Statistical Analysis of Gender Equality in Students' Enrolment in Ambrose Alli University, Ekpoma

Ikpotokin O., Erimafa J.T. and Edokpa I.W.
Department of Mathematics
Ambrose Alli University, Ekpoma
Edo State, Nigeria.
ikpotokinosayomore@yahoo.co.uk, 08039289270

Abstract

In Nigeria, governments over the years have made it a point of duty to ensure that its female population has the same opportunities as the male population. This study examined gender-equality in students' enrolment in Ambrose Alli University, Ekpoma. The results, using the Analysis of Covariance (ANCOVA), show that the difference in students' enrolment by gender is not statistically significant. A further test using the regression coefficient (β), also reveals that there is no gender discrimination in admission of students into various disciplines of the University.

1 Introduction

One of the eight milestones of Millennium Development Goals (MDGs), as set by World leaders in September 2000, for the International Community to meet by the year 2015, is to promote gender equality and empower women, [1, 2]. This goal is vital, because our society has continued to regress downwards in quality of life due to lack of empowerment of women who are usually left to cater for the family after the exit/death of the man. The fact is that the man, who is the breadwinner usually, has a lower life expectancy of 46.4 years (which is 30% below the World average of 63.89 years, according to the United Nation's ranking, Year Book [3]. Ambrose Alli University, being a corporate member of the global society, has an implied

responsibility of helping to achieve this goal. One of the expected means by which it can help achieve this goal is by gender considerations in enrolment of students. Gender refers to society's division of humanity, based on sex, into two distinctive categories. Gender guides how male and female think about themselves, how they interact with each other, and what position they occupy in society as a whole. In global perspective, the preference for males is more pronounced in African and most Asian countries, and this accounts for the common discrimination against women in these countries [4].

the ironies of history are the fact that despite the role women play both at home and in the society, they have remained unnoticed and even belittled [5]. This is borne out of the notion that women's function of being homemakers and caring for children is not important. Women therefore are to be seen and not heard. This has grossly affected women enrolment in educational institutions; and revealed discrimination against women in education. At independence, the Nigerian state did not significantly reconstitute the inherited colonial patriarchal structures that limited women's participation in the public sphere. Hence, women still had limited access to both tangible and intangible societal resources. Till date, the female folk believed that the situation has still persisted as women are still faced with various handicaps and restrictions such as low participation in politics [6]; widowhood rites and disinheritance [7,8]; female genital mutilation, poor access to education, healthcare, jobs, land, credit, early marriage, etc, [9,10].

However, Nigerian governments over the years have made it a point to ensure that its female population has the same opportunities the male population has. The 1999 Constitution of Nigeria prohibits discrimination on the grounds of gender. The government has established a National Committee on the Reform of

Discriminatory Laws against women, which has drafted a degree for the abolition of all forms of discrimination against women.

Hence, in recent times, successive Nigerian governments, in reaction to the various International Conventions and Covenants on women, have undertaken legislative and administrative reforms that would give women full access to economic and productive resources. These have resulted in an improvement in the status of women. Women now enjoy greater participation in governance and its institutions [11, 12]. More women now occupy ministerial positions and seats in parliament. For example, during the 2003 – 2007 administration, there were six women ministers out of a total of thirty four and ten women special advisers out of a total of thirty five as well as twenty one female representatives out of a total of three hundred and sixty, [13]. Women have also enjoyed an increased presence in the labour market and in education, [14, 15, 16].

The aim of this study therefore is to ascertain statistically gender equality/inequality in students' enrolment in Ambrose Alli University, because the issue of social justice and equity can only be attained when both sexes are given equal opportunities in educational training.

2 MATERIALS AND METHODS

2.1 Source of Data

The source of data is the 2010 Annual Report of the Academic Planning Unit of the Ambrose Alli University, Ekpoma. The data in Table 2 are on both male and female students' enrolment in various faculties of studies, from100 level to 400 level. A total of 14,887 students were enrolled within that period of studies, out of which 8,223 are male and 6,662 are female. It is erroneous to conclude that

there is gender inequality (i.e. 8,223 > 6,662) because such decision has not been subjected to statistical inference.

2.2 Methodology

The method used for this study is Analysis of Covariance (ANCOVA), [17, 18, 19, 20]. This method combines the advantages of regression and analysis of variance; hence we can test for significance difference and regression coefficient (β) for both male and female students' enrolments. Suppose y_{ij} are the values of an independent random variable having a normal distribution, with the respective means μ_i and the common variance σ^2. Ordinarily, the mathematical model for a one way analysis of variance is expressed as:

$$y_{ij} = \mu + t_i + e_{ij}, \qquad i = 1,2,\ldots,t; j = 1,2,\ldots,r \tag{1}$$

where

y_{ij} – is the observed value from the unit j receiving treatment i

μ – is the overall mean

t_i – is the effect of treatment i

e_{ij} – is the random error for unit j receiving treatment i .

But because analysis of covariance combines the advantages of regression and analysis of variance, (1) can be expressed as:

$$y_{ij} = \mu + t_i + \beta\left(x_{ij} - \bar{x}\right) + e_{ij}, \qquad i = 1,2,\ldots,t; j = 1,2,\ldots,r_i \tag{2}$$

where

β is the coefficient of linear regression, and x_{ij} is the covariate effect.

If the treatment effects, t_i are assumed in such a way that $\sum_{i=1}^{t} t_i = 0$, $\sum_{i=1}^{t}\sum_{j=1}^{r}(x_{ij} - \bar{x}) = 0$ and $e_{ij} \sim N(0, \sigma^2)$, from (2), the least square estimate for covariance Error Sum of Squares (SSE) can be defined as:

$$SSE = e_{ij}^2 = \sum_{i=1}^{t}\sum_{j=1}^{r}(y_{ij} - \mu - t_i - \beta(x_{ij} - \bar{x}))^2 \quad (3)$$

Differentiating (3) with respect to μ, such that $\frac{\partial SSE}{\partial \mu} = 0$ yields:

$$-2\sum_{i=1}^{t}\sum_{j=1}^{r}(y_{ij} - \mu - t_i - \beta(x_{ij} - \bar{x})) = 0$$

Dividing through by (-2) gives:

$$\sum_{i=1}^{t}\sum_{j=1}^{r} y_{ij} - tr\hat{\mu} - r\sum t_i - t\beta\sum_{i=1}^{t}\sum_{j=1}^{r}(x_{ij} - \bar{x}) = 0$$

Since we assumed $\sum_{i=1}^{t} t_i = 0$ and $\sum_{i=1}^{t}\sum_{j=1}^{r}(x_{ij} - \bar{x}) = 0$, it follows that

$$\sum_{i=1}^{t}\sum_{j=1}^{r} y_{ij} - tr\hat{\mu} = 0$$

Therefore, $\hat{\mu} = \frac{\Sigma_{i=1}^{t}\Sigma_{j=1}^{r} y_{ij}}{rt}$

$$= \frac{y_{..}}{rt} \quad (4)$$

To obtain the Sum of Squares for Treatment (SSt), differentiate (3) with respect to t, such that $\frac{\partial SSE}{\partial t} = 0$ yields:

$$-2\sum_{j=1}^{r}(y_{ij} - \mu - t_i - \beta(x_{ij} - \bar{x})) = 0$$

Dividing through by (-2) gives:

$$\sum_{j=1}^{r} y_{ij} - r\hat{\mu} - r\hat{t}_i - \beta \sum_{j=1}^{r} (x_{ij} - \bar{x}) = 0$$

It follows that

$$r\mu + rt_i + \beta \sum_{j=1}^{r} (x_{ij} - \bar{x}) = y_{i.}$$

Therefore, $\hat{t}_i = \frac{y_{i.}}{r} - \frac{y_{..}}{rt} - \hat{\beta}\left(\frac{x_{i.}}{r} - \frac{x_{..}}{rt}\right)$

The adjusted mean of treatment i can be estimated as

$$\hat{t}_i = \frac{y_{i.}}{r} - \hat{\beta}\left(\frac{x_{i.}}{r} - \frac{x_{..}}{rt}\right) \qquad (5)$$

To obtain the Sum of Squares due to regression coefficient (β), differentiate (3) with respect to β, such that $\frac{\partial SSE}{\partial \beta} = 0$ yields:

$$\sum_i t_i \sum_j (x_{ij} - \bar{x}) + \hat{\beta} \sum_i \sum_j (x_{ij} - \bar{x})^2 = \sum\sum (x_{ij} - \bar{x})\left(y_{ij} - \frac{y_{..}}{rt}\right) = 0$$

Therefore,

$$\hat{\beta} = \frac{\left[\Sigma\Sigma y_{ij}\, x_{ij} - \frac{y_{..}x_{..}}{rt}\right] - \left[\Sigma y_{i.}\, x_{i.} - \frac{y_{..}x_{..}}{rt}\right]}{\left[\Sigma\Sigma x_{ij}^2 - \frac{x_{..}^2}{rt}\right] - \left[\frac{\Sigma x_{i.}^2}{r} - \frac{x_{..}^2}{rt}\right]}$$

$$= \frac{S_{xy} - T_{xy}}{S_{xx} - T_{xx}} = \frac{E_{xy}}{E_{xx}} \qquad (6)$$

Where

S_{xy} – the total sum of product,

T_{xy} – the treatment sum of product,

S_{xx} – the total sum of squares,

T_{xx} – the treatment sum of squares, and

$\frac{S_{xy}^2}{S_{xx}}$ – the sum of squares due to β

The following are the summary of ANOVAs and Adjusted ANOVAs (ANCOVA) Tables.

Table 1(a): Summary of ANOVA Table

$S.V.$	df	x	y	xy
$Treatment$	$t-1$	T_{xx}	T_{yy}	T_{xy}
$Error$	$t(r-1)$	E_{xx}	E_{yy}	E_{xy}
$Total$	$rt-1$	S_{xx}	S_{yy}	S_{xy}

Table 1(b): Summary of ANCOVA Table (Adjusted ANOVA)

$S.V.$	df	SS	MS	$F_{calculated}$	$F_{critical}$
$Treatment$	$t-1$	$SSt = SST - SSe$	$\frac{SSt}{t-1}$	$\frac{MSt}{MSe}$	$F_{\alpha,(t-1),\, t(r-1)-1}$
$Error$	$t(r-1)-1)$	$E_{yy} - \frac{E_{xy}^2}{E_{xx}}$	$\frac{SSe}{t(r-1)-1}$		
$Total$	$rt-1$	$S_{yy} - \frac{S_{xy}^2}{S_{xx}}$			

2.3 Hypothesis

The null hypotheses to be tested for the given data are:

1. The treatment effects (enrolment of male and female students at each level of studies are all equal, against the alternative, that they are not all equal), i.e. $H_0: \mu_1 = \mu_2 = \mu_3 = \mu_4 \; against$ (7)

   $H_1: \mu_1, \quad \mu_2, \mu_3 \; and \; \mu_4$ are not all equal in their means.

   Decision Rule: Reject H_0 if $F_{calculated} > F_{\alpha,(t-1),\, t(r-1)-1}$, and conclude that there is significant difference in enrolment of male and female students at $\alpha = 0.05$.

2. The covariance effects (regression coefficient are not significantly different), i.e. $H_0{:}\beta = 0\ against H_1{:}\beta \neq 0$ (8)

   Decision Rule: Reject H_0 if:

$$F_{calculated} = \frac{E_{xy}^2 / E_{xx}}{S^2} > F_{\alpha,(t-2),t(r-1)-1} \quad (9)$$

   and conclude that $\beta \neq 0$ and therefore, there is need for covariance analysis between enrolment of male and female students at $\alpha = 0.05$.

Therefore, the adjusted mean $\bar{y}_i'$ is given by:

$$\bar{y}_i' = \bar{y}_i - \hat{\beta}(\bar{x}_i - \bar{x}) \ , \ i = 1, 2, 3, 4 \quad (10)$$

where:

$\bar{y}_i'$ – the adjusted mean for male students (M);

$\bar{y}_i$ – the mean of treatment i for male students (M) unadjusted;

$\bar{x}_i$ – the mean of treatment i for female students (F);

$\bar{x}$ – the overall mean of female students (F).

The standard error of difference (SED) is useful for comparison of adjusted mean such as:

$$H_0{:}\mu_i - \mu_j = 0\ against\ H_1{:}\mu_i \neq \mu_j = 0 \quad (11)$$

and the statistical model is given as:

$$SED_{(i\ vs\ j)} = \sqrt{s^2\left[\frac{(t-1)}{r} + \frac{\bar{x}_i - \bar{x}_j}{E_{xx}}\right]} \quad (12)$$

Assuming we are to compare two adjusted means $(\bar{y}_i' = \bar{y}_j)$, the statistical model is given as:

$$T = \frac{\bar{y}_i' = \bar{y}_j}{SED_{(i\ vs\ j)}} \quad (13)$$

The decision rule will be; reject H_0, if $T > t_{e,\alpha/2}$ and conclude that there is a significant difference between the two means compared.

Table 2: Students Enrolment per Faculty, per level of Study (2010/2011 Academic Session)

	Students Enrolment							
	100 L		200 L		300 L		400 L	
Faculties	**M**	**F**	**M**	**F**	**M**	**F**	**M**	**F**
Agriculture	40	42	45	56	45	44	37	72
Arts	116	282	118	230	71	131	91	184
Medicine	306	251	146	149	93	84	122	113
Education	116	233	335	440	285	433	314	406
Engineering & Tech.	587	35	404	11	304	15	198	17
Environmental Sciences	102	20	62	43	72	21	65	17
Law	133	191	74	77	59	65	45	59
Management Science	361	332	250	241	223	180	114	115
Natural Sciences	424	388	410	320	341	254	356	286
Social Sciences	408	221	306	210	332	197	313	199
Total	**2593**	**1995**	**2150**	**1777**	**1825**	**1424**	**1655**	**1468**
Average	**259.3**	**199.5**	**215**	**177.7**	**182.5**	**142.4**	**165.5**	**146.8**

Source: Academic Planning Directorate AAU, Ekpoma

3 RESULTS AND DISCUSION

3.1 Results

Using the data on Table 2, the summary of the analysis of variance and covariance are given in Tables 3a and 3b respectively. Table 3a is obtained due to the model in Table 1a. In this case, variable y replaced by M denotes the number of male students, x replaced by F denotes the number of female students, and yx replaced by MF denotes the cross-product between male and female students.

Table 3a: Summary of the Analysis of Variance (ANOVA)

Source of Variation	*DF*	*M*	*F*	*MF*
Students Enrolment (Treatment)	3	51136.675	21833	32240.7
Error	36	756593.1	608138.6	315465.7
Total	39	807729.775	629971.6	347706.2

Table 3b: Summary of the Analysis of Covariance (ANCOVA) Adjusted (ANOVA)

Source of Variation	*SS*	*DF*	*MS*	*F*
Students Enrolment (Treatment)	22868.3031	3	7622.7677	0.4499
Error	592948.6912	35	16941.3912	
Total	615816.9943	38		

The tabulated value for treatment effects (student's enrolment at the levels of studies) is $F_{0.05,3,35} = 2.88$.

3.2 Discussion

Since $(0.4499 < 2.88)$, the null hypotheses may not be rejected. In other words, the differences among the means obtained for both male and female student's enrolment is not statistically significant. This means that there is no gender inequality when considering students enrolment into the university. Rather, equal chance was given to both sexes to participate. While considering the second hypothesis, we observed that $F_{calculated} = 9.6594 > F_{0.05,2\,35} = 3.275$ from (9). The null hypothesis must be rejected and therefore, there is need for covariance analysis between genders. From (6), the estimated regression coefficient; $\hat{\beta} = 0.5187$ and the adjusted mean estimated from (10) are: $\bar{y}_1' = 242.2348$, $\bar{y}_2' = 209.2424$, $\bar{y}_3' = 195.0007$ and $\bar{y}_4' = 175.7703$. The Standard Error of Difference (SED) estimated from (12) is as follows: $SED(x_{1\,vs\,2}) = 71.2953$, $SED(x_{1\,vs\,3}) = 71.3022$, $SED(x_{1\,vs\,4}) = 71.3014$,

$SED(x_{2\,vs\,3}) = 71.298$, $SED(x_{2\,vs\,4}) = 71.2973$, $SED(x_{3\,vs\,4}) = 71.32902$.

The estimated T's from (13) are: $T(x_{1\,vs\,2}) = 0.4769$, $T(x_{1\,vs\,3}) = 0.6765$, $T(x_{1\,vs\,4}) = 0.9462$, $T(x_{2\,vs\,3}) = 0.1997$, $T(x_{2\,vs\,4}) = 0.4695$, $T(x_{3\,vs\,4}) = 0.2697$; and the critical value is $t_{35,0.05/2} = 2.0315$. Since all the T's < 2.0315, we may not reject the null hypothesis for (11). We therefore conclude that there is no significant difference between the two adjusted means compared. This is further in agreement with the decision from the analysis of covariance table.

4 Conclusion

From this study so far, there is ample evidence that there is gender equality in admission quota in Ambrose Alli University, as evidenced by the admission quotas of the 2010/2011 Academic Session.

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