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Analysis of Students Performance on Admission Placement

Babagana Modu[1,*], Fatima Abdulhamid Yahaya[2]

[1]*Department of Mathematics and Statistics, Yobe State University, Damaturu, Nigeria*
bmodu@ysu.edu.ng
[2]*Computational Laboratory of the Department of Mathematics and Statistics, Yobe State University, Damaturu, Nigeria*
fatimaayahaya1@gmail.com
[*]*Correspondence: bmodu@ysu.edu.ng*

Abstract. In the present-time, getting admission to study a preferred course of choice in the Nigerian tertiary institutions by prospective applicants is highly competitive. As a criteria, applicants are required to meet the UTME (Unified Tertiary Matriculation Examination (UTME) and five (5) relevant ordinary level credits, including English and Mathematics as a prerequisite before securing admission. However, being wrongly placed for a course that is different from ones choice could negatively affect learning and outcomes. Therefore, proper placement would have tendency of enhancing not only learning and outcomes but also self-esteem; thus improved productivity. This paper has examined students' performance based on the course sought at entry and course placed to study. The CGPA of 300-Level students in the 2020/2021 session of the Department of Mathematics and Statistics, Yobe State University was used as a particular case for the investigation. Descriptive and Non-parametric techniques were employed. We found that applicants who sought to study computer science or physics at entry but were placed to study mathematics/statistics performed better than those who sought to study chemistry or biology. However, applicants who sought to study chemistry and placed to study mathematics/statistics are fairly better as compared to biology. Conclusively, the results of this study will inform decision makers and tertiary institution managers towards selecting those suitable to study mathematics/statistics if their preferred courses not secured.

1. Introduction

A wrong placement for admission without consenting to applicants' interests is believed to have a negative impact on academic performance, low self-esteem, and even dropping out of school. One of the main causes of wrong placement for admission is a lack of adequate information about applicants' academic skills [1]. In many instances, applicants are placed solely based on their entrance examination scores, without considering other factors such as previous academic background or interests, and particularly related to mathematics/statistics. Furthermore, the lack of

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standardization in the admission process across different institutions leads to inconsistencies in the placement of applicants. A more holistic approach to the admission process is desirable to overcome the current challenges. This includes taking into consideration factors beyond just entrance examination scores, such as previous academic performance and interest [2]. Additionally, there is a need to standardize the admission process across various institutions to ensure consistency in the placement of students. Consequently, when students are placed in courses that do not match their academic abilities, they may struggle to keep up with the pace of the curriculum. On the other hand, students who are placed in institutions that are below their academic abilities may become bored and disengaged, leading to a lack of motivation and poor academic performance [3]. Therefore, there is a need for more support and resources available for students who may struggle academically due to wrong admission placement.

This study is timely, important and critical to consider at this time as our contemporary society lacks qualified and competent graduates. They are trained not only to teach, but also to effectively serve in various capacities. The specific problem need to be investigated in this study is whether the chosen or preferred course sought by a student and the course offered to study has a negative impact on the student performance. For this purpose, a CGPA record of students at 300-Level of the Department of Mathematics and Statistics, Yobe State University is of interest for the investigation. The students were interviewed for their chosen of courses at entry and courses offered to study. Available records showed that some students sought to study computer science but offered mathematics/statistics, biology offered mathematics/statistics, chemistry offered mathematics/statistics, and physics offered mathematics/statistics. However, there was a particular student sought to study public administration offered mathematics/statistics. The outcome of this study is expected to guide decision making on admission placement, not necessarily to only benefit Yobe State University but also other tertiary institutions across the country; thus curtailing the wrong admission placement menace. Toward overcoming the current problem effectively, as methodology, we proposed deploying techniques such as descriptive statistics and non-parametric methods. These methodologies have been widely used to tackle wide range of problems, as shown by several studies [4–8].

The remainder of this paper is organized as follows: In Section 2, we present some relevant related studies on student performance and admission placement in tertiary institutions, together with the methods used and findings. Section 3 describes the proposed method. Section 4 presents the results of the study. The conclusions and future work are summarized in Section 5.

2. Related Work

In this section, we present some previous studies conducted in the area of measuring students' performance for admission placement in tertiary institutions. For instance, [9] studied a way to find trends in the education system for courses that assess admission capacity, alongside the management and evaluation of different factors affecting students' performance. A similar study by [10]

evaluated a graduate business program by examining students' academic performance and admission procedures using econometric techniques. The results show that graduate business program admission and graduate academic performance are linked, and hence, a more effective admission policy for improving student graduate academic performance is required. The work presented by [11] examined why women's performance is better in college than men with the same admission test score. The investigation was conducted by exploring two potential explanations for females, course-taking patterns and gender differences. The findings reveal that both explain a portion of females under prediction, with conscientiousness being the vital of the two. An impact of the reverse classroom approach on student learning was studied by [12] to measure a case-control study based on admission criteria. This allows for a comparative analysis of students' performance between study and control group, thus identifying significant differences in the performance of students exposed to the flipped model and traditional teaching model. The relationship between admission criteria for selecting candidate and academic performance during the first year in high school was studied by [13]. Admission test scores of individual candidates to the academic performance shows the importance language proficiency and skill in maths and social studies to predict a student's performance. The study findings show that science is not a predictor of academic performance of students, and reveals a lack of readiness to engage in the Grade 7 science curriculum. A predictive model for alternative admission to study dental education was developed by [14] to compare academic progress and student's performance. Two admission systems were used to analyse the power of different components in an alternative admission. The results showed no difference in importance between the groups in terms of academic performance, and empathetic ability was correlated with study rate and clinical examination results. The findings support the development of admission selection criteria, in particular the emphatic ability that predicts students' significant academic achievements. How difficult a decision to make by many students to which college they should apply to pursue their studies. The research was carried out by [15] to investigate a college admission preference for an engineering candidate who finds a suitable college. The results show that the entry examination is the determining factor that may help predict the most appropriate college. A study of [16] examined the comparability of MCAT outcomes and the future performance of medical students as to the likelihood of being accepted into medical school. The results show that students with MCAT scores had no significance difference in the rate of medical admission but had lower rates of passing the USMLES examination from 4 to 8 years. This finding raised questions on the learning environment and support needed to enable students passing the medical school. The modes of admission and academic performance in Nigeria universities was examined by [17] to compare graduates gained admission through Unified Tertiary Matriculation Examination (UTME) and Preliminary Programmes (PP). With the exception of the Faculty of Agricultural Sciences and Engineering, PP graduates achieved much better results than their counterparts at all faculties.

Similar study was carried out by [18] on admission test as a predictor of student performance in political science and psychology departments of Rizal Technology university. The results show that admission test score was significant in predicting the academic performance for both courses. Furthermore, no significance differences in their general weighted average were observed for both courses and hence a recommendation on the admission policies should be strictly implemented to accept grade at least 83%, and admission score at least 75%. Possibility of predicting academic performance was studied by [19] to investigate potential improvements of admission campaign at IT university. A prediction model was developed based on admission metrics which the results show that academic success at IT can predicted based on previous success. The admission selection criteria can ensure that students must have prerequisite skilled necessary to study IT courses.

3. Materials and Methods

In this section, we present the proposed methodologies to use for addressing the problem to be investigated. A secondary data consisting of cumulative grade point averages (CGPA) and grades earned by 300-Level students of the Department of Mathematics and Statistics during the 2020/2021 academic session. The target population is the students from the department, and a purposive sampling procedure will be adopted to choose the sample. For the data analysis, descriptive and inferential statistics will be deployed, and **R** statistical software will be used to handle all the computational tasks.

3.1. **Yobe State University.** Yobe State University is located in Damaturu, the state capital of Yobe. Geographically, the university lies within latitude 11.7596° N and longitude 11.9622° E in the north-eastern region of Nigeria [20]. The university was established in 2006 by the Yobe State government to provide higher educational services to the people of the state and beyond [21]. The university began academic activities in 2007 with three faculties: Faculty of Arts and Education, Faculty of Science and Faculty of Social and Management Sciences. Since then, the university has grown to include more faculties and departments. The university offers undergraduate and postgraduate programs in various fields of study such as agriculture, education, law, science, social and management sciences, health sciences, and environmental studies. Yobe State University has a mission to provide quality education, research, and community service to its students and the society at large. The university also aimed to produce graduates who are well equipped with the necessary skills and knowledge to contribute to the development of their communities and the nation at large.

3.2. **Statistical Techniques.** Spearman's rank correlation is a statistical measure used to evaluate the strength and direction of the relationship between two independent variables, which may not have a linear relationship. It is named after Charles Spearman, who developed the concept in 1904 [22]. The Spearman's rank correlation coefficient, denoted by "r_s" or "ρ", ranges from -1 to

+1. A value of +1 indicates a perfect positive correlation, while a value of -1 indicates a perfect negative correlation. A value of 0 indicates no correlation between the variables. Spearman's rank correlation is based on the ranks of the values of the two variables rather than their actual values. The ranks are assigned to each observation of the variables and then the correlation coefficient is calculated based on the ranks. Spearman's rank correlation is often used in non-parametric statistics when the data is ordinal or not normally distributed. It is also less sensitive to outliers than other correlation measures such as Pearson's correlation coefficient.

3.3. **Kruskal-Wallis Test.** The Kruskal-Wallis test, also called one-way ANOVA on ranks, is a non-parametric test. the Kruskal-Wallis test was used to determine whether the data did not meet the assumptions of the one-way ANOVA test [23]. The Kruskal-Wallis test online checks the null assumption that when selecting a value from each of the n groups, each of these groups will have an equal probability of containing the highest value. To check whether the difference between the ranks of two or more groups was significant, we used sample data. When the groups have similar distribution shapes, the null assumption is stronger and states that the medians of the groups are equal. When performing the Kruskal-Wallis test, we tried to determine if the difference between the ranks reflects a significant difference between the groups or is due to the random noise inside each group. The chi-squared statistic is an approximation of the exact calculation.

3.3.1. *Hypothesis.*

- H_o: $MR_1 = MR_2 = \cdots = MR_k$
- H_1: not($MR_1 = MR_2 = \cdots = MR_k$, where: MR = Mean rank

3.3.2. *Test statistic.*

$$H' = \frac{12}{n(n+1)} \sum_{j=1}^{n} \left(\frac{R_j^2}{n_j} \right) - 3(n+1), \text{and } H \quad = \frac{H'}{1 - \text{correction}} \tag{1}$$

where:

- R_j = the rank sum of group j.
- n_j = the sample size of group j.
- n = total sample size across all groups, $n = n_1 + n_2 + \cdots + n_j$.

3.3.3. *Right-tailed Distribution.* The Kruskal-Wallis test can be use only when the theoretical distribution is right tail [24] as shown in Figure 1. Also, the sample data from all compared groups, $n < 30$) [25].

3.3.4. *Assumptions.*

- Independent samples from independent groups. One subject can't be in more than one group.
- The dependent variable is ordinal variable or continuous variable

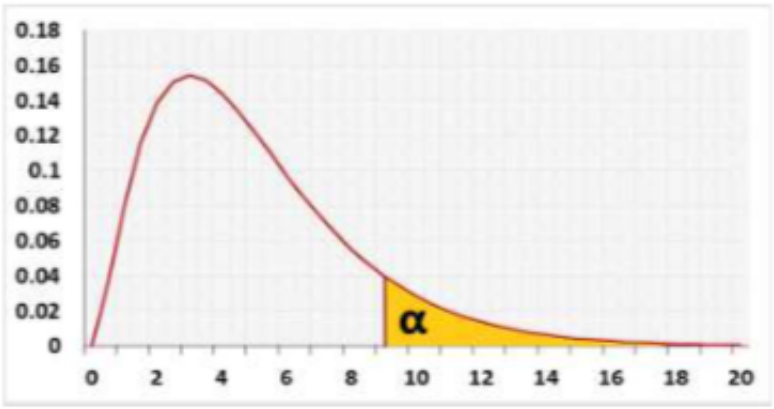

FIGURE 1. χ^2-distribution

- Two or more groups (the independent variable is categorical variable with two or more values)

3.3.5. *Multiple comparisons.* Dunn's test [26], which considers the total number of groups (k), even when comparing only two groups. Mann Whitney U test uses the normal approximation of the Mann Whitney U test and supports the same results as the Kruskal-Wallis test with two groups [24].

4. Results and Discussion

4.1. **Original Data Presentation.** Table 1 presents the records of sixty-four (64) 300-Level students of the Department of Mathematics and Statistics (DMS), arranged according to the courses they applied at entry and admission placements. The students' CGPA, % CGPA, and grades were preprocessed and included to reflect their individual performance.

The information in Table 1 is classified (course applied and admission placement) as follows: Mathematics and Statistics ⇒ Mathematics and Statistics, Computer Science ⇒ Mathematics and Statistics, Biology ⇒ Mathematics and Statistics, Chemistry ⇒ Mathematics and Statistics, and Physics ⇒ Mathematics and Statistics. Out of the 64 students enrolled to study Mathematics and Statistics, 17 students (27%) applied for Mathematics and Statistics ⇒ Mathematics and Statistics, 24 students (38%) applied for Computer Science ⇒ Mathematics and Statistics, 15 students (23%) applied for Biology ⇒ Mathematics and Statistics, 3 students (4%) applied for Physics ⇒ Mathematics and Statistics, and 5 students (8%) applied for Chemistry ⇒ Mathematics and Statistics.

4.2. **Spearman's Correlation Coefficien.** In Table 2, Spearman's rank correlation coefficient [22,29] was used to compute the strength of the relationship between Mathematics and Statistics ⇒ Mathematics and Statistics and Computer Science ⇒ Mathematics and Statistics; Biology ⇒ Mathematics and Statistics. The results for the analysis is presented in Table 2. A strong positive

TABLE 1. Records of 300-Level students of the Department of Mathematics and Statistics, Yobe State University.

S/No	ID	Course Applied	Admission Placement	CGPA	Percentage CGPA	Grade
1.	U/MTH/XX/XXX	CSC	MTH	3.18	63.6	B
2.	U/MTH/XX/XXX	BSC	MTH	2.04	40.8	F
3.	U/MTH/XX/XXX	BSC	MTH	1.49	29.8	F
4.	U/MTH/XX/XXX	BSC	MTH	1.49	29.8	F
5.	U/MTH/XX/XXX	BSC	MTH	1.79	34.8	F
6.	U/MTH/XX/XXX	CSC	MTH	2.88	57.6	C
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
59.	U/MTH/XX/XXX	CSC	MTH	3.12	62.4	B
60.	U/MTH/XX/XXX	BSC	MTH	2.45	49.0	D
61.	U/MTH/XX/XXX	CHM	MTH	2.61	52.2	C
62.	U/MTH/XX/XXX	CSC	MTH	2.51	50.2	C
63.	U/MTH/XX/XXX	CSC	MTH	4.01	80.2	A
64.	U/MTH/XX/XXX	PHY	MTH	4.48	89.6	A

Source: DMS, 300-Level students record (2020/2021)

relationship exists between MST and PHY ($r_s = 0.8692$) and MST vs. CSC ($r_s = 0.7265$); however, a weak correlation was observed between MST and BIO ($r_s = 0.2470$), and a moderate correlation was observed between MST and CHM ($r_s = 0.5619$). Intuitively, this result further revealed that

TABLE 2. Spearman's correlation coefficient and inferences.

Pair-wise course combinations	Spearman's correlation coefficient (r_s)	p-value	95% CI
MST vs CSC	0.7265	0.0119	0.5089, 0.8253
MST vs BIO	0.2470	0.8091	0.1775, 0.3708
MST vs CHM	0.5619	0.0374	0.2126, 0.6138
MST vs PHY	0.8692	0.0026	0.6321, 0.9859

5% level of significance is used.

those students who applied for Computer Science or Physics performed better in the Department of Mathematics and Statistics than those who applied for Chemistry and Biology at entry.

4.3. **Descriptive Statistics.** Expository Data Analysis (EDA) using boxplots and histograms is presented in Figure 2. The results presented using descriptive statistics, as shown in Figure 2, are consistent with those in Table 2. This indicates that Physics and Computer Science are closely related to Mathematics/Statistics on admission placement, as revealed by individual students %CGPA. However, Chemistry is fairly good when compared to biology based on %CGPA performance.

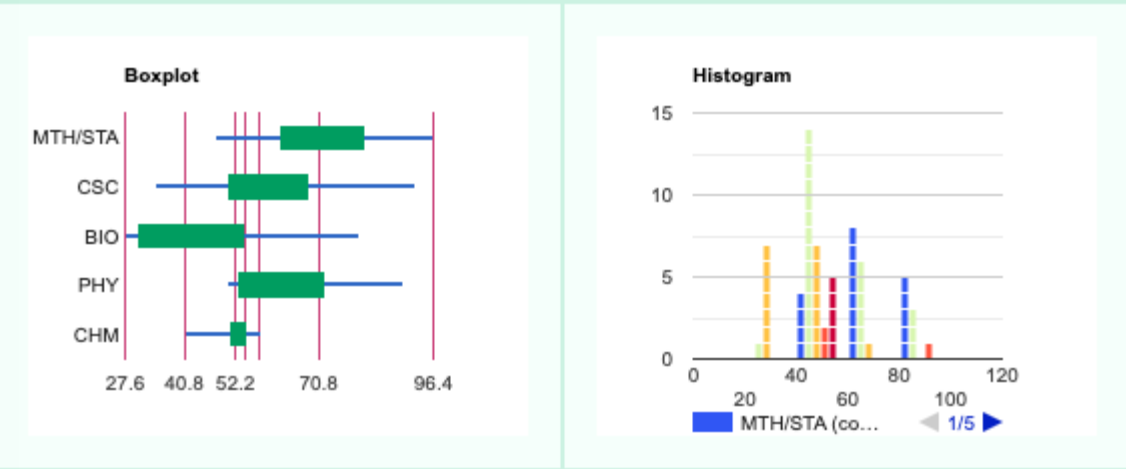

FIGURE 2. Descriptive statistics.

4.4. **Normality Test.** The test for normality is an assumed requirement for applying the Kruskal-Wallis (*KW*) test [27]. In this study, the normality of the data in Table 1 was checked to specify which of the tests was most appropriate. A Shapiro-Wilk (*SW*) test [28] at $\alpha = 5\%$ level of significance was used, and the residuals gave a p-value of 0.2502. Because the p-value is greater than α with at least $n > 30$, the null hypothesis is rejected, and all groups (courses) are distributed normally. Therefore, *KW* test is valid for use as a condition for normality, and the required sample size is met. The summary statistics and distributional characteristics of the data in Table 1 are presented in Table 3.

TABLE 3. Expository Data Analysis.

Groups Summary Statistics	MST	CSC	BIO	PHY	CHM
Skewness shape	-0.0997	0.4739	0.9208	1.6515	-1.1959
Kurtosis shape	-0.9712	0.0648	0.4499	NaN	1.9702
Normality	0.6862	0.6712	0.0605	0.3385	0.6682
Outliers	0.0000	0.0000	0.0000	0.0000	0.0000
Median	70.8	57.4	40.8	54.6	52.2
Sample size (n)	17	244	15	3	5
Rank sum (R^2/n)	786	800	259	108.5	126.5

4.5. **Kruskal-Wallis *H* Test.** The Kruskal-Wallis (*KW*) *H* test was performed, and the results indicated that there was a significant difference in the dependent variable between the different groups (see Table 5 in Appendix **1**). The test statistic $\chi^2(4) = 20.21$, $p < .001$, with a mean rank score of 46.24, 33.33, 17.27, 36.17, and 25.3. The Post-Hoc Dunn's test [26] using a Bonferroni-corrected alpha of 0.005 indicated that the mean rank of the following pair was significantly

different: $X_1 - X_3$. However, when comparing any pair of groups using the *KW* test, the test is similar to the Mann-Whitney *U* test with normal approximation [25].

TABLE 4. Post-hoc test results.

Pair	Mean Rank Difference	Z	SE	Critical Value	p-value	p-value/2
$X_1 - X_2$	12.902	2,1863	5.9012	16.5648	0.0288	0.0144
$X_1 - X_3$	28.9686	4.3929	6.5945	18.5110	0.0000	0.0000
$X_1 - X_4$	10.0686	0.8637	11.6575	32.7231	0.3878	0.1939
$X_1 - X_5$	20.9353	2.2106	9.4706	26.5843	0.0271	0.0135
$X_2 - X_3$	16.0667	2.6222	6.1271	17.1991	0.0087	0.0044
$X_2 - X_4$	-2.8333	0.2485	11.3887	31.9992	0.8037	0.4019
$X_2 - X_5$	8.0333	0.8778	9.1513	25.6881	0.3800	0.1900
$X_3 - X_4$	-18.9000	1.6053	11.7735	33.0487	0.1084	0.0542
$X_3 - X_5$	-8.0333	0.8357	9.6130	26.9841	0.4033	0.2017
$X_4 - X_5$	10.8667	0.7993	13.5959	38.1613	0.4241	0.2121

where: X_1 = MST, X_2 = CSC, X_3 = BIO, X_4 = PHY and X_5 = CHM

Since the p-value $< \alpha$, and thus null hypothesis (H_0) is rejected. We observed that some of the groups' mean ranks were not equal. This is to say the difference between the mean ranks of some groups were large enough to be statistically significant. Therefore, when selecting a value from each group, there are some groups with a higher probability of containing the highest value. The p-value equals 0.0004535, simply means ($P(X \leq 20.2118) = 0.9995$). This means that the chance of a type I error for rejecting a correct H_0 is small, say 0.0004535 (0.045%). The smaller the p-value the stronger the evidence established for rejecting the H_0 or the more it supports the alternative. The test statistic H is 20.2118, which is not in the 95% region of acceptance: [0, 9.4877]. The observed effect size, η^2, was large at 0.27. This indicates that the magnitude of the difference between the averages is large. The mean rank of the following pair is significantly different: $X_1 - X_3$. Although the apriori power was low (0.4909), the null hypothesis was rejected. The observed effect size may be exaggerated or even in the wrong direction. It was suggested that the test power should be improved by

- Sample size: used a larger sample.
- σ: Check if the standard deviation can be reduced by eliminating noise that is not relevant to the tested measurement.
- Effect size*: When planning the research, it was possible to increase the required effect size at the price of the ability to identify smaller effect sizes.
- α^*: When planning the research, it was possible to increase the significance level (α) at the cost of increasing the probability of a type I error.

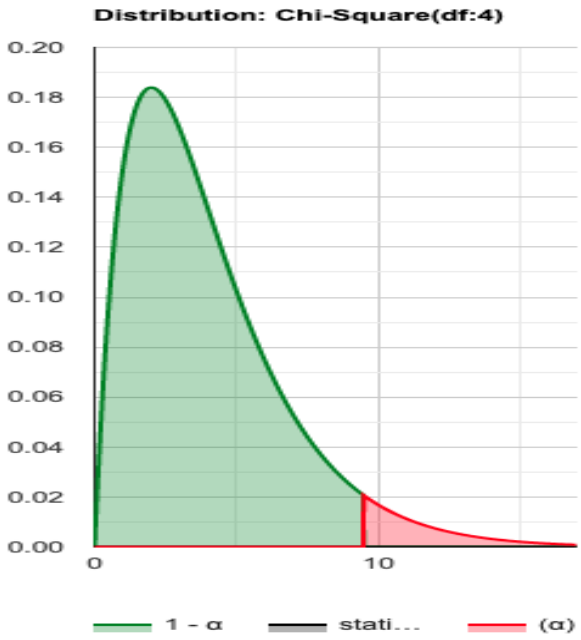

FIGURE 3. Right-tailed the Kruskal-Wallis test.

5. CONCLUSION

In this study we investigated the impact of wrong placement on admission into tertiary institutions and particularly Nigeria. This is a serious problem and if not properly address could result in negative impact on students learning and outcomes. Therefore, it is paramount the institutions should take a serious measures by considering factors beyond just the entrance examination scores and ordinary level certificate. In so doing, students could have chance of being placed or offered admission to study courses that matches individual abilities and interests, thus leading to a better academic performance, final outcome and enhanced country's productivity. Our findings revealed that applicants who sought to study computer science or physics at entry but placed to study mathematics/statistics performed better than those who sought to study chemistry or biology. However, chemistry applicants could be considered for mathematics/statistics where necessary, but as a last resort; and whereas biology applicants are strongly not recommended. The results of this study will serve admission office of tertiary institutions as a guide to ensuring better placement for those interested to study mathematics/statistics. The specific findings and recommendations of this study are summarized below.

- Decision makers of the tertiary institutions should consider placing applicants for admission strictly based on their chosen courses or other related courses within the catchment faculty/department.

- Physics or Computer science applicants who cannot secure a place to study their chosen courses should be encouraged to study mathematics/statistics as the best and alternative options.
- Guidance and counselling unit should be established in the tertiary institutions to support and encourage applicants toward making sure they have chosen the best and alternative option.

Competing interests

The authors declare that they have no competing interests.

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Appendix 1

Table 5. % CGPA by courses placed on admission at 300-Level.

MST	CSC	BIO	PHY	CHM
87.2	63.6	40.8	50.2	50.8
47.8	57.6	29.8	54.6	58.2
58.4	57.4	29.8	89.6	41.0
69.4	92.4	34.8		55.0
62.2	66.6	79.8		52.2
62.4	70.4	31.8		
92.4	73.0	59.2		
81.4	50.8	56.2		
90.0	58.2	52.2		
77.8	51.2	30.8		
76.2	57.4	27.8		
96.4	34.4	49.0		
53.0	40.2	45.0		
70.2	40.2	57.6		
48.0	80.4	27.6		
79.8	40.2			
70.8	54.2			
	48.2			
	56.2			
	53.0			
	71.4			
	62.4			
	50.2			
	80.2			