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Moderating Role of Gender in the Influence of Gender Stereotype on Science Performance among Secondary School Students in Migori County, Kenya

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Abstract:- We carried out this study with the purpose of establishing the influence of gender stereotype on performance in science across gender. We sampled 175 students in Form 4 in Migori County. Our study used questionnaires, interview schedules and focus group discussion guide to collect data. Subsequently, we used descriptive statistics, correlation and linear regression to analyze quantitative data. We organized qualitative data into themes that emerged and interpreted. Boys reported a higher level of science performance (Mean=39.20) than girls (Mean=30.80). This mean difference was statistically significant at α=.05 (t=3.89, p=.00). Girls displayed a higher level of gender stereotype (Mean=1.67) than boys (Mean=1.66). However, this difference was not statistically significant ($t_{(173)}$ = -.187, p = .852). Further, for both boys and girls, gender stereotype significantly correlated with performance in science; boys had r=-.211 (p=.018, n=200) and girls had r=-.171 (p=.035, n=127) indicating a stronger relationship for boys than girls. Gender stereotype predicted performance in science with b=-4.917 (p=.013, n=327) implying that higher levels of gender stereotype were associated with lower levels of performance in science. We recommend that ways of minimizing gender stereotype among secondary school students should be established because it is negatively associated with performance in science.

Keywords:- *Gender Stereotype, Kenya, Science Performance.*

I. INTRODUCTION

Weak performance in sciences among girls still creates a big challenge in the field of science (Diane, 2003). In spite of the strides made in the last 20 years, female students unlike their male counterparts still shy away from taking physics technical science and Math courses in high school. Consequently, this sees a lower number of female students enrolling for Mathematics and science at the college level. The subject and course selection at the high school level is key determiner in college placement and career choice path (Diane, 2003).

Science, Technology, Mathematics and Engineering (STEM) field has been hit by a great labour shortage challenge as most women fail to enroll for courses in this field. Only 28% of global researchers are women. This percentage however varies from one region to the other (UNESCO, 2016). A greater under representation of women is witnessed in the STEM field. This under representation of women is as a result of a number of factors including cultural and societal discrimination, school and labour market marginalization of women (UNESCO, 2016).

Data from the Kenya National Bureau of Statistics (2019) indicate that in general, Kenya has 21,400 female STEM profession and 52,400 male professionals. Only 30 % of university students who take STEM courses are females This weak representation of females in science is again reflected in the performance of sciences down the ladder. Performance in the Kenya Certificate of Secondary Education (KCSE) examination for instance attests to this worrying trend as boys have outshone girls in all science related subjects from the year 2017 to 2019. Performance in science subjects has not been any better in Migori County as well. Although the average national result for all sciences in the 2018 KCSE stood at an average mark of 27.78% for boys and 24.98% for girls, giving a gender disparity of 2.8% in science performance, female students in Migori County scored 22.63% in sciences while male students scored 26.65% in the same giving a 4.02% gender difference (Migori County Education's Office Records, 2020). This goes against the Millennium Development Goals which advocates for gender parity in STEM performance and promotion of STEM subjects for attainment of Vision 2030.

Although some studies show that males perform better than females in sciences, other studies have indicated no difference in the level of science performance across gender. Other studies have even indicated a better female performance in science than males. One cannot therefore conclusively say that males perform better than females in science or vice versa. It is on this basis of conflicting findings Based on these conflicting findings that we sought to establish the gender difference in science performance.

This variation in performance could be possibly explained by the fact that society considers science as a masculine field (Fox et al., 2006; Hill et al., 2010). Students internalize these societal perceptions and define their capabilities based on these parameters. Murphy and Whitelegg (2006) report that female students may choose to drop science courses if the society considers them as

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masculine even if they have the capability of excelling in them. Society has created barriers for girls in science in terms of negative stereotype beliefs (Belkin, 2008; Hill et al., 2010). As such these gender barriers have seen girls register a weaker performance in science than boys (UNESCO, 2016; Else-Quest et al., 2010; Francis & Skelton, 2005; Hill et al., 2010; FAWE, 2003a; Ayoo, 2002 & Chepchieng & Kiboss, 2004).

Noteworthy is that the forementioned studies were either based in the Western countries whose cultural connotation on gender cannot be assumed to be similar to African values attached to gender. The studies also addressed academic performance in general without paying key attention to differences in science performance across gender stereotype. It is this knowledge gap that we sought to fill.

A. *Objectives of the Study The objectives of the study were to:*

- Establish the level of performance in science across gender.
- Establish the level of gender stereotype across gender.
- Examine the influence of gender stereotype on performance in science across gender.

II. RESEARCH METHODOLOGY

A. *Research Design*

We used a mixed methods research design which includes both quantitative and qualitative paradigms. More specifically, we adopted the use of descriptive survey, correlation and qualitative research designs.

B. *Sample Size and Sampling Technique*

From a population of approximately 1,600 Form Four students in the year 2020 spread out in 240 public secondary schools) who were doing all the 4 science subjects (Mathematics, Biology, Chemistry and Physics), we used Fisher et al. (1991) formula to arrive at a sample size of 175. We then stratified the sample by gender followed by simple random sampling technique to sample the students. Additionally, we randomly sampled 30 heads of science department from the 240 schools.

C. *Research Instruments*

We used four tools for data collection; Gender Stereotype Scale (GSS), Science Achievement Test (SAT), Focus Group Discussion Guide and Head of Science Interview Schedule (HOSIS).

D. *Methods of Data Analysis*

We used descriptive statistics, correlation analysis and simple linear regression in the analysis of quantitative data. Consequently, we used the Statistical Package for the Social Sciences (Version 24) software for quantitative data analysis. Qualitative data was analyzed thematically.

E. *Ethical Considerations*

We observed all the protocols for conducting research in Psychology. This study was approved by the Maseno University Ethics Review Committee and the National Commission for Science, Technology and Innovation (NACOSTI) prior to data collection.

III. RESULTS

A. *Reliability Analysis*

We used Cronbach's alpha to ascertain the degree of reliability for the research instruments. Table 1 shows the values of Cronbach's alpha for each of the tools.

Table 1 Reliability Coefficients for Tools Used in the Study

Instrument	**Cronbach's Alpha**	**Cronbach's Alpha Based on Standardized Items**
Science Performance	0.782	0.781
Role Model	0.786	0.787
Gender Stereotype	0.792	0.795

The reliability coefficients were all above the threshold of .70 as suggested by McNeish (2017) who states that a reliability coefficient of above 0.7 is acceptable. Thus, all the instruments were deemed fit and were therefore used for the study.

B. *Level of Science Performance across Gender*

Table 2 shows mean scores in the various science subjects and the overall science performance across gender. The overall mean score for boys (Mean=39.20) was higher than for girls (Mean=30.80). Boys consistently performed better than girls in all the four science subjects. The best performed subject was Mathematics followed by Biology and then Physics. The worst performance was in Chemistry.

Table 2 Level of Performance in Science Across Gender

	Mean Score by Gender	
	Boys	**Girls**
Physics	9.90	7.02
Chemistry	7.39	5.78
Mathematics	11.25	9.08
Biology	10.66	8.92
Overall Mean	**39.20**	**30.80**
Valid N (listwise)	200	127

Overall, performance in science subjects was poor, with boys scoring a mean of 39.20 and girls scoring a mean of 30.80. In addition, boys outperformed girls on the average in each of the subjects. Further, the best performance for both boys and girls was recorded in mathematics followed by biology. The worst was in chemistry.

The highest gender disparity was recorded in physics (Mean difference=2.88) followed by Mathematics (Mean difference=2.17). Biology had the third highest level of gender disparity in performance (Mean difference=1.74) while Chemistry had the lowest gender disparity (Mean difference=1.61).

To determine whether this mean difference in performance of science was statistically significant or not, we used the independent samples t-test at α=.05 (two-tailed). Table 3 displays the result of the analysis which shows that the fundamental assumption for t-test regarding the equality of variances was satisfied at α=.05 (F=.83, p=.37). With equal variances, the difference in science performance between boys and girls was statistically significant at α=.05 (t=3.89, p=.000). Therefore, the mean difference in science performance between boys and girls was a true difference in the population from which the sample was drawn and not a result of chance or sampling error.

Table 3: Test of Significance for Gender Difference in Science Performance

		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	**Sig.**	***t***	***df***	**Sig. (2-tailed)**
Performance in Science	**Equal variances assumed**	.83	.37	3.89	173	.000
	Equal variances not assumed			4.08	100.60	.000

C. Level of Gender Stereotype across Gender

Table 4 displays the means for level of gender stereotype across gender extracted from an independent-samples *t*-test. Boys had a mean of 1.66 while girls had 1.67. This means that girls had a slightly higher level of gender stereotype than boys.

Table 4 Gender Stereotype Across Gender

	Gender	N	Mean	Std. Deviation
Gender Stereotype	**Boys**	125	1.90	.46
	Girls	50	1.76	.22

To determine whether this mean difference in gender stereotype was statistically significant or not, we used the independent samples *t*-test at α = .05 (two-tailed). Table 5 gives the result of the analysis which shows that the fundamental assumption for *t*-test regarding the equality of variances was satisfied at α = .05 although it was borderline (F=3.850, p=.051). However, the mean difference in level of gender stereotype between boys and girls was not statistically significant at α = .05 (t_{173} = -.187, p = .852), indicating that any difference in level of gender stereotype between boys and girls was an outcome of chance or sampling error.

Table 5 Test of Significance for Gender Difference in Gender Stereotype

		Levene's Test for Equality of Variances		*t*-test for Equality of Means		
		F	**Sig.**	**t**	**df**	**Sig. (2-tailed)**
Gender Stereotype	**Equal variances assumed**	3.850	.051	-.19	173	.85
	Equal variances not assumed			-.20	100.19	.85

D. Assessment of Linear Regression Assumptions

We used ordinary least squares regression analysis to determine the relationship between gender stereotype and performance in science across gender. This called for checking the assumptions for regression analysis before running the analysis. We checked the following four important assumptions:

- The distribution of the dependent variable must be normal.
- The variance of the distribution of the dependent variable should be constant for all values of the independent variable i.e. the assumption of homoscedasticity
- The relationship between the dependent variable and the independent variable should be linear, and
- There should be little or no autocorrelation.
- Assessment of the above linear regression model assumptions is presented below.

➢ *Test of normality across gender*. To assess whether performance in science, the dependent variable in this case, violated the normality assumption or not, we plotted a normal P-P Plots across gender as presented in Figure 1. In these graphs, expected cumulative probabilities were plotted against observed cumulative probabilities.

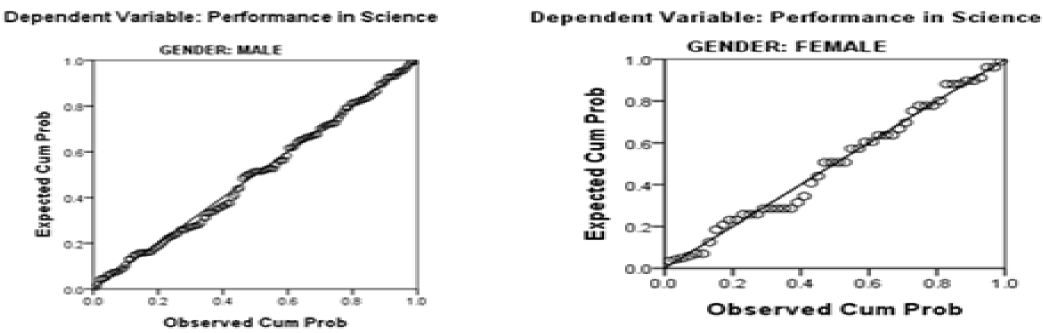

Fig. 1: Normal P-P Plots for Performance in Science Across Gender

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The points in the scatter plots did not deviate much from the diagonal normality line implying that the assumption of normality was not violated for both boys and girls.A graph within a graph is an "inset," not an "insert." The word alternatively is preferred to the word "alternately" (unless you really mean something that alternates).

- *Test of Homoscedasticity Across Gender*. To assess the assumption of homoscedasticity, we plotted the dependent variable (Performance in Science) against regression standardized residuals as shown in Figure 2. The points were close to the diagonal without displaying a funnel shape. This implied that homoscedasticity was not violated.

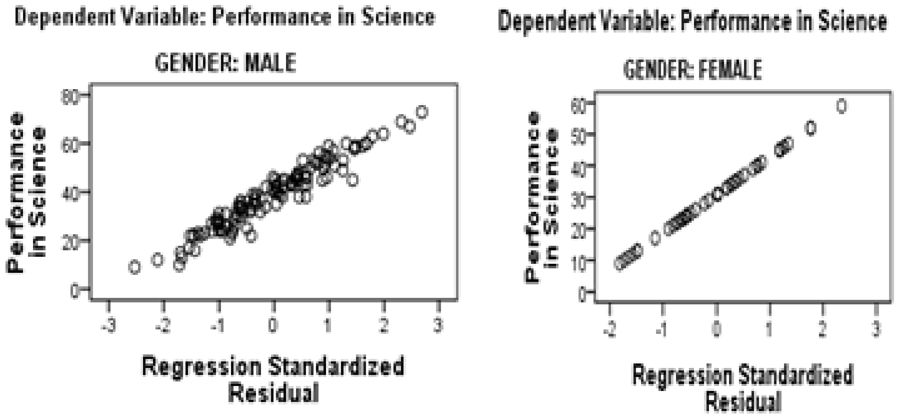

Fig. 2: Scatter Plots for Assessing Violation Against Homoscedasticity Across Gender

- *Test of Linearity Assumption Across Gender*. We assessed the linearity assumption across gender by using scatter plots, with the dependent variable (Performance in Science) along the ordinate and the predictor (Gender Stereotype) along the abscissa. Whereas there was no outlier for the male distribution, the female distribution had a single influential outlier (Gender Stereotype=4 and Performance in Science=45). This case was excluded from subsequent analysis. The scatter plots after excluding the outlier are presented in Figure 3.

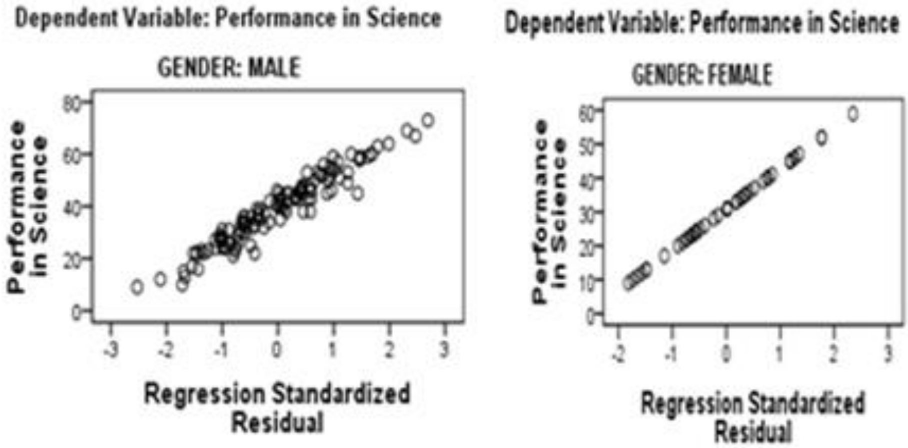

Fig. 3: Scatter Plot for Assessing Linearity Assumption

The scatter plots in Fig. 3 indicate that there was a negative linear relationship between performance in science and gender stereotype for both boys and girls. Thus, the assumption of linearity was not violated.

- *Test for Autocorrelation Across Gender*. Finally, we used the Durbin-Watson statistic to test for autocorrelation. Values for the statistic below 2.0 mean there is positive autocorrelation and above 2.0 indicates negative autocorrelation. A rule of thumb is that the test statistic values in the range of 1.5 to 2.5 suggest little or no autocorrelation. The value generated in this analysis was 2.00 for boys and 1.49 for girls. These outcomes were within the normal range required for ordinary least squares regression analysis.

E. Relationship between Gender Stereotype and Performance in Science across Gender

Subsequent to the above regression diagnostics, and after removing the single outlier in the distribution for girls, we established the correlation between gender stereotype and performance in science for both males and females at α=.05 (2-tailed). The findings are displayed in Table 6. Boys had a statistically significant correlation of r = -.272 (p=.002, n=125). However, girls had a non-significant correlation of r = -.251 (p=.082, n=49). This implies that gender stereotype was a better predictor of performance in science for boys than for girls.

Table 6 Correlation Between Gender Stereotype and Performance in Science Across Gender

			Gender Stereotype	Performance in Science
Boys	Gender Stereotype	Pearson Correlation	1	-.272**
		Sig. (2-tailed)		.002
		N	125	125
	Performance in Science	Pearson Correlation	-.272**	1
		Sig. (2-tailed)	.002	
		N	125	125
Girls	Gender Stereotype	Pearson Correlation	1	-.251
		Sig. (2-tailed)		.082
		N	49	49
	Performance in Science	Pearson Correlation	-.251	1
		Sig. (2-tailed)	.082	
		N	49	49

**. Correlation is significant at the 0.01 level (2-tailed).

Based on the correlations in Table 6, we used ordinary least squares method to find a linear equation for predicting boys' performance in science from gender stereotype at the 95% confidence interval. The results shown in Table 7 indicate that the linear equation for predicting performance in science using gender stereotype as a predictor is Y=54.107-7.859X where Y is Performance in Science and X is Gender Stereotype. Thus, a 1 unit change in Gender Stereotype for boys is associated with a decrease of 7.859 units in Performance in Science.

Table 7 Prediction of Performance in Science for Boys

Model		Unstandardized Coefficients		Standardized Coefficients	*t*	Sig.
		B	Std. Error	Beta		
1	(Constant)	54.107	4.894		11.057	.000
	Gender Stereotype	-7.859	2.509	-.272	-3.133	.002

This finding echoes the qualitative finding from the FGD. The respondents' general opinion during the discussions was that the society played a very big role in continuing to promote gender bias in the field of science. The gender stereotype held by society against female science performance was a major cause of the problem of poor science performance. A story shared by one female respondent gave the deeply rooted barriers erected by society against females' success in science. She reported that:

"One day when our family went to visit a family friend, the issue of careers came up. Children were asked their careers of choice and when I said I wished to pursue a career in Civil Engineering, the whole gathering roared with laughter. Condemnation upon condemnation at how that was a totally wrong career choice followed. I was told by my own father that I should stop being over ambitious but when I pointed out that I had been posting good grades in sciences he told me that that was at a very basic level and that the science at the university level was too technical to be handled by girls' brains. The wife to one of his friends told me that sciences are for men and that I should pursue a female career if I wanted to excel in life as a woman. I felt so frustrated and disappointed in myself for having believed I could succeed in science and from that day my performance in science has ever been on a terrible decline."

After this experience she lost interest in sciences and her performance begun to decline very fast. This same scenario affected most girls as when they reported having interest in pursuing science careers at the university, they were criticized for intending to venture in a male field. The society seemed to glorify male science role models while cast aspersions on prowess of female science role models. Participants reported that the females who had succeeded in science were said to have not done so out of their own effort but from assistance by males around them and so girls were left without genuine role models in science. One female participant reported that:

"When I scored an A in Chemistry and became the best in that subject in last year's third term exams, I was accused of befriending our Chemistry teacher and that those were not my marks. My class members challenged me to bring my paper for their verification. However, upon finding no marking errors, they said the teacher had given me the exams plus the marking scheme and so I just collected what I had copied in his house. I felt so painful about this and this affected my performance a lot."

Generally, all the participants for the discussion were in agreement that the society has made it difficult for girls to excel in this the science field. A statement by one male participant seemed to summarize this problem. He reported that:

"As a woman, nobody, from your teachers, friends, parents and society as a whole believe you can make it in science. Everyone believes you have no capacity to excel in this field and as soon this thought gets into one's brain, they switch off. From here the performance begins to go down and therefore unless nothing happens this field will forever be dominated by males."

One area of science performance that has been so affected by gender stereotype is, Physics. Majority of students came out as holding very negative gender stereotype beliefs about Physics. One student reported that:

"The performance of girls in Physics is so poor. Physics is a male subject and I believe girls should keep off Physics, it is not their field. Why should you go for a subject that you definitely know you cannot excel in? The kind of difficult calculations in Physics cannot be handled by girls and that is why the few pretenders who risk to choose it perform terribly."

It was surprising that even the girl students had the same notion of them not being able to perform as well as boys in Physics. One girl responded that:

"I believe girls cannot compete boys in Physics. Physics is full of boring and difficult stuff that can only be handled by boys. At some point I even regret having chosen this subject because it is turning out to be too technical for me. Again, the thought of being an Engineer scares me. With all the physical work and sweat involved in Engineering, I think it would be so boring, but its too late to drop it anyway."

In general, most of the respondents were in agreement with the notion that girls perform weaker than boys in Physics. One male participant summed it up by saying that:

"Physics has over the decades been presented by society as a male subject and over time this fact has continued to sink in the minds of many, both girls and boys alike. This is what has actually led to many girls shying away from doing this subject and those who do it in most cases end up performing poorly as they believe they can't do better in it even if they try. I think time has come to reverse this trend and we should find actual reasons why there is this gender disparity so that we solve this problem once and for all."

IV. DISCUSSION

We found out that in terms of science performance boys outperform girls in all the science subjects. This in a nutshell shows that girls have a weaker science performance. This finding concurs with the findings Eriba and Sesugh (2006) in Nigeria which showed that boys have a better performance in integrated science and mathematics than girls. Likewise, the findings echo that of Ochwa-Echel (2011) in Uganda in a project, dubbed Female Education in Mathematics and Science in Africa. That study found that girls dismally performed in science subjects in the Uganda Certificate Examinations is very low compared to that of boys.

Consequently, the finding typically mirrors the situation in Kenya since recent literature show that there has been a big problem of poor performance in STEM subjects in Kenya as a whole with girls performing even worse in comparison with the boys (Forum for African Women Educationalists, 2008). The same position is held by Wambua (2007) in his study as he found that boys performed better than girls in STEM subjects. With the Science Achievement Test being developed from science questions in the KCSE exams, the study finding mirrors the true performance scenario on the ground as recent national KCSE results of 2017, 2018 and 2019 have all shown that boys continue to perform better than girls in all the science subjects.

The current finding also corroborates other studies done in the local environment. According to the records at the Migori County Office, boys have continued to perform better than girls in the sciences. For instance, in the 2018 KCSE results, Migori County had girls scoring an average mark for all sciences of 22.63% against the boys' 26.65%, giving a gender disparity of 4.02%. (Migori County Education Office Records, 2019).

Consequently, the study found that gender stereotype influences the level of science performance. The current finding echoes those of previous studies by Spelke (2005), Murphy and Whitelegg (2006), Else-Quest et al. (2010), Raviv et al. (2003), Gilbert (2001) and Brickhouse et al. (2000), who found a direct link between negative gender stereotype comments and poor girl performance in science. Such comments were also blamed for the low numbers of girls in science classes as the comments made the girls feel as though science was a 'male field'. Similarly, Huguet and Regner (2007), Halpern, 2004), Blickenstaff (2005) concurs with these findings as their studies also noticed that stereotype threat significantly impacted girls' performance negatively.

In concurrence with these findings are studies by Wigfield et.al. (2000) and Learch (2003), Onyeizugbo (2003) and Kakonge (2000) who go further to explain how negative gender stereotype beliefs impact science performance negatively. The studies opine that socio-cultural factors may influence girls' attitudes toward mathematics and science. For example, parents tend to view Mathematics as more important for sons and language, arts and social studies as more important for daughters. Parents are more likely to encourage their sons to take advanced high school courses in chemistry, mathematics, and physics and have higher expectations for their success.

V. CONCLUSION AND RECOMMENDATION

In light of the findings of the study, we conclude that male students in Migori county perform better than female students in all the science subjects. In addition, gender stereotype negatively influences the level of science performance. The higher the level of a student's belief in gender stereotype notions, the lower the level of science performance and vice versa. It is therefore recommended that there needs to be meaningful intervention by the government and teachers to initiate public awareness campaigns to demystify existing negative stereotype beliefs that depict science as a preserve of the males through motivational talks, public barazas, official media platforms and social media as these beliefs have shown to negatively impact on girls' science performance.

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