


Assessing Students' Academic Performance Using Symmetry, Quasi-Symmetry and Conditional Symmetry Models

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Abstract

The study examined the agreement measure in students' academic performance based on first-year and final-year CGPA of undergraduates at Modibbo Adama University, Yola. The data were extracted from undergraduates' results for the 2018/2019 academic session, involving four faculties: Agricultural Sciences, Environmental Sciences, Physical Sciences, and Life Sciences. All departments within each faculty were combined. Three models on agreement measures were adopted: the symmetry model, quasi-symmetry model, and conditional symmetry model. The symmetry model assumes chance agreement between the two ratings (first-year and final-year CGPA), while the quasi and conditional symmetry models assume that the agreement between both ratings exceeds chance, as indicated by the upper and lower diagonal entries. The estimated Akaike Information Criterion (AIC) values in the Faculty of Agricultural Sciences clearly show that the quasi and conditional symmetry models (62.568 and 63.189) are lower than the symmetry model (77.56). The tau value is -1.4881, indicating that students' final-year performance is lower compared to their first-year performance. In the Faculty of Environmental Sciences, the AIC values are 74.564, 75.03, and 85.704; the tau value of -9.383 shows that students' final-year performance is lower compared to their first-year performance. In the Faculty of Physical Sciences, the AIC values are 65.085 (both) and are lower than 91.013; with a tau value of -1.485, final-year performance is rated lower compared to first-year performance. In the Faculty of Life Sciences, AIC values are 61.506 (both), which is lower than 66.773, with a tau value of -0.8823. It can be concluded that first-year results provide a more accurate picture of students' performance ratings, which are better or higher than final-year CGPA in all four selected faculties.

Keywords: Academic Performance, Symmetry, Quasi-Symmetry, Conditional Symmetry Models.

1. Introduction

Education is an avenue of training and learning to improve knowledge and develop skills, especially in schools or colleges. The ultimate purpose of education is to empower an individual to excel in a chosen field of endeavor or career and to positively impact his/her environment. The end results of the processes of education are to maintain a high degree of academic distinction and excellence amongst learners and recipients of education in institutions of learning. Reasons that may be responsible for the prevailing circumstances could be largely remote in nature, such as educational policies on student enrolment and admission. Nevertheless, strategies must be sorted and implemented to remedy the situation of poor academic performance in higher institutions. Academic achievement or performance is the outcome of education. Academic achievement is commonly measured by examinations or continuous assessment, but there is no general agreement on how it is best tested or which aspects are most important: procedural knowledge, such as skills or declarative knowledge, such as facts. Academic performance or achievement is the extent to which a student, teacher, or institution has attained their short or long-term educational goals and is measured either by continuous assessment or cumulative grade point average (CGPA) (Alemneh *et al.*, 2019; Mesfn *et al.*, 2022).

Students' low academic performance at the end of a university degree has been a longstanding problem, especially among undergraduate students (Akuma and Abakpa, 2022). Students' academic performance is paramount to every institution as well as other stakeholders. For a student to progress and stay in the institution, she/he should excel in all the examinations that would be conducted (Okeke, 2019). Students are assessed on their performance with their Grade Point Average (GPA) and their Cumulative Grade Point Average (CGPA). This determines how the student is performing for the period. The CGPA is very important to students, employers and other stakeholders in the educational sector (Alemneh *et al*, 2019). In particular, students' academic gain and learning performance is affected by numerous factors including gender, age, teaching faculty, students schooling, father/guardian social economic status, what they consume, residential area of students, medium of instructions in schools, tuition trend, daily study hour and accommodation as hostels or day scholar (Idoko *et al*, 2015).

According to Wu *et al*. (2024), Education Program has a significant impact on students' academic performance and employability in the education sector, to understand how students' perceptions of their academic record and their influence on their employability. Oyediran *et al*. (2018), stated that education is one of the most important aspects of human resource development. The students' performance plays an important role in producing best quality graduates who will become great leaders and manpower for the country, thus responsible for the country's economic and social development. Academic achievement is one of the major factors considered by employers in hiring workers especially for the fresh graduates. Thus, students have to put the greatest effort in their study to obtain good grades and to prepare themselves for future opportunities in their career and fulfil the employer's demand.

1.1 Statement of the Problem

Academic performance or achievement is generally measured by examinations or tests so as to arrive at substantive indicators of the true ability of the student(s). These measured outcomes are often used as tools in rating and/or ranking such students in their future endeavors especially when in competition for limited resources, positions or allocations. Most often, the student is/are made to write a series of examinations (some on a continuous interval, e.g. (CGPA). Thus, this research seeks to expand on the study conducted by Akinrefon and Adejumo (2012) by examining agreement patterns under symmetry, quasi-symmetry and conditional symmetry model's situations to ascertain which of the alternative results reflect the true performance of students.

1.2 Objectives

The objectives of these study are to:

- i. Determine the academic performance of students under Symmetry conditions;
- ii. Examine the Condition of Symmetry agreement of students' academic performance; and
- iii. Evaluate the Quasi-Symmetry agreement in the results.

2. Literature

Akinrefon and Adejumo (2012) conducted research to assess and investigate undergraduate students' academic performance in their first and final years. The aim was to determine which year better reflects a student's true ability in their chosen course of study and to identify the effects of various factors on their final grades. The Conditional Symmetry Model and Multinomial Logit Regression were employed for the analysis. The results indicated that, across all cross-classified data, first-year performances rated students' abilities higher than their final-year performances. Additionally, the multinomial logit model showed that the estimated odds of a student achieving a first or second class (upper division) were higher in their first year compared to their final year.

The study by Ogbodo *et al*. (2014) focused on Nigerian Federal Universities to determine the relationships between students' academic performance, admission criteria policy, and retention rates. A sample of 42,288 first-year

undergraduate students from five Federal Universities in South-West Nigeria was surveyed. The variables examined included admission policy and academic achievement. Data were analyzed using descriptive and inferential statistical procedures. The findings revealed a significant relationship between the academic performance of students admitted through criteria policy and their retention rates. The study suggested that admission policies should be better aligned with institutional strategies to improve student academic performance and enhance retention.

In another study conducted by Akinrefon and Balogun (2014), control charts were utilized to monitor students' performances. The researchers identified causes underlying chart statistics that fell below the lower control limits, indicating a negative shift in students' CGPA. Similarly, reasons for statistics exceeding the upper control limit, which indicated a positive shift in student CGPA, were also identified.

Balogun and Elepo (2016) employed Cohen's Kappa to examine the performance of students in the Faculty of Science at the University of Ilorin. Data were collected from eight departments within the faculty, covering student performance measured by Grade Point Average (GPA) and cumulative Grade Point Average (CGPA) from 2000 to 2006. This study determined the proportion of students who improved their performance, those who dropped from their initial grade point class, and those who maintained their performance using a psychometric approach. It also examined the strength of agreement between first-year and final-year performances.

Akuma and Abakpa (2022) predicted that students' academic performance in university changes from one academic year to another as they progress through their academic programs. Predicting students' academic performance in higher educational institutions is challenging due to the absence of a centralized database for student performance records. Additionally, there is a lack of standardized methods for predicting student performance, alongside moderating factors such as physical, economic, and health issues affecting student progress. This study developed a model to predict students' performance based on their CGPA using a linear regression algorithm. Analyzed data from 70 undergraduate computer science students indicated that the model could accurately predict fourth-year CGPA based on previous cumulative grades from the past three years, achieving an accuracy rate of 87.84% with a correlation coefficient of 0.9338. The study also identified that second-semester CGPA in the first year and first-semester CGPA in the second year were critical indicators affecting prediction accuracy.

According to Ogunbodede and Oribhabor (2022), digital resource usage significantly impacts academic performance among undergraduate students at the University of Africa, Toru-Orua (UAT), Bayelsa State, Nigeria. The researchers employed a descriptive survey design involving 1,500 students during the 2020/2021 academic session. A validated questionnaire was used for data collection, which achieved a reliability coefficient of 0.98 via Cronbach's alpha. Out of 1,500 distributed questionnaires, 1,342 responses were retrieved from students across levels 100 to 400. Data analysis involved frequency counts, simple percentages, and statistical software for generating means and standard deviations; Pearson's product-moment correlation coefficient was utilized to test hypotheses at a 0.05 significance level.

The findings revealed that digital resource usage was low, with only 4% of students utilizing these resources daily. However, it was established that students accessed internet resources, e-books, online educational videos on platforms like YouTube, e-journals, and e-newspapers. Students expressed a positive perception regarding the impact of digital resource usage on their academic performance. Hypothesis testing indicated a significant relationship between digital resource usage and academic performance among undergraduate students at UAT; increased usage positively correlated with improved student performance (Tokumbo *et al.*, 2018).

Meng and Zhang (2023) highlighted challenges faced in higher education related to unsatisfactory academic performance and dropout rates globally. Their study emphasized that "student-centered" pedagogy necessitates

universities address student needs effectively. Research has shown that academic self-efficacy is a vital psychological factor in preventing burnout among students and reducing dropout rates through enhanced academic engagement and improved performance. Their study aimed to explore the relationship between academic self-efficacy and academic achievement among university students while examining the mediating role of academic engagement.

A total of 258 participants were included in this cross-sectional study. Relationships among academic self-efficacy, engagement, and performance were assessed using Pearson correlation coefficients; mediation analysis was applied to explore engagement's role between self-efficacy and achievement. Results indicated a strong positive correlation among these variables; self-efficacy emerged as both a direct predictor of achievement and an indirect predictor through engagement's mediating effect. The findings offer theoretical insights for university researchers while providing practical recommendations for administrators seeking to enhance student performance through increased self-efficacy and engagement initiatives.

3. Methodology

The data were collected using secondary sources obtained from undergraduate results across various faculties for year 2018 / 2019 academic session at Modibbo Adama University, Yola and was analyzed using symmetry, conditional symmetry, and quasi-symmetry models, respectively.

3.1 Loglinear Model

The loglinear model describes association patterns among categorical variables. This approach models cell counts in a contingency table in terms of association among the variables, treating one variable as a response and others as explanatory variables (Wasi and Sarim, 2017; Wickramasingher, 2019). The model can be expressed mathematically as follows (Indika, 2019):

$$\log(m_{ij\dots l}) = \mu + \lambda_i^{R_1} + \lambda_j^{R_2} + \dots + \lambda_l^{R_k}, \quad i, j, \dots, l = 1, 2, \dots, I \tag{1}$$

where $m_{ij\dots l}$ = the expected cell count in the $ij \dots l$ th cell of the joint K -dimensional cross-classification of the ratings. μ = the overall effect. $\lambda_i^{R_k}$ = the effect due to categorization by the k th rater in the c th category ($k = 1, \dots, k; c = 1 \dots I$) and The sum of effects is given by:

$$\sum_{i=1}^I \lambda_i^{R_1} = \dots = \sum_{i=1}^I \lambda_i^{R_k} = 0. \tag{2}$$

$$\log(m_{ij\dots l}) = \mu + \lambda_i^{R_1} + \lambda_j^{R_2} + \dots + \lambda_l^{R_k} + \delta_{ij\dots l}, \quad i, j, \dots, l = 1, 2, \dots, I, \tag{3}$$

Here $\delta_{ij\dots l}$, represents agreements beyond chance for the $ij \dots l$ th cell.

3.2 Symmetry Model (SM)

For a given $I \times I$ contingency table, let π_{ij} be the probability of cell i, j . Also, let R_1 and R_2 be rater 1 and rater 2, respectively. There exists a symmetry if $\pi_{ij} = \pi_{ji}$, whenever $i \neq j$. Let m_{ij} denote be the expected value of the cell i, j , such that $m_{ij} = n\pi_{ij}$. Then, the symmetry model can be represented as a loglinear model given as;

$$\log(m_{ij\dots l}) = \mu + \lambda_i + \lambda_j + \lambda_{ij}, \quad i, j, = 1, 2, \dots, I \tag{4}$$

where $\lambda_{ij} = \lambda_{ji}$, $\sum_{i=1}^I \lambda_i = 0$ and $\sum_{i=1}^I \lambda_{ij} = 0$ for $j = 1, 2, \dots, I$.

There are no superscripts on the main or marginal effects terms because they are the same for rows and columns; that is $\lambda_i^{R_1} = \lambda_j^{R_2}$ where $i = j$. In other words the row and column margins are equal; that is, $m_{i+} = m_{+i}$.

$$df = I(I - 1) - \frac{I(I - 1)}{2} = I(I - 1)/2 \tag{5}$$

3.3 Conditional Symmetry Model (CS)

Conditional Symmetry model was proposed by Macullagh (1978) and is given as

$$\pi_{ij} = \begin{cases} \theta\phi_{ij} & \text{if } i < j, \\ \phi_{ii} & \text{if } i = j, \\ (2 - \theta)\phi_{ij} & \text{if } i > j, \end{cases} \tag{6}$$

with $\phi_{ij} = \phi_{ji}$ and $\sum_{i=1}^I \sum_{j=1}^I \phi_{ij} = 1$. Conditional Symmetry model is palindromic invariant and not permutation invariant (Macullagh, 1978). However, the reverse permutation applied to conditional symmetry model yields

$$\pi_{ij} = \begin{cases} (2 - \theta)\phi_{I-i+1, I-j+1} & \text{if } i < j, \\ \phi_{I-i+1, I-i+1} & \text{if } i = j, \\ \theta\phi_{I-i+1, I-j+1} & \text{if } i > j. \end{cases} \tag{7}$$

with $\phi_{I-i+1, I-j+1} = \phi_{I-j+1, I-i+1}$, and $\sum_{i=1}^I \sum_{j=1}^I \phi_{I-i+1, I-j+1} = 1$ for $i = j = 1, 2, \dots, I$. The conditional symmetry model as loglinear model is given as

$$\log(m_{ij}) = \mu + \lambda_i^{R_1} + \lambda_j^{R_2} + \lambda_{ij}^{R_1 R_2} + \tau I(i < j), \quad i, j = 1, 2, \dots, I \tag{8}$$

where $\lambda_{ij}^{R_1 R_2} = \lambda_{ji}^{R_1 R_2}$, $\sum_{i=1}^I \lambda_i^{R_1} = 0$, and $\sum_{i=1}^I \lambda_{ij}^{R_1 R_2} = 0$ for $j = 1, 2, \dots, I$ and $I(ij)$ is the indicator functions defined as $I(i < j) = \begin{cases} 1, & \text{if } i < j, \\ 0, & \text{if } i \geq j. \end{cases}$

This CS model is mainly for ordered classification when symmetry does not hold, often either $\pi_{ij} > \pi_{ji}$ for all $i < j$, or $\pi_{ij} < \pi_{ji}$ for all $i < j$. The CS model implies that for all $i < j$, if R_1 denote the row number and R_2 denote the column number of an observation made according to distribution $\{\pi_{ij}\}$, the conditional interpretation of CS model is $p\left(R_1 = i, R_2 = \frac{j}{R_1} < R_2\right) = p\left(R_1 = j, R_2 = \frac{i}{R_1} > R_2\right) = \phi_{ij}$. This means the cells' probabilities above the main diagonal are mirror image of the cell's probabilities below it. Based on this property the model is called conditional symmetry model.

The residual degree of freedom, $df = \frac{(I+1)(I-2)}{2}$, which is one less than that of the symmetry because of the additional parameter $\tau I(i < j)$. Also, a logit form of this model is $\log\left\{\frac{m_{ij}}{m_{ji}}\right\} = \tau$, for $i < j$.

3.4 Quasi-Symmetry Model (QS)

Quasi-Symmetry model was introduced by Caussinus (1965), as extension of a symmetry model. There are a number of equivalent definitions, one given by Macullagh (1978), is $\pi_{ij} = c \frac{\alpha_i}{\alpha_j} \phi_{ij}$, with $\phi_{ij} = \phi_{ji}$, $\sum \sum \phi_{ij} =$

1, $\alpha_1 = 1$ and c a constant to make $\sum \sum \pi_{ij} = 1$. The Quasi-Symmetry model according to Macullagh (1978) is permutation invariant, such that if an arbitrary permutation is applied to both rows and columns, the new cell probability, π'_{ij} , are given by $\pi'_{ij} = c \frac{\alpha'_i}{\alpha'_j} \phi'_{ij}$ where α' is permutation of the elements of α and ϕ' , is obtained from ϕ by permuting both rows and columns. The log-linear Quasi-symmetry model is given as

$$\log(m_{ij}) = \mu + \lambda_i^{R_1} + \lambda_j^{R_2} + \lambda_{ij}^{R_1 R_2}, \tag{9}$$

where $\lambda_i^{R_1} \neq \lambda_i^{R_2}$ and $\lambda_{ij}^{R_1 R_2} = \lambda_{ji}^{R_1 R_2}$ for $i \neq j$.

3.5 Fitting of the selected Model

Model fitting is the most important aspect in modern statistical analysis. Consequently, there is a need to obtain the estimate for the parameters in the models. Generalized linear model (GLM) procedure is used to fit these models. The likelihood function is

$$l(\theta, \phi) = \sum_{i=1}^n (y_i b(\theta_i) - c(\theta_i) + d(y_i \phi)), \tag{10}$$

where θ subsumes of the θ_i . It could also be written as a function of β and ϕ because (given the x_i) β determines all the θ_i . The main approach of maximizing β is by maximizing 3.3.5 the fact that $G(\mu_i) = x_i \beta$ suggest a crude approximation estimate, $G(y_i)$, on x_i , perhaps modified y_i in order to avoid valuating range restrictions (such as taking $\log(0)$), and accounting for the different variances of the observations. Fisher scoring iteration is the widely used technique for maximizing the GLM likelihood over β . The basic steps are

$$\beta^{(k+1)} = \beta^k - \left(E \left(\frac{\partial^2 l}{\partial \beta \partial \beta'} \right) \right)^{-1} \frac{\partial l}{\partial \beta} \tag{11}$$

where l is the *loglikelihood* function for the entire sample, y_1, \dots, y_N and the expectations are taken with $\beta = \beta^{(k)}$. This is the same as Newton step, except that Hessian of l is replaced by its expectations. Fisher's scoring simplifies to;

$$\beta^{(k+1)} = (X^T W X)^{-1} X^T W Z, \tag{12}$$

where W is diagonal matrix with

$$W_{ii} = (G'(\mu_i)^2 b''(\theta_i))^{-1},$$

and

$$z_i = (Y_i - \mu_i) G'(\mu_i) + x_i \beta.$$

The weight, W_{ii} , have the usual interpretation as reciprocal of variance: $b''(\theta_i)$ is proportional to the variance of Y_i and the $G'(\mu)$ factor in Z_i is squared in W_{ii} and institutional environment on student performance at university of Gujrat.

4. Results and Discussions

4.1 Faculty of Agricultural Sciences

Here we assess the measure of agreement for performance of students in Faculty of Agricultural sciences using their first year CGPA and their final year CGPA. Three models were adopted namely: symmetry, quasi- symmetry and

the conditional symmetry models. The symmetry model assumes chance agreement between the two ratings (first year and final year CGPAs) while quasi-symmetry and conditional symmetry models assume that agreement between both ratings are beyond chance agreement, determine the upper and lower diagonal entries. The residual deviance and the AIC values are presented for the three models. From Table 2, “A” value is 1.4582 implying that the main effects of the final year CGPA differ by 45 percent.

From Table 3, the τ value for combined data in Faculty of Agric Sciences is -1.4881, and $\exp(\tau)$ is 0.22580127 and this showed that the students’ final year performance rate is lower compared to that of their first-year performance. This implies that their first-year result gave the true performance of the students, rating them better or higher than their final year CGPA. This showed that the estimated probability for the Faculty of Agric Sciences is that the final year CGPA is less consistent in rating the students’ performance (about 0.22580127 times) than that of their first year CGPA. According to Table 4, the estimated Akaike Information Criterion (AIC) values for the Faculty of Agricultural Sciences indicate that both the quasi-symmetry model (62.568) and conditional symmetry model (63.189) are lower than the symmetry model (77.56), implying that a beyond chance agreement measure is more suitable. Further examination between the AIC values for beyond chance agreement measure indicates that the quasi-symmetry model is better suited than the conditional symmetry model. The tau value of -1.4881 indicates that students’ final-year performance is lower compared to their first-year performance. From Table 4, based on the goodness-of-fit, we would observe that the data fit well for quasi- and conditional symmetry models, where the χ^2 values for the three models are 18.51128, 5.1232 and 5.5786, respectively. Accordingly, based on the results obtained from the analysis, we conclude that students’ grades in their first year gave a better picture of their performance than their final year.

Table 1. Parameters’ estimates under symmetry model in the Faculty of Agricultural Sciences

| Coefficient | Value | S.E. | Pr < Z |
|----------------|----------|------------|------------|
| Intercept | 1.0986 | 0.0000 | <2e-16 *** |
| λ_{11} | -19.4012 | 0.0000 | <2e-16 *** |
| λ_{12} | 0.5108 | 0.0000 | <2e-16 *** |
| λ_{22} | 2.0369 | 0.0000 | <2e-16 *** |
| λ_{13} | -1.0986 | 1.2910 | 0.395 |
| λ_{23} | 1.1527 | 0.0000 | <2e-16 *** |
| λ_{33} | 2.2336 | 0.0000 | <2e-16 *** |
| λ_{14} | -19.4012 | 12784.7906 | 0.999 |
| λ_{24} | -19.4012 | 15658.1068 | 0.999 |
| λ_{34} | 0.1542 | 1.3801 | 0.911 |

Significance Codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1; Null deviance: 174.413 on 15 degrees of freedom; Residual deviance: 23.562 on 6 degrees of freedom; Akaike Information Criterion (AIC): 77.56; Number of Fisher Scoring iterations: 16.

Table 2. Parameters’ estimates under quasi-symmetry model in the Faculty of Agricultural Sciences.

| Coefficients | Value | S.E. | Pr < Z |
|----------------|----------|--------|------------|
| Intercept | -4.7343 | 0.0000 | <2e-16 *** |
| A | 1.4582 | 0.0000 | <2e-16 *** |
| λ_{11} | -17.0265 | 0.0000 | <2e-16 *** |
| λ_{12} | 3.9113 | 0.0000 | <2e-16 *** |
| λ_{22} | 4.9533 | 0.0000 | <2e-16 *** |
| λ_{13} | 1.0000 | 0.0000 | <2e-16 *** |
| λ_{23} | 3.0949 | 0.0000 | <2e-16 *** |

| | | | |
|----------------|----------|--------|------------|
| λ_{33} | 3.6918 | 0.0000 | <2e-16 *** |
| λ_{14} | -19.8521 | 0.0000 | <2e-16 *** |
| λ_{24} | -20.3070 | 0.0000 | <2e-16 *** |
| λ_{34} | 0.6381 | 0.0000 | <2e-16 *** |

Significance Codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1; Null deviance: 174.4133 on 15 degrees of freedom; Residual deviance: 6.5684 on 5 degree of freedom; Akaike Information Criterion (AIC): 62.568; Number of Fisher Scoring iterations: 18.

Table 3. Parameters’ estimates under conditional symmetry model in the Faculty of Agricultural Sciences.

| Coefficients | Value | S. E. | Pr < Z |
|----------------|----------|--------|------------|
| Intercept | 1.0986 | 0.0000 | <2e-16 *** |
| λ_{11} | -21.4012 | 0.0000 | <2e-16 *** |
| λ_{12} | 1.0004 | 0.0000 | <2e-16 *** |
| λ_{22} | 2.0369 | 0.0000 | <2e-16 *** |
| λ_{13} | -0.6091 | 0.0000 | <2e-16 *** |
| λ_{23} | 1.6422 | 0.0000 | <2e-16 *** |
| λ_{33} | 2.2336 | 0.0000 | <2e-16 *** |
| λ_{14} | -20.7623 | 0.0000 | <2e-16 *** |
| λ_{24} | -20.7623 | 0.0000 | <2e-16 *** |
| λ_{34} | 0.6437 | 0.0000 | <2e-16 *** |
| τ | -1.4881 | 0.0000 | <2e-16 *** |

Significance Codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1; Null deviance: 174.413 on 15 degrees of freedom; Residual deviance: 7.189 on 5 degrees of freedom; Akaike Information Criterion (AIC): 63.189; Number of Fisher Scoring iterations: 18.

Table 4: Summary table for the three models in the Faculty of Agricultural Sciences.

| | SYMM | QS | CS |
|-------------------|----------|--------|--------|
| Residual deviance | 23.562 | 6.5684 | 7.189 |
| AIC | 77.56 | 62.568 | 63.189 |
| χ^2 | 18.51128 | 5.1232 | 5.5786 |

4.2 Faculty of Environmental Sciences

Here, we assess the measure of agreement for performance of students in Faculty of Environmental Sciences using their first year CGPA and their final year CGPA, residual deviance and the AIC values presented for the three models. The data calculated using the three models are summarized in Tables 5 to 7. From Table 6, A value is 0.9371 implying that the main effects of the final year CGPA differ by 93 percent. From Table 8, based on the goodness-of-fit, the data fit well for quasi-symmetry and conditional symmetry models, where the χ^2 values for the three models are 20.3442, 9.667 and 10.0102, respectively. From Table 7, the τ value for combined data in Faculty of Environmental sciences is -0.9383 and $\exp(\tau)$ is 0.0000841424, and this showed that the students’ final year performance rate is lower compared to that of their first-year performance. This implies that their first-year results gave true performance of the students rating them better or higher than their final year CGPA. This showed that the estimated probability for the Faculty of Environmental sciences is that the final year CGPA is less consistent in rating the students’ performance (about 0.0000841424 times) than that of their first-year CGPA.

Table 8 presents the summary table for the three models in the Faculty of Environmental Sciences. Clearly, from Table 8, the AIC values for the beyond chance agreement measure from the quasi-symmetry and conditional

symmetry models are lower than that of the symmetry model which assesses chance agreement. In the Faculty of Environmental Sciences, AIC values were recorded as 74.564, 75.03, and 85.704; with a tau value of -9.383 indicating that final-year performance is also lower than first-year performance. Further examination between the AIC values for beyond chance agreement measures indicates that the quasi-symmetry is better suited than the conditional symmetry model. From the results obtained from the analysis, we conclude that students' grades in their first year gave a better picture of their performance than their final year.

Table 5: Parameters' estimates under symmetry model in the Faculty of Environmental Sciences

| Coefficients | Value | S. E. | Pr < Z |
|----------------|------------|-----------|------------|
| Intercept | -4.374e-15 | 2.828e+00 | 1.000 |
| λ_{11} | 2.079e+00 | 0.000e+00 | <2e-16 *** |
| λ_{12} | 2.197e+00 | 0.000e+00 | <2e-16 *** |
| λ_{22} | 4.522e+00 | 0.000e+00 | <2e-16 *** |
| λ_{13} | -6.931e-01 | 1.414e+00 | 0.624 |
| λ_{23} | 3.020e+00 | 0.000e+00 | <2e-16 *** |
| λ_{33} | 4.407e+00 | 0.000e+00 | <2e-16 *** |
| λ_{14} | -1.830e+01 | 1.667e+04 | 0.999 |
| λ_{24} | -1.830e+01 | 2.101e+04 | 0.999 |
| λ_{34} | 6.931e-01 | 1.118e+00 | 0.535 |

Significance Codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1; Null deviance: 590.793 on 15 degrees of freedom; Residual deviance: 23.856 on 6 degrees of freedom; Akaike Information Criterion (AIC): 85.704; Number of Fisher Scoring iterations: 16.

Table 6. Parameters' estimates under quasi-symmetry model in the Faculty of Environmental Sciences

| Coefficients | Value | S. E. | Pr < Z |
|----------------|----------|------------|------------|
| Intercept | -3.7483 | 4.2065 | 0.3729 |
| A | 0.9371 | 0.0000 | <2e-16 *** |
| λ_{11} | 4.8907 | 0.0000 | <2e-16 *** |
| λ_{12} | 4.4340 | 0.0000 | <2e-16 *** |
| λ_{22} | 6.3960 | 3.2420 | 0.0485* |
| λ_{13} | 0.7943 | 1.4565 | 0.5855 |
| λ_{23} | 4.3201 | 0.0000 | <2e-16 *** |
| λ_{33} | 5.3438 | 0.0000 | <2e-16 *** |
| λ_{14} | -18.1594 | 14621.4242 | 0.9990 |
| λ_{24} | -18.5027 | 5883.7812 | 0.9975 |
| λ_{34} | 1.0557 | 0.0000 | <2e-16 *** |

Significance Codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1; Null deviance: 590.793 on 15 degrees of freedom; Residual deviance: 10.806 on 5 degrees of freedom; Akaike Information Criterion (AIC): 74.654; Number of Fisher Scoring iterations: 17.

Table 7. Parameters' Estimates under conditional symmetry model in the Faculty of Environmental Sciences

| Coefficients | Value | S. E. | Pr < Z |
|----------------|------------|-----------|--------------|
| Intercept | -4.278e-15 | 0.000e+00 | < 2e-16 *** |
| λ_{11} | 2.079e+00 | 0.000e+00 | <2e-16 *** |
| λ_{12} | 2.560e+00 | 2.914e+00 | 0.380 |
| λ_{22} | 4.522e+00 | 1.005e+00 | 6.88e-06 *** |
| λ_{13} | -3.302e-01 | 0.000e+00 | < 2e-16 *** |
| λ_{23} | 3.383e+00 | 0.000e+00 | <2e-16 *** |
| λ_{33} | 4.407e+00 | 2.846e+00 | 0.121 |
| λ_{14} | -1.887e+01 | 6.433e+03 | 0.998 |
| λ_{24} | -1.887e+01 | 0.000e+00 | < 2e-16 *** |
| λ_{34} | 1.056e+00 | 0.000e+00 | < 2e-16 *** |
| τ | -9.383e-01 | 0.000e+00 | < 2e-16 *** |

Significance Codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1; Null deviance: 590.793 on 15 degrees of freedom; Residual deviance: 11.182 on 5 degrees of freedom; Akaike Information Criterion (AIC): 75.03; Number of Fisher Scoring iterations: 17.

Table 8: Summary table for the three models in the Faculty of Environmental Sciences

| | SYMM | QS | CS |
|-------------------|---------|--------|---------|
| Residual deviance | 23.856 | 10.806 | 11.182 |
| AIC | 85.704 | 74.654 | 75.03 |
| χ^2 | 20.3442 | 9.667 | 10.0102 |

4.3 Faculty of Physical Sciences

Here, we assess the measure of agreement for performance of students in Faculty of Physical Sciences using their first year CGPA and their final year CGPA, residual deviance and the AIC values presented for the three models. The evaluated data for the three models are presented in Table 9 to 11. From Table 10, A value is 4.657e+00 implying that the main effects of the final year CGPA differ. From Table 12, based on Goodness-of-fit, the data fit well for Quasi-Symmetry and Conditional Symmetry model where the χ^2 values for the three models are 25.9163, 0.0910 and 0.0910, respectively.

From Table 11, the τ value for combined data in Faculty of Physical Sciences is -1.485 and $\exp(\tau)$ is 0.22650 and this showed that the students' final year performance rate is lower compared to that of their first-year performance. This implies that their first-year results gave the true performance of the students, rating them better or higher than their final year CGPA. This showed that the estimated probabilities for the Faculty of Physical Sciences is that the final year CGPA is less consistent in rating the students' performance (about 0.22650 times) than that of their first year CGPA. From the results obtained from the analysis, we conclude that students' grades in their first year gave a better picture of their performance than their final year. The data summary for the three models in the Faculty of Physical Sciences is presented in Table 12. Clearly, from Table 12, the AIC values for the beyond chance agreement measure from the quasi- and conditional symmetry models are lower than that of the symmetry model which assesses chance agreement. For the Faculty of Physical Sciences, both AIC values were 65.085, which is lower than 91.013; with a tau value of -1.485 suggesting that final-year performance is rated lower compared to first-year performance. Further examination between the AIC values for beyond chance agreement measures indicates that the quasi- and conditional symmetry models suited well.

Table 9: Parameters' Estimates under Symmetry model in the Faculty of Physical Sciences

| Coefficients | Value | S. E. | Pr < Z |
|----------------|----------|------------|------------|
| Intercept | 2.1972 | 1.1055 | 0.0469 * |
| λ_{11} | 0.2007 | 0.0000 | <2e-16 *** |
| λ_{12} | 0.1542 | 0.0000 | <2e-16 *** |
| λ_{22} | 2.1068 | 0.0000 | <2e-16 *** |
| λ_{13} | -20.4998 | 0.0000 | <2e-16 *** |
| λ_{23} | 0.7205 | 0.0000 | <2e-16 *** |
| λ_{33} | 1.8458 | 0.0000 | <2e-16 *** |
| λ_{14} | -20.4998 | 16669.3275 | 0.9990 |
| λ_{24} | -20.4998 | 22143.9068 | 0.9993 |
| λ_{34} | -0.9445 | 1.2344 | 0.4442 |

Significance Codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1; Null deviance: 426.087 on 15 degrees of freedom; Residual deviance: 28.024 on 6 degrees of freedom; Akaike Information Criterion (AIC): 91.013; Number of Fisher Scoring iterations: 16.

Table 10: Parameters' estimates under quasi-symmetry model in the Faculty of Physical Sciences

| Coefficients | Value | S. E. | Pr < Z |
|----------------|------------|-----------|------------|
| Intercept | -3.744e+00 | 4.383e+00 | 0.3929 |
| A | 4.657e+00 | 0.000e+00 | <2e-16 *** |
| λ_{11} | 0.2007 | 0.0000 | <2e-16 *** |
| λ_{12} | 3.614e+00 | 0.000e+00 | <2e-16 *** |
| λ_{22} | 5.078e+00 | 2.422e+00 | 0.0361 * |
| λ_{13} | -2.363e+01 | 1.123e+05 | 0.9998 |
| λ_{23} | 2.695e+00 | 0.000e+00 | <2e-16 *** |
| λ_{33} | 3.331e+00 | 0.000e+00 | <2e-16 *** |
| λ_{14} | -2.444e+01 | 1.355e+05 | 0.9999 |
| λ_{24} | -2.512e+01 | 1.123e+05 | 0.9998 |
| λ_{34} | -4.554e-01 | 0.000e+00 | <2e-16 *** |

Significance Codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1; Null deviance: 426.08658 on 15 degrees of freedom; Residual deviance: 0.09634 on 5 degrees of freedom; Akaike Information Criterion (AIC): 65.085; Number of Fisher Scoring iterations: 22.

Table 11: Parameters' Estimates under Conditional Symmetry model in the Faculty of Physical Sciences

| Coefficients | Value | S.E. | Pr < Z |
|----------------|------------|-----------|-------------|
| Intercept | 2.1972 | 1.1055 | 0.04687 * |
| λ_{11} | 2.007e-01 | 0.000e+00 | <2e-16 *** |
| λ_{12} | 6.432e-01 | 1.336e+00 | 0.63015 |
| λ_{22} | 2.107e+00 | 7.060e-01 | 0.00285 ** |
| λ_{13} | -2.576e+01 | 0.000e+00 | <2e-16 *** |
| λ_{23} | 1.210e+00 | 0.000e+00 | <2e-16 *** |
| λ_{33} | 1.846e+00 | 1.190e+00 | 0.12076 |
| λ_{14} | -2.576e+01 | 1.436e+05 | 0.99986 |
| λ_{24} | -2.576e+01 | 0.000e+00 | < 2e-16 *** |
| λ_{34} | -4.554e-01 | 0.000e+00 | < 2e-16 *** |
| τ | -1.485e+00 | 0.000e+00 | < 2e-16 *** |

Significance Codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1; Null deviance: 426.08658 on 15 degrees freedom; Residual deviance: 0.09634 on 5 degrees freedom; Akaike Information Criterion (AIC): 65.085; Number of Fisher Scoring iterations: 22

Table 12: Summary table for the three models in the Faculty of Physical Sciences

| | SYMM | QS | CS |
|-------------------|---------|---------|---------|
| Residual deviance | 28.024 | 0.09634 | 0.09634 |
| AIC | 91.013 | 65.085 | 65.085 |
| χ^2 | 25.9163 | 0.0910 | 0.0910 |

4.4 Faculty of Life Sciences

Here, we assess the measure of agreement for performance of students in Faculty of Life sciences using their first year CGPA and their final year CGPA, residual deviance and the AIC values presented for the three models. Tables 13 to 15 summarized the data obtained with the three models. From Table 14, A value is 0.88239 implying that the main effects of the final year CGPA differ by 88 percent. From Table 15, the τ value for combined data in Faculty of Life sciences is -0.8823 and $\exp(\tau)$ is 0.413793 and this showed that the students' final year performance rate is lower compared to that of their first-year performance. This implies that their first-year results gave the true performance of the students rating them better or higher than their final year CGPA. This implies that the estimated Probability for the Faculty of Life sciences is that the final year CGPA is less consistent in rating the students' performance (about 0.413793 times) than that of their first year CGPA. From the results obtained from the analysis, we conclude that students' grades in their first year gave a better picture of their performance than their final year. Clearly, from Table 16, the AIC values for the beyond chance agreement measure from the quasi-symmetry and conditional symmetry models are lower than that of the symmetry model which assesses chance agreement. In the Faculty of Life Sciences, AIC values were both recorded at 61.506, lower than 66.773, with a tau value of -0.8823, implying that a beyond chance agreement measure is more suitable. Further examination between the AIC values for beyond chance agreement measures indicates that the quasi-symmetry and conditional symmetry models suited well. From Table 16, based on the goodness-of-fit the data fit well for quasi- and conditional symmetry models, where the χ^2 values for the three models are 10.9524, 4.7140 and 4.7140, respectively.

Table 13: Parameters' estimates under symmetry model in the Faculty of Life Sciences

| Coefficients | Value | S.E. | Pr < Z |
|----------------|----------|------------|------------|
| Intercept | 1.3863 | 0.0000 | <2e-16 *** |
| λ_{11} | -20.6889 | 0.0000 | <2e-16 *** |
| λ_{12} | -0.1335 | 0.0000 | <2e-16 *** |
| λ_{22} | 2.3749 | 0.0000 | <2e-16 *** |
| λ_{13} | -20.6889 | 0.0000 | <2e-16 *** |
| λ_{23} | 1.2528 | 0.0000 | <2e-16 *** |
| λ_{33} | 2.5455 | 0.0000 | <2e-16 *** |
| λ_{14} | -20.6889 | 17635.5853 | 0.999 |
| λ_{24} | -20.6889 | 27483.0748 | 0.999 |
| λ_{34} | -0.2877 | 1.4434 | 0.842 |

Significance Codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1; Null deviance: 327.016 on 15 degrees of freedom; Residual deviance: 13.911 on 6 degrees of freedom; Akaike Information Criterion (AIC): 66.773; Number of Fisher Scoring iterations: 17.

Table 14. Parameters' estimates under quasi symmetry model in the Faculty of Life Sciences

| Coefficients | Value | S. E. | Pr < Z |
|----------------|-----------|---------|------------|
| Intercept | -2.14326 | 0.00000 | <2e-16 *** |
| A | 0.88239 | 0.00000 | <2e-16 *** |
| λ_{11} | -19.04171 | 0.00000 | <2e-16 *** |
| λ_{12} | 1.97812 | 0.00000 | <2e-16 *** |
| λ_{22} | 4.13968 | 0.00000 | <2e-16 *** |
| λ_{13} | -20.09276 | 0.00000 | <2e-16 *** |
| λ_{23} | 2.48202 | 0.00000 | <2e-16 *** |
| λ_{33} | 3.42792 | 0.00000 | <2e-16 *** |
| λ_{14} | -20.70074 | 0.00000 | <2e-16 *** |
| λ_{24} | -20.97515 | 0.00000 | <2e-16 *** |
| λ_{34} | 0.05919 | 0.00000 | <2e-16 *** |

Significance Codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1; Null deviance: 327.0158 on 15 degrees of freedom; Residual deviance: 6.6448 on 5 degrees of freedom; Akaike Information Criterion (AIC): 61.506; Number of Fisher Scoring iterations: 18.

Table 15. Parameters' estimates under conditional symmetry model in the Faculty of Life Sciences

| Coefficients | Value | S. E. | Pr < Z |
|----------------|-----------|---------|------------|
| Intercept | 1.3863 | 0.00000 | <2e-16 *** |
| λ_{11} | -21.68888 | 0.00000 | <2e-16 *** |
| λ_{12} | 0.21334 | 0.00000 | <2e-16 *** |
| λ_{22} | 2.37491 | 0.00000 | <2e-16 *** |
| λ_{13} | -21.28861 | 0.00000 | <2e-16 *** |
| λ_{23} | 1.59963 | 0.00000 | <2e-16 *** |
| λ_{33} | 2.54553 | 0.00000 | <2e-16 *** |
| λ_{14} | -21.28861 | 0.00000 | <2e-16 *** |
| λ_{24} | -21.28861 | 0.00000 | <2e-16 *** |
| λ_{34} | 0.05919 | 0.00000 | <2e-16 *** |
| τ | -0.88239 | 0.00000 | <2e-16 *** |

Significance Codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1; Null deviance: 327.0158 on 15 degrees of freedom; Residual deviance: 6.6448 on 5 degrees of freedom; Akaike Information Criterion (AIC): 61.506; No of Fisher Scoring iterations: 18.

Table 16: Summary table for the three models in the Faculty of Life Sciences

| | SYMM | QS | CS |
|-------------------|---------|--------|--------|
| Residual deviance | 13.911 | 6.6448 | 6.6448 |
| AIC | 66.773 | 61.506 | 61.506 |
| χ^2 | 10.9524 | 4.7140 | 4.7140 |

5. Conclusion

This study examined the academic performance of undergraduate students at Modibbo Adama University, Yola, by comparing first-year and final-year Cumulative Grade Point Averages (CGPA) across four faculties: Agricultural Sciences, Environmental Sciences, Physical Sciences, and Life Sciences. The analysis employed three models: symmetry, quasi-symmetry, and conditional symmetry. The findings reveal a consistent pattern of declining academic performance from the first year to the final year. Specifically, the results indicate that first-year CGPA

ratings are generally higher than those in the final year across all faculties studied. The Akaike Information Criterion (AIC) values further support this conclusion, with quasi-symmetry and conditional symmetry models demonstrating better fit compared to the symmetry model. The tau values confirm that students' final-year performances are significantly lower than their first-year performances. These results suggest that first-year academic achievements may provide a more accurate reflection of students' true capabilities than their final-year results. The decline in performance raises important questions regarding the factors contributing to this trend, including educational policies, teaching quality, and student engagement. To address these issues, it is essential for educational institutions to implement strategies aimed at improving student performance throughout their academic journey. This may include enhancing support services, refining admission policies to align with institutional goals, and fostering an environment conducive to continuous learning.

6. Recommendations

Based on the findings of the study the following recommendations are made:

- i. A guidance and counselling unit should be established in the University which aids in proffering advice to struggling students through the academic career.
- ii. Students should seek to maintain the initial real their entry so as to maintain or improve upon their first-year results.
- iii. At points where a student(s) should get counselling on the possibility of switching to courses within their mental capacity so as to ensure good CGPA in their final year.

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