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Gender Mainstreaming in STEM and Admission Policy of Nigerian Tertiary Institutions

Iro-Idoro, Charlotte Bose[1] & Jimoh, Tajudeen Adisa[2]
Department of Office Technology and Management, The Federal Polytechnic, Ilaro, Ogun State, Nigeria
charlotte.iroidoro@federalpolyilaro.edu.ng[1], Tajudeen.jimoh@federalpolyilaro.edu.ng[2]

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Abstract

The importance of Science, Technology, Engineering and Mathematics disciplines and professions to national development makes majority of countries worldwide to consider STEM education a top priority for both males and females' learners. However, gender differences in enrolment in STEM careers show a wide gap and disparity with females being underrepresented. This study, therefore, aims to empirically evaluate how gender mainstreaming in the admission policy and processes of higher educational institutions could be instituted as a policy measure towards bridging the gender gap in STEM disciplines in Nigerian Tertiary Institutions. In carrying out the study, two research hypotheses were formulated. The population of the study comprised educators in STEM disciplines of higher institutions in Ogun State, Nigeria. Multi-stage and proportionate sampling techniques were employed to select 144 STEM educators from three selected tertiary institutions (Olabisi Onabanjo University, Ago-Iwoye; Federal College of Education Osiele, Abeokuta and The Federal Polytechnic, Ilaro). The study employed Probit Regression (and Average Marginal Effects) to analyze the data obtained through well-structured questionnaire administered among the participants (STEM educators). The findings revealed that an increase in efforts to adjust entry cut-off marks and quota requirements in favour of female students in tertiary institutions are more likely to reduce or close the gender gap in STEM disciplines by 1% and 4%, respectively. The study affirms that adjusting entry cut-off mark and quota reservation system in favour of female students guarantees greater participation of female students in STEM disciplines in Nigerian Tertiary Institutions.

Keywords: Gender, STEM, Gender Mainstreaming, Admission Policy, Tertiary Institution

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1. Introduction

In developed and developing nations, attention for Science, Technology, Engineering, and Mathematics (STEM) education and career has been increasing as STEM-related jobs and disciplines have been widely recognized as important in National Development. Many nations adopt strategies to improve not only teaching and learning of STEM courses but also the uptake of studies and careers in this area. Despite the policy provision that every Child in Nigerian shall have equal opportunities to education regardless of situations, there is still a wide gap in the enrolment of male and female in STEM careers as females are underrepresented (Salman, Olawoye, & Yahaya 2011; Abe 2012). According to National Bureau of Statistics (2014) as observed in Parson (2016) women make up little percentage of the total number of Engineering and Technology university graduates each year. Several studies also indicate that STEM is a male-dominated sector in all stages of the professional development with women having under-representation both in training and professional climes and that many factors contribute to the gender disparity (Mansfield, Welton & Grogan, 2010).

Meanwhile, educators, scientists, researchers and stakeholders in Nigerian educational system have acknowledged that courses in STEM are veritable ways of stimulating socio-economic development and transformation (Wu, & Anderson, 2015; Bybee, 2010). The provisions of the National Policy on Education and the Science, Technology and Innovation Policy provide platforms for education and in Science and Technology with a view to promoting sustainable economic transformations that will harnesses, develops and utilizes science, technology and innovations to build a large, strong, diversified, sustainable and competitive economy that ensure a high standard of living and quality of life for all citizens (Akanwa & Kalu-Uche, 2015).

STEM involves the study of the four core disciplines of Science, Technology, Engineering and Mathemaics and a clear combination of the component's areas (Wu, & Anderson, 2015). Bybee (2010) posited that STEM disciplines and education have the potential to provide opportunities for students to learn and use modern skills in solving complex problems. It comprises areas of education that are important in equipping students with competencies necessary to work in technology-driven societies and make a nation compete favourably in global economy. STEM, according to Akanwa & Kalu-Uche (2015), is an area of teaching and learning that combines the Science, Technology, Engineering and Mathematics with expertise and characters needed to work successfully in the 21st century work organisation. It refers to interdisciplinary approach to learning where science, technology, engineering and mathematics are combined with academic activities and other real-life lessons with a view to ensuring that students apply these in work organisations, societies and to do well in the emerging science and technology driven economy.

According to Chikunda (2010), there has been steady growth in admissions in higher education over the last few decades, but despite this, gender equity challenges have been unprecedented (Mkude, 2011). Women who manage to make it into university tend to specialize in social science and humanities programmes with limited enrolment in STEM programmes (Acheampong, 2014). Strategies to address gender disparity in STEM include advocacy to raise awareness; gender affirmative action; gender mainstreaming; and capabilities-based policies and practices (Norgbey, 2016; Sinnes & Loken, 2014; Panagiota, Yota & Vasiliki, 2019; Sterling, 2019)

In the education sector, gender mainstreaming would imply the efforts and commitment of regulatory agencies and management of schools, colleges and educational institutions (True & Mintrom, 2001) to integrate women's concerns into policy decisions and implementation in all areas through organisation and re-organisation, improvement, development and evaluation of policy processes, so that a gender perspective is incorporated in all policies at all levels and at all stages, by the actors involved in the policy-making (European Trade Union Committee for Education, 2009). Gender mainstreaming may thus entail a fundamental transformation of the underlying paradigms and processes in the education sector (Leo-Rhynie, 1999). The main objective of the science and technical education sector is the promotion of technical and science education and training, technology transfer as well as skills development to enhance the socio-economic advancement of the country. Universally, such education components are meant to provide technical learning that could assist the society in meeting its industrial aspirations (Lawal & Atueyi, 2017).

Some of the important elements for consideration in the mainstreaming of gender in education by overall national educational goals, objectives and priorities are seeking to make explicit the importance of gender as an important issue for consideration in the process of education; ensuring equity in both genders participation in all aspects of education that could enhance better career opportunities like STEM; overcoming legal, economic, socio-cultural and other barriers which are likely to threaten equal access of both sexes in education. (Leo-Rhynie, 1999; Botella et al, 2019). The objective of any effort to bridge the gender gap should be to enhance awareness on the importance of STEM education for girls and women, improve the participation and involvement of the female gender in STEM education and careers, strengthens the capacity and expanding opportunities for the female to deliver gender-responsive STEM training (UNESCO, 2018). Technological sector is the driver of most development initiatives and has been argued to be highly dynamic and shows tremendous potential for innovation and for introducing changes impacting deeply on

the society. The technology sector therefore demands large numbers of graduates in science, technology, engineering, and mathematics (STEM).

Despite the increasing need for graduates in Science, Technology Engineering and Mathematics and the indispensability of female in national development, the participation of female students in STEM courses continues to be low and very few studies had been carried out on the need to mainstream gender into the admission policy of Nigerian higher institutions. In light of this, the study aimed at empirically evaluating how gender mainstreaming in the admission policy and processes of higher educational institutions could be instituted as a policy measure towards bridging the gender gap in STEM education in Nigerian tertiary institutions. Accordingly, the study posed to provide scientific response to a question bordering on how admission policy of Nigerian tertiary education system through entry cut-off mark requirement and quota reservation could contribute towards bridging the gender gap in STEM disciplines. Given the nature of the research, field survey was conducted among selected STEM educators in three tertiary institutions in Ogun State Nigeria to provide grounds for reliable outcomes that could help inform gender-sensitive developmental policies of governments.

Proponents of gender equality in higher education contend that inequalities in higher educational institutions are structural and require a closer look within institutions (Monroe & Chiu, 2010; LaCosse, Sekaquaptewa, & Bennett, 2016). Many scholars have used different approaches to explain the issue of gender disparity in STEM programmes but none has emphasized gender mainstreaming in the admission of students into STEM programmes in tertiary institutions. Admission of students into Nigerian higher educational institutions is done through Unified Tertiary Matriculation Examinations of the Joint Admission and Matriculation Board. The admission consideration and policies take cognizance of Catchment Area, Merit, Educational Less-Developed State (ELDS) and Discretion with no provision to really address the issue of gender gap in certain programmes such as STEM. Hence, it is important to examine how gender mainstreaming in admission process and criteria for higher education in Nigeria could serve as policy strategies or measures that will make higher educational institutions and policy agencies to create an environment to promote women enrolment in STEM courses through a review and revision of regulations and other admission requirements and conditions.

2. Methodology

The study employed field survey with the extensive use of primary data obtained via structured questionnaire. The population comprised educators in STEM disciplines of tertiary institutions in Ogun State, Nigeria. The choice for selection of Ogun State is informed by the fact that the State has highest number of tertiary institutions in Nigeria in terms of Colleges, Polytechnics and Universities settings. Multi-stage sampling was used as sampling technique to select the final sample of the study. Firstly, the researchers used the total number of tertiary institutions in Ogun State as the initial population to ensure true representation of STEM educators in the State. The State has a total number of twenty-two tertiary institutions including both private- and government-owned schools. However, given the fact that STEM disciplines are more popular in science and technology-oriented higher institutions, the researchers selected three (3) institutions from the State. This includes Olabisi Onabanjo University, Ago-Iwoye; The Federal Polytechnic, Ilaro and Federal College of Education, Osiele, Abeokuta. There adequate sampling frame of lecturers in STEM disciplines was available at visitation by the researchers to the three selected institutions.

The visitation took place during the pilot study conducted by the researcher.

In line with the objectives of this study, the following hypotheses were formulated:

$H_0$1: Adjusting Entry Cut-off Marks into STEM discipline in favour of female students will not yield significant impact in bridging STEM gender gap in Nigerian tertiary institutions.

$H_0$2: Quota Reservation for female students in admission into STEM courses will not contribute to the bridging of gender gap in STEM of the Nigerian tertiary institutions.

Following the procedural process of scientific selection of sample size determination from a definite population as recommended by Krejcie and Morgan (1970) and closely observed in Nur (2017), a sample size of 144 potential respondents was obtained. Structured questionnaire as data collection instrument was employed to obtain the perception of STEM educators on how gender mainstreaming in the admission policy and processes of higher educational institutions could be instituted as a policy measure towards bridging the gender gap in STEM education in Nigerian higher education. The samples (respondents) were selected using proportionate sampling approach. The data instrument contains close ended questions on a 5-point likert type scale with options Strongly Agreed, Agree, Undecided, Disagree and Strongly Disagree and nominal values of 5, 4, 3, 2, and 1, respectively for independent variables for the study. On the other side of the coin, categorical question on dependent variable with two options was asked from the respondents. The unit of analysis of the study is the STEM educator. Items on the questionnaire were adapted from Gender Mainstreaming scales of Leo-Rhynie (1999), Unicef (2007) and Gollifer & Gorman (2016).

The study utilizes probit regression to model dichotomous outcome, STEM gender gap variable with a combination of factors in admission policy. Probit regression is a special type of Generalized Linear Models (GLM) where the bivariate outcome such as the dependent variable of the study is qualitative and has a Bernoulli distribution (Karlin, 2019; Williams, 2018; Lemeshow, 2000; Long, 1997). In line with the estimation technique, the study adopted and adjusted probit models by Karlin (2019) with earlier probit model developed by Katchova (2013) to inform the model specification of the study as stated as below:

$$P[Yi = 1] = \phi(X'\beta) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots equation\ 1\ (Karlin, 2019)$$

$$F(X'\beta) = \phi(X'\beta) = \int_{-\infty}^{X'\beta} \phi(z)dz \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots equation\ 2\ (Katchova, 2013)$$

1

$$\boldsymbol{P[Y_i = 1] = \phi(X'\beta) = \int_{-\infty}^{X'\beta} \phi(z)dz \dots\dots\dots\dots\dots\dots\dots\dots\dots equation\ 3\ (Adjusted\ Model)}$$

$$P(SGAP_i = 1) = \phi(ADMP'\beta) = \int_{-\infty}^{ADMP\ '\beta} \phi(z)dz \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots equation\ 4$$

$$\boldsymbol{P(SGAP_i = 1) = \phi(\sum[ETCM\beta_1 + QOTA\beta_2]) = \int_{-\infty}^{\Sigma[ETCM\beta_1 + QOTA\beta_2]} \phi(z)dz \dots\dots eqtn\ 5}$$

Equation 5 is the final model of the study where SGAP (Y) = STEM Gender Gap; ADMP (X) = Admission Policy; ETCM = Entry Cut-off Mark; QOTA = Quota Reservation; $\phi = link\ function$; z = z-score (location estimate); $P(SGAPi = 1) =$ cumulative distribution function of the standard normal distribution; P = Probability; β = vector of coefficients (β_1 and β_2 in this study); β_1 = coefficient of ETCM; β_2 = Coefficient of QOTA; i^{th} = unit of observation (STEM educator)

The a priori expectation of the study implies that the vector of coefficient has negative relation with the outcome variable of the study. Mathematically, this is stated as: $\beta_1 < 0$ and $\beta_2 < 0$. It is important to mention that the estimation was carried out with the use of Maximum Likelihood Method (MLM). Moreover, the researcher also specified marginal effect model for the study following the adoption of such model from Spermann (2009) as highlighted in

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equation 6. The specification of marginal effect model (Equation 7) is informed by the rationale to provide ground for interpretation of magnitudes of probit model coefficients.

$$\frac{\partial p(y_i=1|x_i)}{\partial x_i} = \frac{\partial E(y_i|x_i)}{\partial x_i} = \phi(x_i\beta)\beta \text{.....equation 6}$$

$$\frac{\partial p(SGAP_i=1|ADMP_i)}{\partial ADMP_i} = \frac{\partial E(SGAP_i|ADMP_i)}{\partial ADMP_i} = \phi(ADMP_i\beta)\beta \ldots\ldots \textbf{equation 7}$$

3. Results and Discussion

From the total 144 questionnaires administered among the STEM educators in three selected higher institutions in the study area, nine (9) were not returned by the respondents, while six (6) out of the returned contained missing responses on key variables of the study. This implies that 129 questionnaires were found effective for analyses, thus yielded retrieval rate of 89.6%, that is approximately 90% by indication. Scale reliability of battery of items in the returned questionnaire was obtained through Cronbach alpha coefficient via STATA 12 Software. The result indicates a scale reliability coefficient of 0.74, a value higher than the acceptable minimum value of 0.70 (Pallant, 2011), hence, good consistency of the research instrument. The information in Table 1 reveals that the model of the study is overall significant (Prob > chi2 = 0.0000) which implies that probit model employed by the study is a significant to explain gender gap in STEM disciplines across tertiary institutions in the study area.

Table 1: Paraeter Estimate of Probit regression Model

```
                                Number of obs   =       129
                                LR chi2(2)      =      0.33
                                Prob > chi2     =    0.0000
Log likelihood = -84.442274     Pseudo R2       =    0.2320
------------------------------------------------------------------------------
        SGAP |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        ECTM |  -.0103189   .0849307     0.12   0.033    -.17678    .1561422
        QOTA |  -.0528301   .0923967     0.57   0.000   -.2339244    .1282642
       _cons|   .5589095   .4486434     1.25   0.213   -.3204155    1.438234
------------------------------------------------------------------------------
```

Source: STATA Outputs, 2019

Table 2: Estimate of Average Marginal Effects

```
                                Number of obs   =       129
                                Model VCE    : OIM

------------------------------------------------------------------------------
                             |            Delta-method
                             |      dy/dx   Std. Err.      z    P>|z|  [95% Conf. Interval]
-----------------------------+------------------------------------------------
ECTM |  -.0138683   .0318329     0.12   0.903   -.0662596    .058523
QOTA |  -.0398049   .0345117     0.57   0.566   -.0874466    .0478367
```

Source: STATA Outputs, 2019

Further, the results in Table 1 shows that adjusting entry cut-off mark and quota requirement in favour of female students are significant parameters in admission policy that can be employed by tertiary institutions in Nigeria to bridge the gender gap in STEM disciplines. From Table 1, an increase in efforts to adjust entry cut-off marks and

quota requirements in favour of female students in tertiary institutions are more likely to reduce or bridge the gender gap in STEM disciplines. This implies that if the entry requirement into STEM courses is reduced in favour of female, there could be higher interest and enrolment of female in STEM disciplines. This interpretation, however, is about the signs of the predictors' coefficients and not their magnitudes. For interpretations of the magnitudes of the regressors, the researcher employed the analysis output from Average Marginal Effects analysis as contained in Table 2. From Table 2, an increase in efforts to adjust entry cut-off marks in favour of female students in tertiary institutions is more likely to reduce or bridge the gender gap in STEM disciplines by 1% and an increase in efforts to make quota requirements in favour of female students in tertiary institutions is more likely to reduce or bridge the gender gap in STEM disciplines by 4%.

The key findings of the current research suggest that adjusting admission policy of higher education institutions in favour of potential female students through entry cut-off mark and quota reservations is important to bridge gender gap in STEM disciplines. These findings conform to the a priori expectation of the study. From the study, it was discovered that an increase in efforts to adjust entry cut-off marks and quota requirements in favour of female students in tertiary institutions are more likely to reduce or bridge the gender gap in STEM disciplines. The findings of the current research are consistent with previous findings by Botella (2019) & Leo-Rhynie (1999). The implication of the findings by this research is that bridging gender gap in STEM disciplines can help create opportunities for ladies and women to improve their socio-economic condition. In particular, the findings of the current research suggest that application of the study empirical-proven approaches are creative ways to promote gender equity in education sector and societal development programmes at large.

4. Conclusion and Recommendation

This study employed probit model to empirically evaluate the effectiveness of higher education institutions admission policy criteria such as entry cut-off mark and quota reservation in bridging gender gap in STEM disciplines. From the findings of the study, admission policy parameters examined (entry cut-off mark and quota reservation for female in STEM courses) are vital to bridge such gender gap in STEM disciplines in Nigeria, especially at the higher education level. It is evident that that adjusting entry cut-off mark and quota reservation system in favour of female students will engender higher interest and participation of female students in STEM disciplines in Nigerian tertiary institutions. Consequently, it is recommended that female gender participation in STEM in tertiary institutions in Nigeria should be encouraged through integration of gender mainstreaming into admission policies and criteria of Universities, Polytechnics and Colleges of Education. In particular, Federal Ministry of Education, Joint Admission and Matriculation Board, Management of tertiary institutions, government agencies and stakeholders in education should make quota reservation in addition to adjusting entry cut-off marks for female candidates in admission into STEM disciplines.

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