

University Student's Academic Performance: An Approach of Tau Statistic

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Abstract

The poor performance of tertiary graduates in Nigeria has been the subject of speculation for stakeholders in the education sector. In pursuance of Academic excellence, Nigeria's target is to become one of the top 20 economies. Performance is the ability of a student to complete a task. The task completion results could be positive or negative. Academic performance in private universities is undulating between first and third classes. These results are in public universities. If the result is positive, it indicates that the student performs brilliantly or excellently, but on the other hand, if it is negative, it indicates woeful performance. Student performance is an outcome of a rigorous evaluation through examination or other assessment methods. Performance criteria start from day one on campus, and it extends and accumulates to the end of the student's study. The study uses 1841 students' academic records from seven Engineering departments from the School of Engineering, Covenant University, Nigeria. This study examines the relationship between the first year and final year results and the reliability between first year results and final year results. The methodology adopted in this study is a quantitative technique. The analysis for the study carried out with IBM SPSS version 27 using Pearson correlation and Tau statistic. The Pearson correlation coefficient shows a strong positive correlation between the students of the first year and final year results, and it shows a significant linear relationship between students' first and final year results from the seven departments. This work will serve as a valuable source of advice to stakeholders in the education sector, inside and outside the university system, to enhance students' academic performance in the University system.

Keywords: Tau Statistic, Agreement Index, Significant, Academic Performance, Cumulative Grade Point Average

Introduction

Performance is the ability of a student to complete a task. The task completion results could be positive or negative. Academic performance in private universities is undulating between first and third classes, rare in public universities. If the result is positive, it indicates that the student performs brilliantly or excellently, but on the other hand, if it is negative, it indicates woeful performance. Student performance is an outcome of a rigorous evaluation through examination or other assessment methods.

Performance criteria start from day one on campus, and it extends and accumulates to the end of the student's study. Student performance literature is growing globally, and recent studies touched on the effect of flipped classroom versus traditional teaching on student performance using meta-analysis.

The authors discovered the flipped classroom's moderative positive effect on student performance regardless of discipline and education level (Strelan, Osborn, and Palmer, 2020). Different factors are responsible for student performance; Schwartz and Rothbart, (2020) study shows the impact of universal free meals on student performance and concludes that increases in school free lunch improve poor and non-poor student academic performance.

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Tomasevic, Gvozdenovic, and Vranes (2020) also contributed to the literature on student performance and gave an overview and predict student examination performance with supervised data mining techniques. The authors conclude that adequate data acquisition functionalities and the student's interaction with the learning environment require a robust student examination performance.

Sunday et al. (2020) focused on student performance in the context of programming education by using classification data analysis techniques and discovers class attendance as the determinant of success or failure of student academic performance.

The poor performance of tertiary graduates in Nigeria has been the subject of speculation for stakeholders in the education sector every year, mainly because of its target of becoming one of the world's top 20 economies this year (<https://digitalcommons.unl.edu/libphilprac>).

Recent statistics published by the review bodies have shown that good performance is scarce as average performance rises. This research analyzed the relationship between the first year and final year results and the reliability between the first year and the final year students of seven Engineering department at Covenant University.

The first-year performance represented the class of degree that the students start engineering courses from 200 level and the final year result was the class of degree at graduation. Reliability approaches determine the consistency between the first year and the final year to know the coefficient of reliability between them.

The agreement is a particular case of association and not the other way around. It represents the degree to which the observer classifies a given subject identically into the same group. In contrast, the association's measure represents the strength of the predictable relationship between the two observers or raters' ratings. Notwithstanding estimating the psychometric nature of different ratings, it is possible to ascertain the interrater reliability or interrater agreement. The interrater reliability coefficient indicates the accuracy of the response pattern or the ranking of responses between two or more raters, regardless of those ratings.

Jolayemi (1990) suggested a statistic for the calculation of agreement that uses the Chi-square distribution. The statistic evolves from the coefficient of determination R^2 , an index for the regression model's stated variability, which applies to the square contingency table. Despite the impact of the recent studies examined, there is still a gap in tau statistics as a reliability measure for students' academic performance.

This study intervenes to fill this gap and to contribute to the student performance literature. The outstanding research question that this study intends to answer is: Why is it essential to examine the reliability measure of academic performance in a tertiary institution, and what is the impact of the student performance reliability to students and the University decision-makers? The study intends to check whether there is a strong correlation between the first year and final year result and examine if there is a significant linear relationship between the first year and final year result of students across the School of Engineering School.

This study divides into five parts, and for clarity, the first part is an introduction, second, literature review, third, methodology, fourth, discussion, and finally a conclusion. The study also discusses the study limitation and future study.

Theory of Academic Performance

Students have the capability for extraordinary academic achievement in a University environment. This proposition diver among different students. Down-to-the-earth accomplishments happen in day-to-day practice in University settings. At the beginning of the semester, the teachers and administrators take a turn to inspire the students to pursue their dreams to come out with flying colors at the end of their study. Since accomplishments are a shared vision of the entire academic community, a theory of performance is applicable in many learning contexts.

The theory of academic performance (ToP) emanates from Elger (2007), and the author described 'perform' as an ability to produce a valued result and 'performer' as an individual or a group that engages in collaboration while the level of performance as the location in an academic journey. According to Elger (2007), there are six components of performance levels, and they are: level of knowledge, levels of skills, level of identity, personal factors, and fixed factors and proposed three axioms for effective performance as performer's mindset, immersion in an enriching environment, and engagement in reflective practice.

The theory of performance challenges educators to improve their performance through empowerment to help others learn effectively and grow. This type of learning will foster quick success and produce knowledge that will influence society. Inferring from the study of Wiske (1998), performance indicates learning-for-understanding.

Higher academic performance produces results that lead to an increase in academic quality. This process creates an environment where performance exceeds the expectations of the academic community stakeholders. There will also be a decrease in cost; that is, the financial resources involved in producing the desired result will be reduced. Higher academic performance will also increase capability, capacity, knowledge, skills, and motivations. This development is a good signal for the university publicity and acceptance.

Applying the academic performance theory to the Private University results, the performer will need to stabilize the students at the forefront and encourage the backing students to improve drastically. The performer can set a challenging goal for the student from the beginning of the semester and allows failure as part of the rubrics to motivate high performance. This intervention should be a gradual process.

Related Literature

The literature on academic performance across different levels of education globally is advancing, and this development established the visibility of academic performance research domain. Earlier, Brown et al. (2008) examined social cognitive as predictors of academic performance in College setting using meta-analytic. Turner, Chandler and Heffer, (2009) digressed from social cognitive and researched on the influence of parenting styles, achievement motivation and self-efficacy of College students. Since academic importance is all-encompassing, Akiri and Ugborugbo, (2009) focused on how teacher's effectiveness impacts the academic performance of the secondary school students. Similarly, Akinsolu, (2010) combined teachers and students' academic performance as an implication for planning in Nigerian Secondary Schools. Also, Koles, et al. (2010) studied the impact of team-based learning on medical students' academic performance while Li, Chen and Duanmu,

(2010) embarked on a comparative study of Chinese students and their colleagues in other international schools and gives insight into the determinants of international students' academic performance. Gaultney, (2010) studied the effects of sleep disorders of college students on their academic performance while Farooq, Chaudhry, Shafiq and Berhanu, (2011) researched on the factors that affect students' academic performance quality. It means the students perform, but not all the students did not attain academic performance quality level.

Investigating student performance is very in institutions to help students work hard and assist administrators in their plans to get the best performance from their students. Several researchers have worked on different areas of academic performance. Samaha and Hawi (2016) used Pearson correlation and Multivariate analysis of variance to examine if satisfaction with life mediates stress and academic performance facilities Smartphone addition. Also, Balogun, Oyelere and Atsa'am (2019) examined the relationship between student's first year and final year academic performance using Regression and Correlation analysis.

Kusurkar et al. (2013) applied a structural equation modelling technique to assess how Relative Autonomous Motivation (RAM) influences academic performance through a sound research strategy and higher study effort.

Giunchiglia et al. (2018) examined the impact of social media on students' performance, and the result showed that social media usage negatively impacts students' academic performance. Similarly, the study carried out by Paul, Baker and Cochran, 2012; Junco, 2012; Meier, Reinecke and Meltzer, 2016 showed a similar result.

Balogun, Moshin and Olaleye (2020) used Cohen's kappa, Intra kappa statistic and Pearson correlation coefficient to determine the agreement and relationship between students' first year Grade Point Average (GPA) and final year Cumulative Grade Point Average (CGPA).

In the same vein, Elepo and Balogun (2016) applied Kappa statistics to investigate student's academic performance using the students' first-year GPA and graduating CGPA.

Literature on Predicting Academic Performance

Fernandes et al. (2019) applied Gradient Boosting Machine (GBM) to predict student's academic performance at the end of the school year. The result shows that the neighbourhood, school, and age indicate students' academic success or failure.

In a study carried out by Miguéis et al. (2018), the authors proposed a two-stage model that uses students' first year to predict their overall academic performance. The result shows Random Forest to be superior to other methods used in terms of accuracy.

Iyanda et al. (2018) conducted a comparison of neural network models to predict student academic performance based on a single performance factor. The result shows that the Generalized Regression Neural Network performs better than the Multilayer Perceptron model in terms of accuracy to predict students' academic performance.

Zaffar, Savita and Hashmani (2018) applied the Feature selection algorithm, a form of Educational Data Mining (EDM), to predict students' academic performance. The result shows a 10% difference in the prediction accuracy between the dataset with different features.

Material and Methods

This study collects data from the School of Engineering which comprises of Chemical, Civil, Computer, Electrical and Electronics, Information and Communication, Mechanical and Petroleum Engineering of Covenant University, Nigeria, during the 2005/2006 academic session were followed-up to their year of graduation in 2010.

The study further checked the spreadsheet of each student to know the category or class of degree they started with 100 level for students who admitted with University Matriculation Examination and 200 level for direct entry.

The appropriate class of degree for each student recorded and equally checked to know the class of degree that he or she later graduated. The study is limited to the first year and final year students' academic performance from seven departments in the School of Engineering from 2005/2006 to 2009/2010 sessions.

The analysis for this study carried out using IBM SPSS version 27 using Pearson correlation and Tau statistic.

Pearson Correlation

Accord to Wang (2012) a nonparametric measure of association for two random variables is known as Pearson correlation coefficient r . It has the value between +1 and -1.

The Pearson correlation coefficient defined as:

$$r = \frac{n(\sum XY) - \sum X \sum Y}{\sqrt{[n \sum X^2 - (\sum X)^2][n \sum Y^2 - (\sum Y)^2]}}$$

Tau Statistic

Jolayemi (1990) suggested a statistic for an agreement calculation that uses the Chi-square distribution. The statistic was introduced from the perspective of R^2 , the coefficient of determination, an index for the stated variability of the regression model applied to the square contingency table. The author proposed a theorem that was also shown to consider the I x I (square) contingency table obtained by classifying the same N subjects in one of the possible I outcomes by two raters.

The Pearson Chi-square (χ^2) statistic for independence is said to be at most $(I - 1)N$. The author also proposed a statistic which measures agreement, the statistic is denoted by $\tau = \sqrt{\lambda}$, $-1 < \tau < 1$.

Where the λ which is R^2 type statistic is defined by $\lambda = \frac{\chi^2}{\max(\chi^2)}$ and

$\max(\chi^2)$ is proved to be $(I - 1)N$. Hence, $\lambda = \frac{\chi^2}{(I - 1)N}$.

The benefit of this statistic over kappa is that ($\lambda = \tau^2$) is possible to make an inference to τ even by means of λ , which estimates the stated variability shown by the configuration of the table. The author also proposed some arbitrary division based on $|\tau|$ with the respective strength of the agreement, as Landis and Koch also proposed for the Cohen Kappa statistic (Landis & Koch, 1977).

Range of Tau Statistic with the Respective Strength of Agreement

$ \tau $ statistic	Strength of agreement
0.00 — 0.20	Poor
0.21 — 0.40	slight
0.41 — 0.60	moderate
0.61 — 0.80	substantial
0.81 — 1.00	almost perfect

When $\tau < 0$, the agreement is negative.

Result

This section comprises of the results from Pearson correlation and Tau statistic. A sample of the R code used for the Tau statistic is attached at the appendix section.

Table 1: Pearson Correlation Coefficient for Chemical Engineering department

		Final year	
		Pearson Coefficient	P-value
First year		0.893	<0.001
Pearson Correlation Coefficient for Civil Engineering department			
		Final year	
		Pearson Coefficient	P-value
First year		0.899	<0.001
Pearson Correlation Coefficient for Computer Engineering department			
		Final year	
		Pearson Coefficient	P-value
First year		0.915	<0.001
Pearson Correlation Coefficient for Electrical and Electronics Engineering department			
		Final year	
		Pearson Coefficient	P-value
First year		0.880	<0.001
Pearson Correlation Coefficient for Information and Communication Engineering department			
		Final year	
		Pearson Coefficient	P-value
First year		0.905	<0.001
Pearson Correlation Coefficient for Mechanical Engineering department			
		Final year	
		Pearson Coefficient	Pearson Coefficient
First year		0.890	<0.001
Pearson Correlation Coefficient for Petroleum Engineering department			
		Final year	
		Pearson Coefficient	P-value
First year		0.923	<0.001

Table 2: tau statistic and interpretation for the seven departments

Department	Jolayemi tau statistic	Interpretation	Chi-square	p-value	Interpretation
Chemical Engineering	0.5827	Moderate	201.65	<0.001	Significant
Civil Engineering	0.5348	Moderate	130.40	<0.001	Significant
Computer Engineering	0.5628	Moderate	473.78	<0.001	Significant
Electrical and	0.5363	Moderate	468.21	<0.001	Significant

Electronics Engineering					
Information and Communication Engineering	0.5225	Moderate	381.07	<0.001	Significant
Mechanical Engineering	0.5893	Moderate	172.92	<0.001	Significant
Petroleum Engineering	0.5042	Moderate	198.30	<0.001	Significant
School of Engineering	0.5230	Moderate	2014.50	<0.001	Significant

Confidence Bound for the tau statistic for School of Engineering

The 95% confidence interval is defined as follows:

$$\begin{aligned}
 C.I. &= \tau \pm Z_{\alpha/2} \sqrt{\frac{\tau(1-\tau)}{n}} \\
 &= \tau \pm Z_{1-\alpha/2} \sqrt{\frac{\tau(1-\tau)}{n}} \\
 &= 0.5230 \pm 1.96 \sqrt{\frac{0.5230(1-0.5230)}{1841}} \\
 &= 0.5230 \pm 1.96(0.011640808) \\
 &= 0.5230 \pm 0.02282 \\
 &= (0.50018, 0.54582)
 \end{aligned}$$

Interpretation: the 95% confidence interval shows that the reliability coefficient for the School of Engineering is between 50% and 55%.

Discussion

This study aims at examining the relationship between the first year and final year results and the reliability between first year results and final year results from seven Engineering departments and the School of Engineering. From the result of the Pearson correlation coefficient, it shows there is a strong positive correlation between the students the first year and final year result, and it also shows there is a significant linear relationship between students first and final year result from the seven departments.

For Chemical Engineering, about 58% of the variation was accounted for, the remaining 42% was due to the variance of the first year even when the final year was taken into account, about 58% of the students would end up with the class of degree they started with.

For Civil Engineering, about 53% of the variation was accounted for the remaining 47% was due to the variance of the first year even when the final year was taken into account, about 53% of the students would end up with the class of degree they started with.

For Computer Engineering, about 56% of the variation was accounted for the remaining 44% was due to the variance of the first year even when the final year was taken into account, about 56% of the students would end up with the class of degree they started with.

For Electrical and Electronics Engineering, about 54% of the variation was accounted for the remaining 46% was due to the variance of the first year even when the final year was taken into account, about 54% of the students would end up with the class of degree they started with.

For Information and Communication Engineering, about 52% of the variation was accounted for, the remaining 48% was due to the variance of the first year even when the final year was taken into account, about 52% of the students would end up with the class of degree they started with.

For Mechanical Engineering, about 59% of the variation was accounted for, the remaining 41% was due to the variance of the first year even when the final year was taken into account, about 59% of the students would end up with the class of degree they started with.

Furthermore, For Petroleum Engineering, about 50% of the variation was accounted for, the remaining 50% was due to the variance of the first year even when the final year was taken into account, about 50% of the students would end up with the class of degree they started with. Lastly, For School of Engineering which comprises all the departments, about 52% of the variation was accounted for, the remaining 48% was due to the variance of the first year even when the final year was taken into account, about 52% of the students would end up with the class of degree they started with.

The chi-square shows there is significant association between the first year and final year results from the seven Engineering department and the School of Engineering ($p - \text{value} < 0.001$).

The results of this research shared similar findings with other existing studies. For example, the study carried out by Balogun, Moshin and Olaleye (2020) which adopted kappa statistic as their method of analysis using data collected from a private University while in our study tau statistic was adopted to examine the academic performance of students from private University. From both studies, we noticed that a reasonable proportion of the students will end up with the class of degree they started with in their first year. Besides, Banjoko et al. (2015) applied kappa statistic using data collected from public University while we implemented tau statistic using the academic performance of students from private University. Both studies revealed that more than half of the students' considered will end up with the class of degree they started with in the first year. Also, the study conducted by Elepo and Balogun (2016) examined students' performance from a public university using Kappa statistic on the data from public University while our study considered the academic performance of students from private University. The summary of the findings of both studies showed that majority of the students will end up with the class of degree they started with in the first year. Lastly, Ibidoja, Ajare and Jolayemi (2016) and our study adopted tau statistic, but the data considered differs. The findings also showed that majority of students will end up with class of degree they started with in the first year.

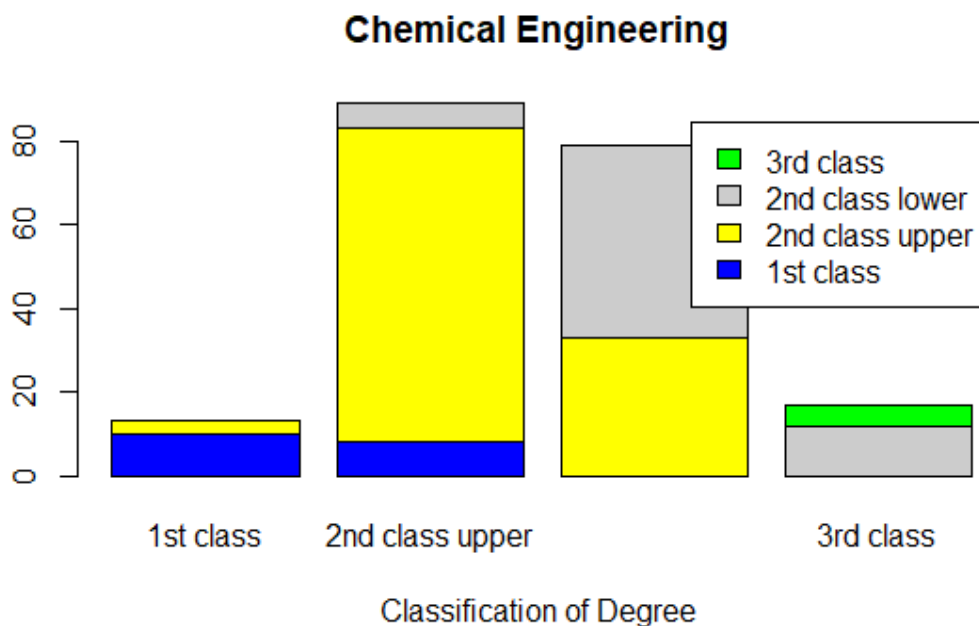


Figure 1: Bar Plot for Chemical Engineering Department

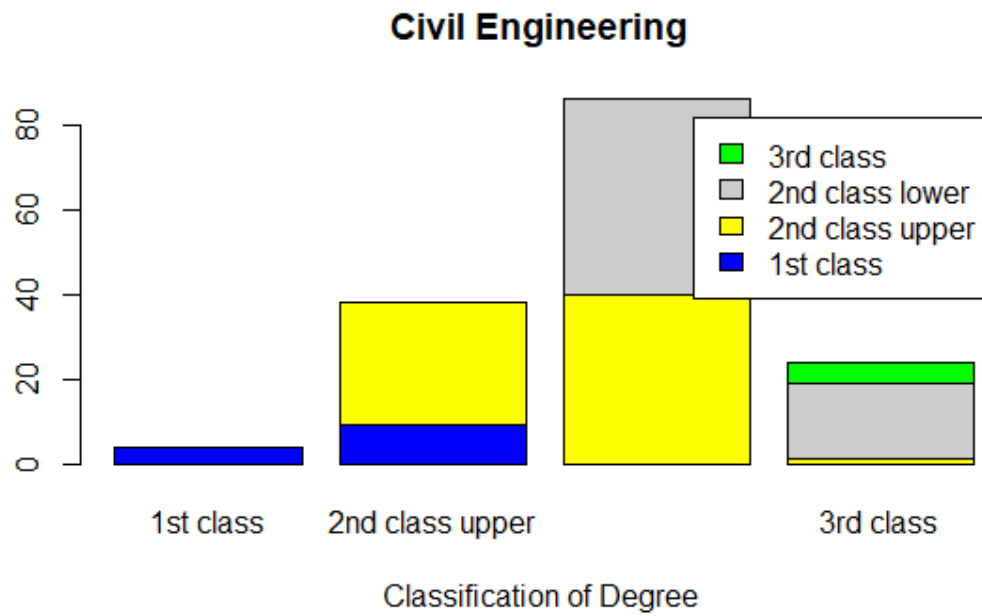


Figure 2: Bar Plot for Civil Engineering Department

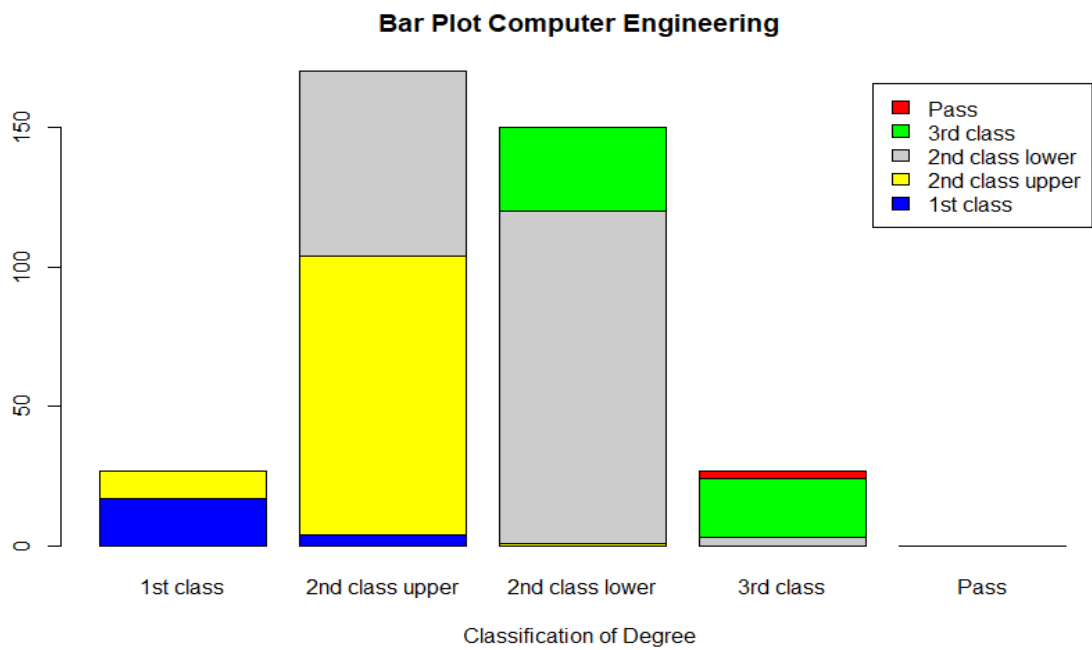


Figure 3: Bar Plot for Computer Engineering Department

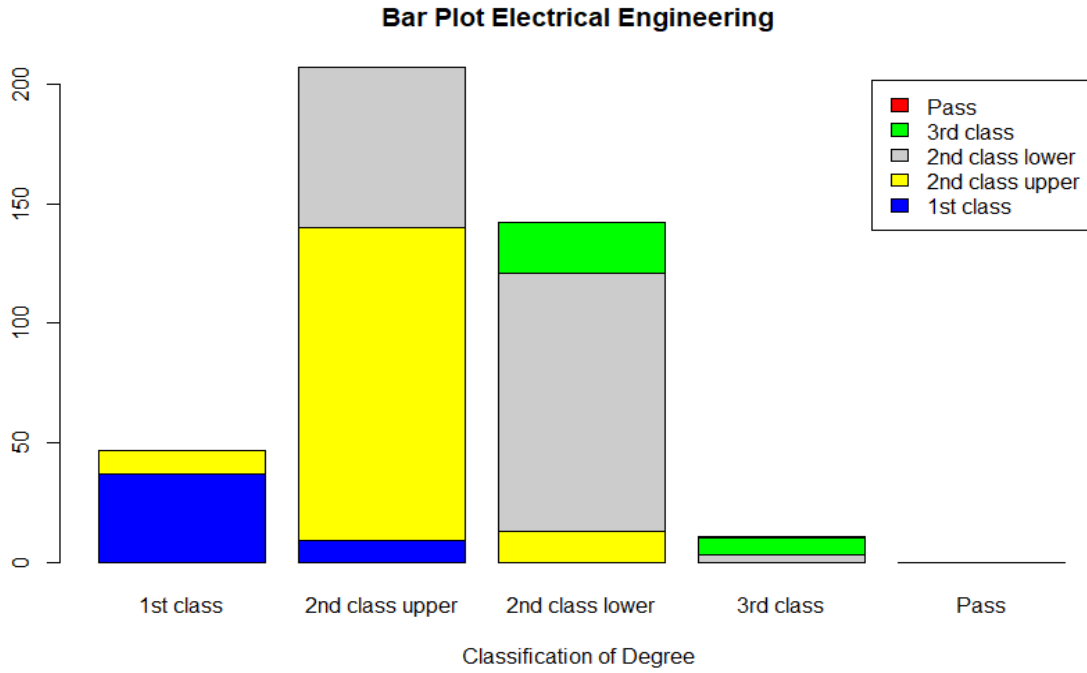


Figure 4: Bar Plot for Electrical and Electronic Engineering Department

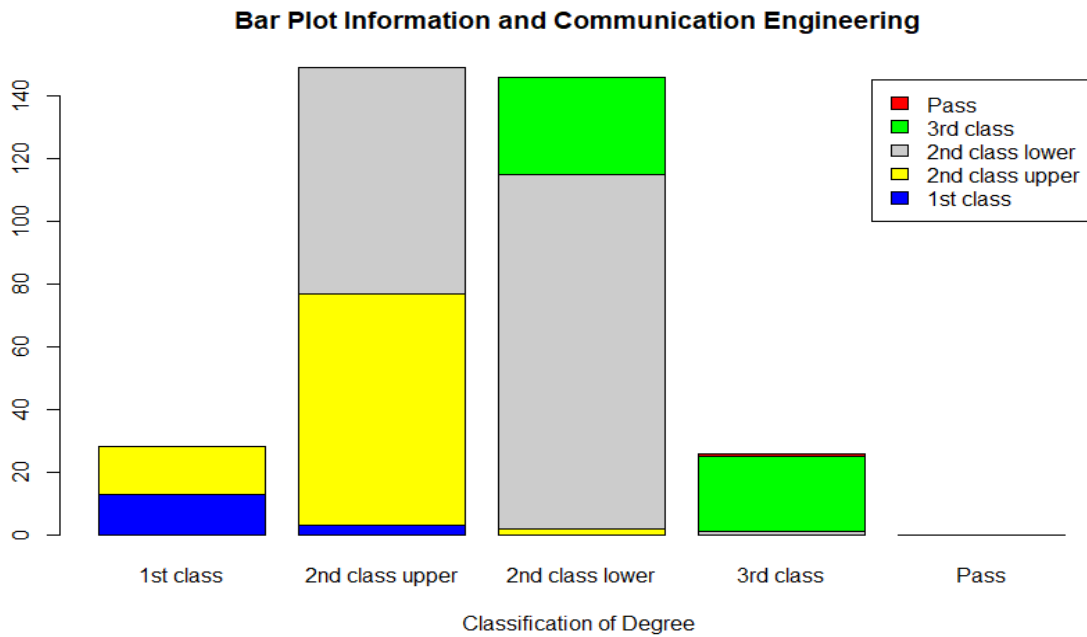


Figure 5: Bar Plot for Information and Communication Engineering Department

Bar Plot Mechanical Engineering

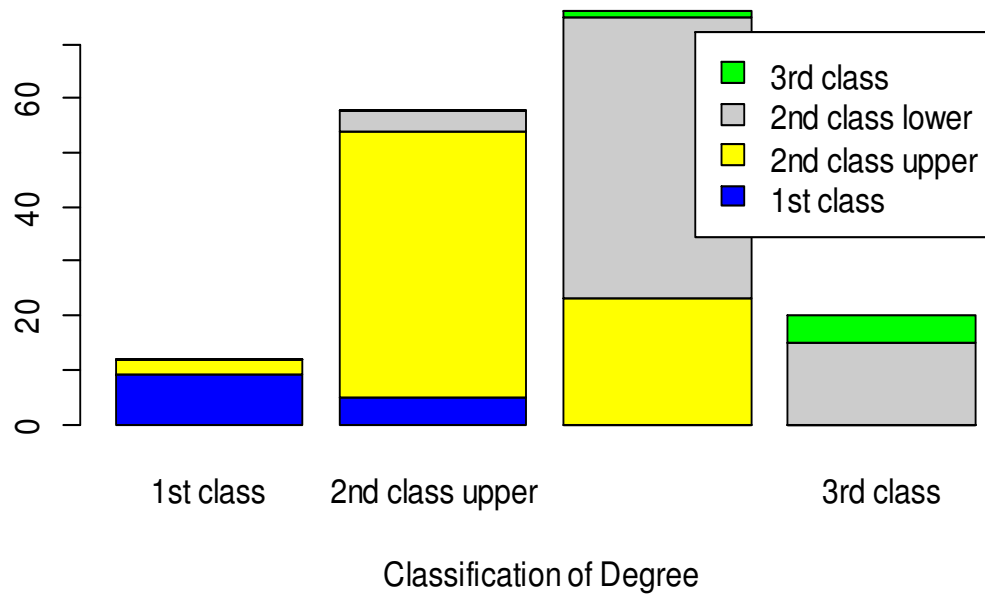


Figure 6: Bar Plot for Mechanical Engineering Department

Bar Plot Petroleum Engineering



Figure 7: Bar Plot for Petroleum Engineering Department

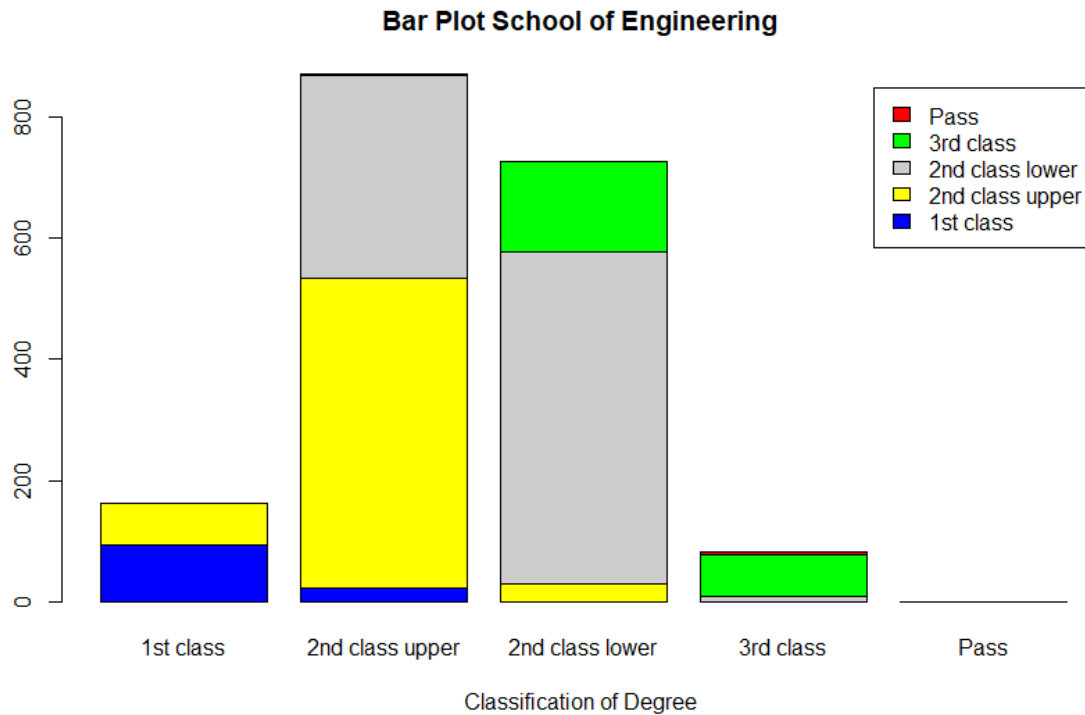


Figure 7: Bar Plot for School of Engineering Department

Conclusion

The study shows that there is a strong correlation between the first year and final year result and also it shows that there is a significant linear relationship between the first year and final year result of students across the seven departments in the School of Engineering.

The analysis showed that the relationship between the first year and final year in the Department of Chemical, Civil, Computer, Electrical, Information and Communication, Petroleum Engineering and the School of Engineering which comprises of all the departments were moderate.

From the tau statistic, it shows that about 58% of the students from Chemical Engineering department would end up with the class of degree they started with while about 58% of the students from Chemical Engineering department would end up with the class of degree they started.

The result from tau statistic reveals that about 53% of the students from the Civil Engineering department would end up with the class of degree they started.

It also shows about 56% of the students from the Computer Engineering department would end up with the class of degree they started and about 54% of the students from the Electrical and Electronics Engineering department would end up with the class of degree they started.

Similarly, the result shows about 52% of the students from the Information and Communication Engineering department would end up with the class of degree they started.

The tau statistic shows that about 59% of the students from the Mechanical Engineering department would end up with the class of degree they started with,

Furthermore, the result from tau statistic shows that about 50% of the students from Petroleum Engineering department would end up with the class of degree they started with, and about 52% of the students from the School of Engineering which comprises of all the departments would end up with the class of degree they started.

The study also shows there is a significant association between the first year and final year results of students from the seven departments and in the School of Engineering of the University. The 95% confidence interval shows the School of Engineering's reliability coefficient to be between 50% and 55%. This study is limited to secondary data extracted from the academic records of students of seven departments from the School of Engineering from the 2005/2006 session to the 2009/2010 session of Covenant University, Nigeria. Future research will make a comparison between tau and kappa statistic. Also, the various outcomes of this work will serve as valuable therapy tools for stakeholders in the education sector inside and outside the university system to enhance students' academic performance in the system. This research would also support parents and guardians from introducing the requisite steps to help enhance their children's academic performance at the university.

Lastly, this study recommends that students spend a lot of their time reading than using it on social networks and watching soccer. Students should develop the practice of reading books in the library and using books in the library. Students should use internet facilities to research their courses.

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Appendix

- R code shows the result for the tau statistic, the chi-square and the histogram.
- `mechanical=matrix(c(9,5,0,0,3,49,23,0,0,4,52,15,0,0,1,5), nrow=4,byrow=T)`
- `dimnames(mechanical)=list(firstyr=c("1st class","2nd class upper","2nd class lower","3rd class"),finalyr=c("1st class","2nd class upper","2nd class lower","3rd class"))`
- `chisq.test(mechanical)`
- `x1mechanical=ncol(mechanical)-1`
- `x2mechanical=sum(mechanical)`
- `taumechanical=sqrt(172.92/(x1mechanical*x2mechanical))`
- `barplot(info,main ="Bar plot mechanical Engineering ",xlab="Classification of Degree ",col=c("blue","yellow","grey80","green"),legend=rownames(mechanical))`
- The same process is repeated for all the departments and the school of Engineering.