-
1st year YGPA	1
2nd year YGPA	1
3rd year YGPA	2
4th year YGPA	4
FGPA	1

All five outliers were identified and removed to obtain the cleaned dataset. This cleaned data set consists of the data of 177 students.

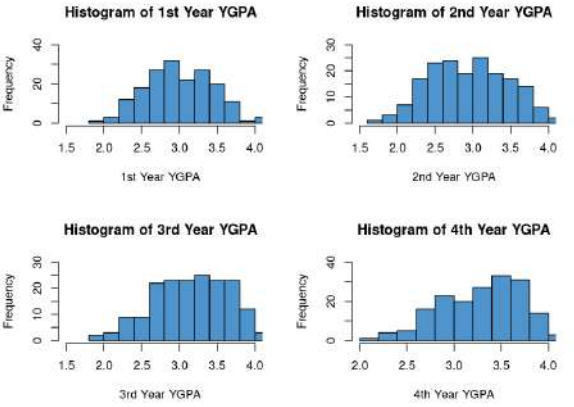

Figure 7: Histograms of cleaned 1st, 2nd, 3rd and 4th year YGPA

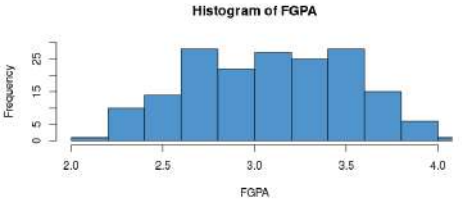

Figure 8: Histogram of cleaned FGPA

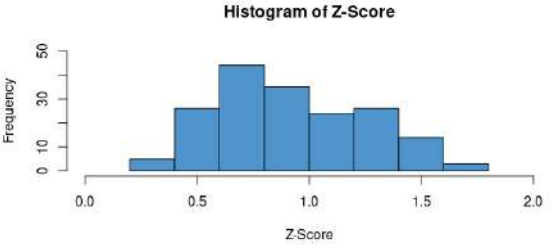

Figure 9: Histogram of cleaned Z-score

Test of assumption of normality of GPA

The density plot of the 1st year YGPA data shows that the distribution was not symmetric and right skewed. Both histogram and density plot illustrate that the shape of both plots deviates from the bell-shaped behavior of a normal distribution. Therefore, the 1st year YGPA data are not normal.

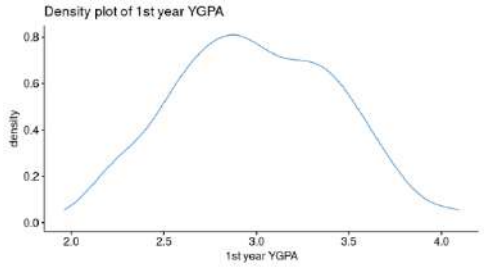

Figure 10: Density Plot of 1st year YGPA

The density plot of the 2nd year YGPA data shows that the distribution was not symmetric. Thus, the 2nd year YGPA data are not normal.

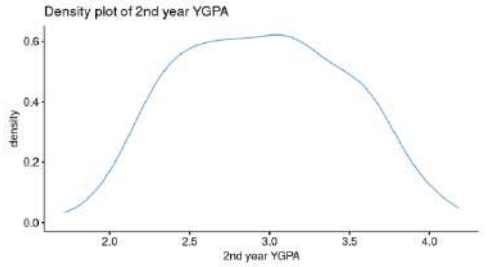

Figure 11: Density Plot of 2nd year YGPA

The density plot of the 3rd year YGPA data shows that the distribution was not symmetric and left-skewed. Therefore, the 3rd year YGPA data are not normal.

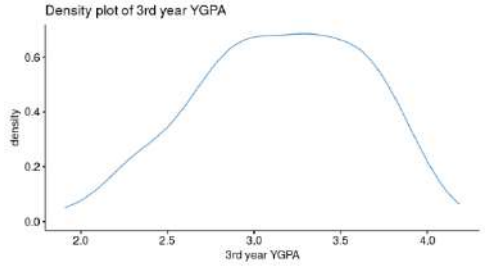

Figure 12: Density Plot of 3rd year YGPA

The density plot of the 4th year YGPA data shows that the distribution was not symmetric and left-skewed. Therefore, the 4th year YGPA data are not normal.

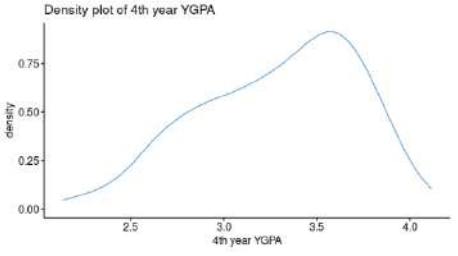

Figure 13: Density Plot of 4th year YGPA

The density plot of the FGPA data shows that the distribution was not symmetric and left-skewed. Therefore, the FGPA data are not normal.

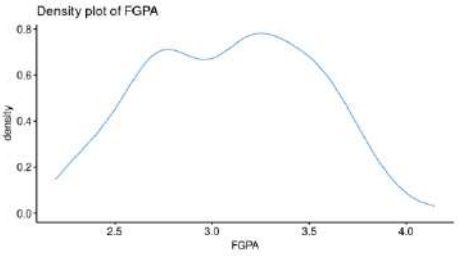

Figure 14: Density Plot of FGPA

The normal quantile-quantile plot illustrates that the more points vary significantly from a 45° reference line, the less likely a normal distribution is. Hence, the 1st year, 2nd year, 3rd year and 4th year YGPAs and FGPA data are not normal according to the Q-Q plot.

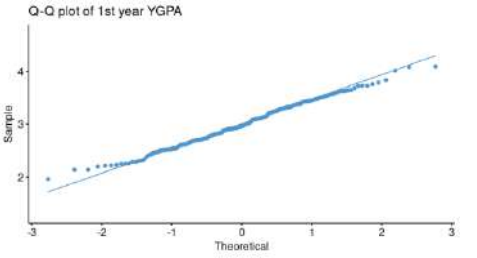

Figure 15: Normal Q-Q plot of 1st year YGPA

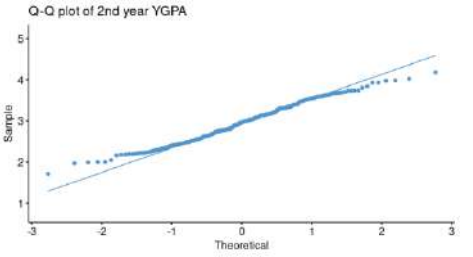

Figure 16: Normal Q-Q plot of 2nd year YGPA

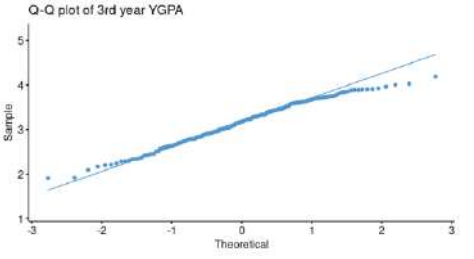

Figure 17: Normal Q-Q plot of 3rd year YGPA

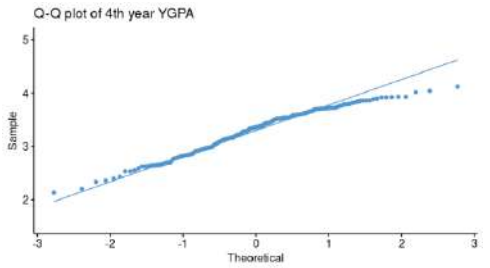

Figure 18: Normal Q-Q plot of 4th year YGPA

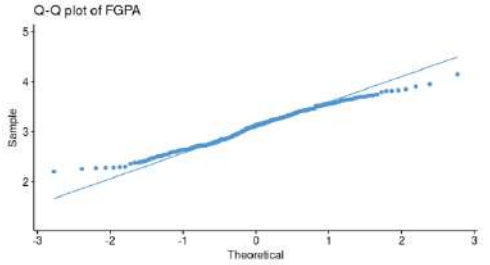

Figure 19: Normal Q-Q plot of FGPA

The skewness and Kurtosis were calculated for five variables to check the normality. R studio output is given in Table 4.

Table 4: Skewness and Kurtosis of GPA variables

Variable	Skewness	Kurtosis
1st year YGPA	0.0678	2.4700
2nd year YGPA	0.0644	2.199
3rd year YGPA	-0.2632	2.3957
4th year YGPA	-0.4374	2.4236
FGPA	-0.0414	2.1718

The skewness of the 1st year YGPA and 2nd year YGPA were positive; the tail was on the right side of the distribution. Further, the skewness of the 3rd year YGPA, 4th year YGPA, and FGPA were negative; the tail was on the left side of the distribution. Kurtosis of all variables is less than three, and it was a playkurtic, suggesting it produces fewer and less extreme outliers than the normal distribution. Since skewness is positive and Kurtosis is less than three. Thus, according to the skewness and Kurtosis, the 1st year YGPA and 2nd year YGPA data are not normal. Further, since skewness is negative, and Kurtosis is less than three. Thus, according to the skewness and Kurtosis, the 3rd year YGPA, 4th year YGPA, and FGPA data are not normal. R studio outputs of the test of Shapiro-Wilk and Kolmogorov-Smirnov were summarized in Table 5.

According to the Shapiro-Wilk normality test, students' distributions of first- and second-year YGPAs are normal. The distribution of 3rd year YGPA, 4th year YGPA, and FGPA is not normal. However, according to the Kolmogorov-Smirnov test, all the GPA variables are not normal. In consideration of this, the categorized students' GPA was selected as the response variable for the subsequent data analysis of univariate and advanced analysis. Nonparametric tests were performed to analyze the data since the population did not have a specific distribution, such as a normal distribution.

As the study concentrated on university students' academic performance, the student's class division was selected as the dependent variable for further investigations.

Class Distribution

The classes have been calculated using the students' FGPA values. The distribution of the categorized GPA values under standard criteria; First class (GPA > 3.7), Second class (Upper Division) (3.3<GPA>3.7), Second class (Lower Division) (3.0<GPA<3.3), General pass (2.0<GPA<3.0) and Not Completed (GPA<2.0) are represented in the Figure 20.

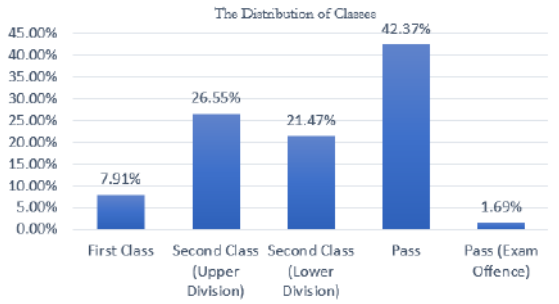

Figure 20: Class Distribution

The figure shows that 7.91% of students achieved first-class. The most significant number of students received general passes based on their grade point averages. 34.46% of students (61 out of 177) received first or second upper classes (equal to or more than 3.3 grade

point value). The percentage of students who had a class was 55.93%.

Test for the Normality of Z-Score

It is essential to identify whether the distribution of the Z-score is normally distributed. R studio outputs of the test of Shapiro-Wilk and Kolmogorov-Smirnov were summarized in Table 6.

The Z-score rejected the null hypothesis that the data came from a normally distributed population, according to Kolmogorov-Smirnov and Shapiro-Wilk statistical tests.

Relationship between GPAs and Z-score

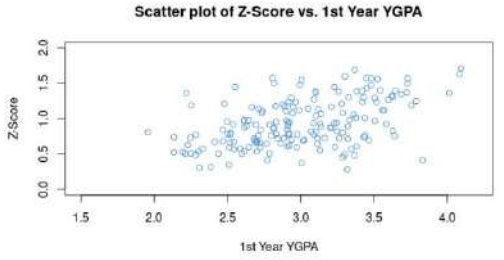

Figure 21: Scatter plot of Z-score vs 1st year YGPA

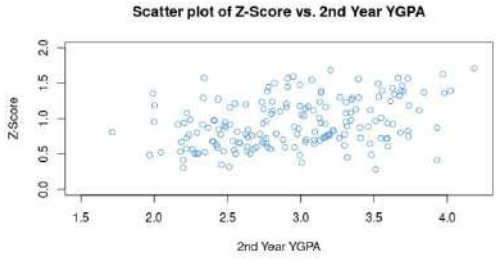

Figure 22: Scatter plot of Z-score vs 2nd year YGPA

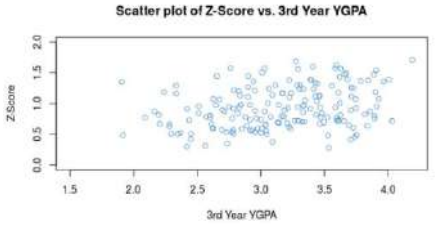

Figure 23: Scatter plot of Z-score vs 3rd year YGPA

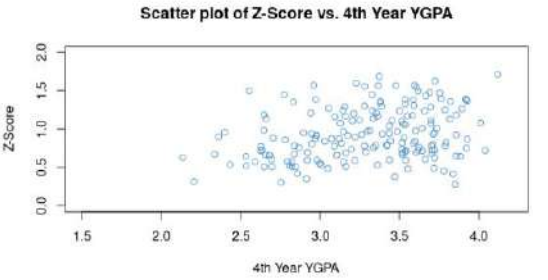

Figure 24: Scatter plot of Z-score vs 4th year YGPA

Based on the scatter diagrams, there was a positive relationship between GPA variables and the Z-score.

Statistical Test Results

R studio outputs of the test of Spearman Rank Correlation and Kendall Rank Correlation were summarized in Table 7.

According to Table 7, it was obvious that each pair of variables is positively significant at the 5% level of significance for both tests. Therefore, the null hypothesis is rejected, and it concluded that there is an association between each pair of variables.

The Spearman and Kendall Rank Correlation coefficients were positive values for each pair of variables. There is a strong positive correlation between Z-score and the 1st year GPA than the 2nd, 3rd, and 4th year GPAs in both tests. It is observable that the correlation between the Z-score and YGPA decreases drastically through the second and third years of students' undergraduate period. Then it decreases slightly in the 4th year.

Table 5: Tests of Normality

	Shapiro-Wilk		Kolmogorov-Smirnov	
	Test Statistic	Significant Value	Test Statistic	Significant Value
1st year YGPA	0.99156	0.3885	0.97798	2.2e-16
2nd year YGPA	0.98494	0.05387	0.96984	2.2e-16
3rd year YGPA	0.98411	0.04177	0.97183	2.2e-16
4th year YGPA	0.97039	0.0008046	0.98355	2.2e-16
FGPA	0.98295	0.02925	0.98589	2.2e-16

Table 6: Test for normality of Z-score

Shapiro-Wilk		Kolmogorov-Smirnov	
Test Statistic	Significant Value	Test Statistic	Significant Value
0.97081	0.0008981	0.63915	2.2e-16

Table 7: Tests for Association

	Spearman's Rank Correlation Test		Kendall Rank Correlation Test	
	Significant Value	Correlation Coefficient	Significant Value	Correlation Coefficient
Z-Score vs 1st year YGPA	3.143e-11	0.4724838	4.016e-11	0.3343934
Z-Score vs 2nd year YGPA	8.933e-07	0.3594692	6.415e-07	0.2520069
Z-Score vs 3rd year YGPA	0.0001276	0.2840148	0.0001173	0.1949904
Z-Score vs 4th year YGPA	0.0003914	0.2636555	0.00038	0.1799146
Z-Score vs FGPA	1.593e-07	0.3816638	8.199e-08	0.2714924

Further, a strong positive correlation exists between the Z-score and the Final GPA value. However, it could not be more potent as the correlation between 1st year GPA and Z-score.

This study aimed to identify whether students' performance in the GCE Advanced Level impacted their GPA. However, the Z-score was not normally distributed according to the descriptive test results in the study.

According to the study results, a positive relationship existed between Z-score and the student's GPAs. The fact that there is a positive association between the

A/L examination performance and the student's first-year YGPA is a noteworthy finding in the study since the A/L examination is the last performance indicator at the school level before university admittance.

Moreover, there is a drastic decrease in the correlation between the Z-score and the year GPA values throughout the undergraduate period. Students' interest in studying is decreasing during their undergraduate years.

For further study, it is essential to conduct a future study to identify the factors that affect the lower academic performance of students at the university, even if they had satisfactory performances in school.

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