



PREDICTORS OF GIRLS' PERFORMANCE IN MATHEMATICS AMONG SENIOR HIGH SCHOOL STUDENTS

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ABSTRACT: *The study employed the Explanatory Sequential design of the Mixed-Methods approach to investigate the factors that affect female students' performance in mathematics. Stratified and Simple Random Sampling techniques were used to sample three hundred and fifty-six (356) participants from four different Senior High Schools within the Northern Region to participate in the survey while 12 key informants were selected using the Expert Purposive Sampling technique for key informant interviews. Questionnaires and interview guides were the main instruments used for data collection. Inferential statistics were used to analyse the quantitative data while inductive thematic analysis was used in analysing the qualitative data. The results of the analyses showed that gender stereotypes, the socio-economic status of parents, self-motivation by the female students, the social environment in which the female students find themselves and teacher efficacy were the main factors affecting female students' performance in mathematics.*

KEYWORDS: Expectancy-Value Theory, Gender, Gender Stratification Theory, Gender Stereotype, Gender Studies, Girls' Performance, Female Students, Mathematics, Parents, Performance, Self-Motivation, Social Environment



INTRODUCTION

Over the past 20 years, numerous studies have been conducted on gender differences in mathematics achievement. In their study of gender differences, the researchers focused on a variety of factors ranging from gender differences in visuospatial skills (Chan & Cheung, 2018), the influence of environmental factors such as parental support (van Mier et al., 2019), student-teacher interactions (Bieg et al., 2015), stereotypical role patterns (Xie et al., 2019), to different enrolments in courses (Van Mier et al., 2019). Giberti (2019) finds that research on gender differences and cognitive complexity in Asia suggests that as the complexity of cognitive processes required to successfully complete a task increases, gender differences in mathematics topics and other science-related topics tend to become more favourable to boys.

In Africa, Ashcraft (2019) identified mathematics and other science-related subjects as the critical filters that prevent women from entering many prestigious and lucrative professions. They concluded that one of the fairly well-documented sex differences is that boys are superior in mathematical ability, although there are few sex differences until the early teenage years when boys' mathematical skills increase more rapidly than girls. Picho and Schmader (2018) came to a similar conclusion in their review, stating that there are no significant differences between girls' and boys' mathematical performance until the early years of primary school or the early years of secondary school. Picho and Schmader (2018), however, went a step further in their analysis by taking into account the cognitive level of the measures used. More specifically, they pointed out that when differences occur, they are in favour of boys when higher-level cognitive tasks are used, but in favour of girls when lower-level cognitive tasks are used. A year earlier, Hornburg et al. (2017) made the same findings regarding gender differences in mathematics performance among secondary school students.

In Ghana, Letsoalo (2017) reviewed the literature on gender and mathematics achievement in WASSCE up to and including 2017 and came to three conclusions: (1) boys in secondary schools perform slightly better than girls in secondary schools on tests of mathematical reasoning (mainly solving word problems); (2) boys and girls perform similarly on tests of algebra and basic mathematical knowledge; (3) girls occasionally outperform boys on tests of numeracy. In Kenya, Moreno-García et al. (2017) conclude that the findings that boys outperform girls on tests of quantitative or mathematical ability are robust. According to her, differences also appear at the beginning of bridging grades or in secondary school. This study aims to assess the factors that affect female students' performance in mathematics in the northern region of Ghana using mixed methods. This paper examined the extent to which gender stereotypes, socio-economic background of parents, teacher efficacy, the social environment in which female students find themselves and self-motivation by female students to learn and pursue mathematics and its related courses predict the mathematics achievement in Senior High School female students in the Northern Region of Ghana using a mixed methods approach. The study raises several questions: What is the effect of gender stereotypes on the mathematics performance of female students in the Northern Region of Ghana? What is the effect of the social environment on the mathematics performance of female students in the Northern Region of Ghana? How does the socio-economic status of parents affect the performance of female students in mathematics in the Northern Region of Ghana? How does teacher efficacy affect the mathematics performance of female students in the Northern Region of Ghana? How does self-motivation impact the performance of female students in mathematics in the Northern Region of Ghana? Answers to these questions will inform policy formulation in addressing the causative factors of poor female students' performance in



mathematics in the Northern Region of Ghana. The objective of the study was to determine whether there is a relationship between:

- a. the social environment and the performance of female students in mathematics among Senior High Schools in the Northern Region of Ghana.
- b. self-motivation and the mathematics performance of female students among Senior High Schools in the Northern Region of Ghana.
- c. Gender stereotypes and the performance of girls in mathematics among Senior High Schools in the Northern Region of Ghana.
- d. The socio-economic background of parents and the performance of their female wards in mathematics among Senior High Schools in the Northern Region of Ghana.
- e. Teacher efficacy and the mathematics achievement of female students in the Northern Region of Ghana.

LITERATURE/THEORETICAL UNDERPINNING

The theoretical frameworks backing this study are the Expectancy-Value Theory and Gender Stratification Theory. These theories provide viewpoints, ideas and other propositions that may better explain the performance of girls in general. The relevance of these theories to the study is discussed as follows:

Eccles and Wigfield (2020) proposed and tested an expectancy-value theoretical model to explain the gender gap in mathematics achievement and the underrepresentation of women in science and engineering careers. According to this model, people do not take up a challenge unless they value it and have some expectation of success. Perceptions of the value of a task, such as taking a challenging mathematics course, are shaped by the cultural environment (for example, the gender segregation of professions, cultural stereotypes about the subject) and the person's short-term and long-term goals (for example, becoming a primary school teacher and thinking that one does not need a lot of pure mathematics or becoming a civil engineer and knowing that one needs more of pure mathematics). Sociocultural forces such as parental and teacher attitudes and expectations, including stereotypes, also shape self-concept and attitudes towards the subject (Prieto, 2018).

According to the expectancy-value theory, a girl who believes that the career opportunities available or suitable for women do not require a lot of mathematics is less likely to invest more time and energy in excelling or even taking mathematics courses. In fact, she may view pure mathematics as less useful or valuable and therefore places less value on it. The theory has received abundant empirical support (Eccles & Wigfield, 2020) and provides a clear model for why cultural inequalities in educational or career opportunities adversely affect girls and women considering STEM careers. According to Selvarajan et al. (2018), individuals do not engage in tasks that are perceived to be of little value.

The gender stratification hypothesis (Bussey & Bandura, 1999) on the other hand states that, in patriarchal cultures, male students associate their performance with future opportunities and results. Due to the reduced opportunities for women, girls do not see such a link and therefore



do not perform well as boys in domains that they consider less useful. (Bussey & Bandura, 1999) argued that female students who are given fewer opportunities may consider pure mathematics to be less important for their future and hear this in various ways from teachers, parents and friends. In short, opportunity structures can shape numerous socialisation processes that determine performance. In general, the gender stratification hypothesis states that where there is more social stratification based on gender, and thus more inequality of opportunities, girls will report fewer positive attitudes and more negative attitudes and therefore will perform less well on mathematics tests than their male peers. But where there is more gender equality of opportunities, gender similarities in mathematics will be evident.

The Social Environment and Girls' Performance in Mathematics

The social environment as used in this context refers to students' social interaction with teachers and peers and the availability of teaching and learning resources in mathematics. Both social and physical environments have been found to have an impact on student performance in general. In a study of student performance in mathematics among Senior High School students in the Western region, Marginson and Dang (2017) employed an exploratory design involving 68 students and 12 teachers to assess the factors that accounted for the poor performance of students in Mathematics. Performance in Mathematics was measured by students' scores in Mathematics in their last two terms and their scores in the Basic Education Certificate Examination (BECE). They found that student performance in mathematics was affected by factors such as teacher-student relationships, students' relationships with their peers, students' family background, students' gender and students' perception of Mathematics. They concluded that most of the factors that predicted students' performance was from the school environment and could be addressed by the school management. While their study investigated the factors affecting students' performance in Mathematics, they did not pay specific attention to the specific factors that affect female students in their mathematics performance. This study considers the factors that affect female students' performance in Mathematics in the Northern Region of Ghana.

Self-Motivation and Female Students' Performance in Mathematics

Mathematics education requires highly motivated learners because it requires reasoning, making interpretations and solving problems, mathematical issues and concepts. The challenge of mathematics education for today's schools is that it requires discipline, concentration and motivation. To meet these challenges, students need to be focused and motivated to make progress. Anghel et al. (2019) investigated the relationship between classroom motivation and academic achievement among elementary school-aged children which involved 122 first-grade participants and 129 third-grade participants. Consistent with previous studies, they found that for higher levels of mastery, motivation was related to higher mathematics scores. The teacher's role in motivating students to learn should not be underestimated. To help students become motivated learners and producers of mathematical knowledge, the teacher's most important task is to create a learning environment in which students can engage in mathematical thinking activities and conceive of mathematics as something that requires "exploration, conjecture, representation, generalisation, verification and reflection (Davadas & Lay, 2017). The study collected data and determined whether the girls' attitudes towards Mathematics in Westlands District were attributable to demographic factors, gender factors, parental influences and learning facilities. Conclusions were drawn on this basis.



Socio-Economic Status of Parents and Performance in Mathematics

Socio-economic status has been found to be a predictor of mathematics achievement. Studies have repeatedly shown that parents' annual income is correlated with pupils' mathematics achievement (Letsoalo, 2017). Socioeconomic status was found to be significant in mathematics and science scores (Hornburg et al., 2017). Another study found that the poor academic performance of Canadian students was due to the low socio-economic status of their parents (Jiang et al., 2018). Socio-economic status was examined and found to be one of the four main predictors of differences in academic performance of South African students aged 15 in reading, mathematics and science by the Program for International Students Assessment (Letsoalo, 2017). Several studies show that parents with higher socioeconomic status are more involved in their children's education than parents with lower socioeconomic status. This greater involvement results in the development of positive attitudes of children towards school, classes, and improvement in academic performance (Migosi & Muola, 2013). Low socioeconomic status is believed to have a negative impact on academic achievement, in part because it denies students access to various educational materials and resources and creates a troubling atmosphere at homes such as possible disruptions to parenting or an increased likelihood of family conflict (Migosi & Muola, 2013). For these reasons, the socio-economic status of the parents of a pupil is a common factor determining school performance including performance in mathematics.

Gender Stereotypes and Female Students' Performance in Mathematics

Many variables have long been studied as predictors of academic performance. However, gender aspects of academic achievement have been the most studied by researchers. For example, a meta-analysis shows that males perform better on mathematics tests that require problem-solving (Anghel et al., 2019). Another study shows that women achieve better grades in mathematics than men (Matteucci & Mignani, 2021). Some recent studies have shown that gender differences in mathematics education seem to be narrowing in many countries. However, studies show that as students reach higher grades, gender differences favour male performance in mathematics (Matteucci & Mignani, 2021). For example, the results of the Third International Mathematics and Science Study (2018) showed that the mathematics performance of each gender group was close in primary and secondary schools. However, evidence of gender differences in mathematics performance was found in the final year of secondary school. Another study, conducted to analyse the factors influencing the mathematics performance of 11th graders in mathematics classes with an identified gender gap, also showed that males scored higher than females on the 11th-grade mathematics test, but that this difference narrowed from the 10th grade onwards (Breda & Napp, 2019). Moreover, gender differences in perceptions and attitudes about the usefulness of mathematics for secondary school students were found to be statistically significant (Matteucci & Mignani, 2021). It is also reported that girls tend to learn mathematical concepts through rules or cooperative activities, whereas boys tend to be in competition to master mathematical concepts. The literature on gender differences provides evidence that gender issues affect performance in mathematics.



Teacher Efficacy and Female Students' Performance in Mathematics

Many studies report that what teachers know and believe about mathematics is directly linked to their instructional choices and procedures. Also, it seems undisputed that the teacher's philosophy about mathematics has a significant impact on the structure of mathematics lessons. Teachers must have the skills and knowledge to apply their philosophy of teaching and instructional decisions. In the 21st century, there is a shifting paradigm in education about teachers' roles and competencies. Findings from research on teacher competencies suggest that if teachers are to prepare an increasingly diverse group of learners for much more challenging work - for formulating problems; finding, integrating and summarising information; creating new solutions; independent learning; and collaborating - they will need significantly more knowledge and radically different skills than most now have and most education schools are now developing (Luttenberger et al., 2018). Teachers must not only have knowledge of a particular subject, but also pedagogical knowledge and knowledge of their students (Moreno-García et al., 2017).

Teacher competence in these areas is closely linked to pupils' thinking, understanding and learning in mathematics education. There is no doubt that student achievement in mathematics education requires that teachers have a rigorous understanding of the subject matter and epistemology that guides mathematics education (Jiang et al., 2018) as well as an equally rigorous understanding of the different types of instructional activities that promote mathematics education. Skilled mathematics teachers provide a roadmap to lead students to an organised understanding of mathematical concepts, to reflective learning, to critical thinking, and ultimately to mathematical achievement (Jiang et al., 2018).

Trends of Female Students' Performance in Mathematics

Many studies have found small but consistent gender differences in students' attribution patterns for their performance in mathematics. Boys attribute their success in mathematics more to stable factors, for example, task difficulty or ability, in contrast to girls who attribute more to unstable factors such as effort, luck, and a good teacher (Breda & Napp, 2019). Law (2018) examined the differences in attributions between high-achieving boys and girls for success and failure in general academic subjects, language skills, science, and mathematics. Highly gifted children were found to attribute failure to effort rather than to giftedness. Significant gender differences were found in the performance pattern of boys and girls. For 62 fourth-grade and 99 fifth-grade pupils, the findings of a study by Xie et al. (2019) indicated that girls' performance in mathematics was similar to or better than that of boys and that girls' attribution patterns were more self-enhancing than those of other studies reviewed for the study. However, girls were found to lack self-confidence in relation to their actual mathematics performance while boys were more likely to attribute failure in mathematics to a lack of help from teachers. In the West African Secondary School Certificate Examinations (WASSCE), which are held at the end of secondary school to gain entry to tertiary education, the results again show a significant gap between the performance of boys and girls. The 2018 WASSCE exam results show that, out of those who sat for the exam, 55 per cent were boys and 45 per cent were girls. 30 per cent of boys taking the WASSCE exam achieved an average grade of C+ or higher, while only 23 per cent of girls taking the exam achieved an average grade of C+ or higher (Prieto, 2018). In mathematics, the gap was even more evident in the 2020 WASSCE examinations, where female students achieved an average score of 17.8 per cent in mathematics, compared to 37.8 per cent for their male counterparts. This study collected



statistics on girls' performance in mathematics over the years and used the information to analyse the variables that influence girls' perceptions and attitudes, and by extension, their performance in mathematics.

METHODOLOGY

This study was conducted using a mixed-methods approach so that it could make use of any research tool or technique as needed without being constrained by one particular methodology. The study made use of the explanatory sequential mixed methods design. This methodology was chosen because it allowed the researcher to gather and analysed the quantitative data first, after which the qualitative data was then collected and also analysed. The results of both the quantitative and qualitative data were then merged in the interpretation of the results. Cross-validating the data was made possible by this method. There were no notable discrepancies between the outcomes of the quantitative and qualitative data. The quantitative data were collected via a questionnaire. This offered the study more statistical power and enabled the researcher to collect data from a broader group of female students and mathematics teachers. To collect the qualitative data, key informant interviews with management employees were done. This made it possible to get thorough data regarding the predictive factors of girls' performance in mathematics among the Senior High Schools in the Northern Region of Ghana.

Target Population

The target population for the study was all female students, mathematics teachers and school management staff of all the twenty-three (23) public senior high schools in the Northern Region of Ghana. This group was targeted due to their in-depth knowledge about the predictive factors of girls' performance in mathematics among the Senior High schools in the Northern Region of Ghana. It was not possible to conduct the study in all the Senior High Schools in the Northern Region of Ghana. There are twenty-three (23) public Senior High Schools in the Northern Region. As a result, a simple random sampling technique was used to select four (4) public Senior High Schools out of the twenty-three (23) public Senior High Schools. The sampled schools were; Tamale Senior High School (TAMASCO), Gushegu Senior High School (GUSEC), Zabzugu Senior High School (ZABSEC), and Tolon Senior High School (TOSS). The sample frame was constructed by obtaining the nominal roll of students, a list of mathematics teachers and a list of school management staff. The total of all the female students and all mathematics teachers in the four (4) sampled schools stood at four thousand, eight hundred and seventy-one (4,871), constituting 94% female students and 6% mathematics teachers.

Sample and Sampling Procedure

Cochran's formula for sample size determination was used to determine a sample size of 356 respondents out of the 4,871 female students and mathematics teachers in the four sampled schools. Furthermore, all female students from the four schools were kept in one cluster and treated as a homogenous population and all the mathematics teachers from the four schools were also kept in another cluster and treated as a homogenous population. The female student population constituted 94% of the target population and hence they were equally given 94% representation in the final sample while the mathematics teachers were given 6% representation in the final sample based on their percentage contribution to the target population. A simple



random sampling technique was again used to select respective respondents from the two clusters. Table 1 below shows the distribution of the selected respondents:

Table 1: Selected Respondents

S/N	District	Name of school	Number Selected		Total
			Female Students	Math Teachers	
1	Sagnarigu	Tamale Senior High School	92	4	96
2	Gushegu	Gushegu Senior High School	81	2	83
3	Zabzugu	Zabzugu Senior High School	89	6	95
4	Tolon	Tolon Senior High School	74	8	82
Total			336	20	356

Source: Field Data, 2022

In all, three hundred and thirty-six (336) female students and twenty (20) mathematics teachers were selected to take part in the quantitative study; giving a total of three hundred and fifty-six (356) respondents. In addition to these, the Counselling coordinators, Assistant Headmasters in charge of Academics and the Heads of Departments for mathematics of each school were purposively selected for Key Informant Interviews due to their deep experiences with female students' performance in mathematics.

Instruments for Data Collection

Two main instruments were used to gather data for the study: questionnaires and interview guides. The questionnaires which were built based on the indicators identified during the literature review were used to gather data from the respondents who were selected using non-purposive sampling techniques. The questionnaires were divided into two categories: the female students' questionnaire and the mathematics teachers' questionnaire. An average of the end-of-semester results of the female students was used to measure their performance in mathematics. The collected data was analysed using inferential statistics. The credibility and relevance of the test items on the questionnaires were considered by developing them based on the indicators that were identified during the literature review. The Cronbach Alpha reliability measure was used to check the reliability of the test items from the scores of a pilot test. This gives an alpha level of 0.84 and 0.88 for the female students' questionnaire and mathematics teachers' questionnaire respectively.

An ordinary Least Square regression model was used to determine the association between the Social Environment, Gender Stereotype, Socio-economic Status of parents, Self-Motivation, Teacher Efficacy and female students' performance in mathematics in the Northern Region of Ghana, after correlation and reliability statistics were run to determine the suitability of the items and the model adopted for the analysis.

The interview guides were used to interview the key informants. There were 12 key informants purposively selected for interviews. An interview with each key informant lasted for at least



45 minutes. The interview questions were centred on the factors that determine female students' performance in Mathematics. The qualitative data were analysed using inductive thematic analysis. The qualitative data were coded and categorised into themes based on the responses of the key management staff from the interviews. Also, the data was presented in a narrative form where the voices of the interviewees were captured in the analysis.

The research tools were made available to other researchers for peer evaluation to ensure the study's dependability, credibility, and reliability. The final development of the instruments considered the reviewers' comments. The eligibility of the questionnaire items for analysis was further determined by running a reliability statistic on them. According to Creswell (2015), questions in a survey are regarded as appropriate for analysis if the Cronbach Alpha value in a reliability statistic is not less than 0.5. This means that elements with a Cronbach Alpha value of less than 0.5 do not accurately measure a construct, hence those items would need to be eliminated in order to raise the Cronbach Alpha number. The results of the reliability statistics for this investigation are displayed in Table 2.

Table 2: Reliability Statistics

Construct	Number of Test Items	Number of Items Retained	Scale of Cronbach Alpha
Social Environment	10	7	0.94
Gender Stereotype	10	6	0.89
Parents' Socio-economic Status	11	8	0.92
Self-Motivation by the female students	9	7	0.98
Teacher Efficacy	11	6	0.96

Source: *Field Data, 2022*

As shown in table 2, the test items whose removal would have raised the Cronbach Alpha scale for the latent constructs were eliminated. To determine the Cronbach Alpha scale, only tests that accurately evaluated the latent construct were used. Ten elements made up the construct "Social Environment," however only seven were employed in the analysis because the other three had scales that impacted the Cronbach Alpha's score. Ten test items were included in the construct "Gender Stereotype," but only six of them were used. Only eight of the eleven test items for "Parents' Socio-economic Status" were kept following the reliability investigation. Nine components made up the construct of "Self-Motivation," of which seven were kept following reliability calculations, and eleven test items made up the construct of "Teacher Efficacy," of which only six were kept. The Cronbach Alpha scale for each construct was more than 0.8, indicating that the test items accurately captured the objectives of each construct.



RESULTS/FINDINGS

The quantitative data was analysed using inferential statistics. SPSS was used to compile and input the respondents' replies. To ensure that the correct model was used for the analysis, correlational statistics were conducted to find out whether there were multicollinearity issues.

Correlational Statistics

A correlational statistic of all variables was run to see if there were multi-collinearity issues. The results revealed strong correlations between the variables as shown in table 5. This means that the collinearity matrix was high between the variables. The least correlation was between the Social Environment (SE) and the Socio-economic Status of Parents (SSP) ($r = 0.433$). The highest was between the Socio-economic Status of Parents (SSP) and Female Students' Performance in Mathematics (FSPM) ($r = 0.84$). These values as shown in table 5 below were high enough to affect the fitness of the model (Altmann et al., 2019). The study, therefore, adopted an Ordinary Least Square Regression model as recommended for use by Durmaz et al. (2018) in cases of multicollinearity issues. Table 3 summarises the correlational matrix of the study variables.

Table 3: Correlational Statistics

Variables	SE	GS	SSP	TE	SM	FSPM	MD	STD
SE	1	0.47	0.58**	0.71**	0.55**	0.51**	2.27	0.78
GS	0.64**	1	0.71**	0.65**	0.54**	0.61**	2.86	1.12
SSP	0.433	0.81**	1	0.52**	0.72**	0.84**	3.11	1.21
TE	0.63**	0.74**	0.82**	1	0.55**	0.67**	2.66	0.93
SM	0.57**	0.66**	0.54**	0.51**	1	0.62**	2.72	0.95
FSPM	0.59**	0.60**	0.73**	0.48	0.58**	1	3.12	1.31

Source: Field Data, 2022

KEY: SE = Social Environment, GS = Gender Stereotype, SSP = Socio-economic Status of Parents, TE = Teacher Efficacy, SM = Self-Motivation, FSPM = Female Students' Performance in Mathematics, MD = Mean Deviation, STD = Standard Deviation

The correlational matrix necessitated the choice of an Ordinary Least Square Regression model. This was used to test the dependability of Female Students' Performance in Mathematics (FSPM) on the Social Environment (SE), Gender Stereotype (GS), Socio-economic Status of Parents (SSP), Self-Motivation (SM) and Teacher Efficacy in the Northern Region of Ghana.

The results were as shown in table 4 below:



Table 4: The Standardised Beta Test on the Factors Influencing Female Students' Performance in Mathematics

Variable	Standardised Coefficients	Standard Error	Stand. >t	T	F	[95% Conf. Interval	
						Lower	Upper
SE	2.45	0.12	.283	0	0	1.89	3.23
TE	-4.12	0.99	3.21	-	0	1.56	2.347
SSP	3.03	0.97	.87	9	0	2.22	3.011
SM	5.21	0.61	.11	7	0	1.31	2.44
GS	4.91	0.22	.84	1	0	2.34	3.25

F=0.00, R²=0.91, Significance level $p < 0.05$ Source: Field Data 2022

** Dependent Variable is Female Students' Performance in Mathematics (FSPM)

KEY: SE = Social Environment, GS = Gender Stereotype, SSP = Socio-economic Status of Parents, TE = Teacher Efficacy, SM = Self-Motivation

Thematic analysis was used to examine the qualitative information obtained from interviews about how factors such as the social environment, gender stereotype, socio-economic background of parents, self-motivation and teacher efficacy affect female students' performance in mathematics in the northern region of Ghana. The researcher repeatedly reviewed the transcripts of the data to become comfortable with the material. By underlining, colouring, and creating shorthand labels to explain the contents of text passages, the researcher coded the transcribed data. By using these codes, the researcher was able to quickly summarise the key ideas and recurring meanings in the data. Then, by mixing the codes, themes were created by finding patterns in the resulting codes. Reviewing and mapping these themes against the complete data set was done. A few of the themes were divided into subthemes, and others were blended to provide the themes with more depth and use. The concepts were then given names before being ultimately interpreted. Table 5 displays this information.



Table 5: Qualitative Analysis of Factors Affecting Female Students' Performance in Mathematics in Northern Region of Ghana

Initial Coding	Axial Coding	Main themes
Gender roles Women are different Men are hard Simple tasks Women can do better Men do difficult task Women must not suffer Women cannot do House keeping No need to suffer Poor Very poor Struggling family Pay for extra lessons Attend good basic schools Poor communities Little value for education Academic engagement Need to succeed Future career Desire to compete with the men Career women Perceive need for mathematics Peer motivation Peer pressure Competition Value of education Support for the girl child Encouragement for the girl child Sexual harassment Sexual promiscuity Coercive sex Adolescence anxiety Familiar with it Knows what he or she is doing Master of the subject Confidence levels Ability to break complex problems to simpler ones Extremely good	Women do not need mathematics to perform their roles Men have better arithmetic abilities than women Men are better positioned to carry out complex task Women do not need to suffer Female students from poor homes attend poor quality schools Poor parents are unable to get their wards extra mathematics tuition at home Poor parents do not send their wards to early education programmes Motivated students put more efforts in learning mathematics Female students who are career oriented would put more energies in studying mathematics Female students who perceive they will need mathematics in their future careers will be more motivated to study and pass mathematics very well Female students who find themselves among other girls who are career oriented will perform better in mathematics Female students who are not sexually exploited will perform better in mathematics Female students who receive support from teachers and peers will perform better in mathematics Female students who receive social support from their teachers and parents during the adolescent crises will be more focus and perform better in mathematics Female students understand better when teachers demonstrate a good understanding and mastery of content of the subject mathematics Female students develop interest in mathematics when the teacher appears to be good at the subject Female students understand better when the teacher delivers with self-confidence and much efficacy	Females are stereotyped as weak and not fit for complex tasks like mathematics and its related courses Socio-economic status of parents affects the quality of education they give to their female children and their subsequent performance at higher levels Self-motivation affects female students' performance in mathematics The social environment of female students affects their performance in mathematics Teacher efficacy affects female students' performance in mathematics

Source: Field Data, 2022

As indicated in table 5, the F statistic was statistically significant at 0.000 which means that the model was fit for the analysis. R^2 was 0.91 indicating that the variables combined to explain 91% of the total variability in the performance of female students in mathematics. At a confidence level of 95%, gender stereotypes, teacher efficacy, socio-economic status of parents, self-motivation, and social environment were found to be closely associated with



female students' performance in mathematics. Gender Stereotype (GS) had a standardised coefficient of 4.91 and was significant at 0.000 (Coe = 4.91, $p = 0.000$) indicating that any change in gender stereotypes on female students' performance in mathematics will lead to a 49.1% change in the performance of female students in the subject. The Social Environment (SE) female students find themselves had a standardized coefficient of 2.45 and was significant at 0.02 (Coe = 2.45, $p = 0.000$). This means that a single variation in the social environment of female students among the Senior High Schools in the Northern Region of Ghana will lead to a 24.5% change in the performance of female students in mathematics. Teacher Efficacy (TE) was significant at 0.000 and had a negative standardised coefficient of the value of 4.12 (Coe = -4.12, $p = 0.000$) indicating that for any single decrease in the efficacy of mathematics teachers at Senior High Schools in Northern Ghana, there will be a 41.2% decrease in female students' performance in mathematics. The socio-economic Status of Parents (SSP) was found to be significant in affecting female students' performance in mathematics at 0.000 and with a standardised coefficient value of 3.03 (Coe = 3.03, $p = 0.000$). This also means that, should there be a single variation in the socio-economic status of parents, there will be a corresponding 30.3% change in the performance of the female student in mathematics. Female students' self-motivation to study mathematics was equally found to be statistically significant in predicting female students' performance in mathematics as it had a standardised coefficient value of 5.21 and a p -value of 0.01 (Coe = 5.21, $p = 0.01$) indicating that at any single variation in the self-motivation of female students to study mathematics, there will be a 52.1% change in the performance of female students in mathematics.

The qualitative data that was collected around these constructs indicated similar findings as contained in table 7, where the thematic analysis identified factors affecting female students' performance in mathematics to be Gender Stereotypes, Teacher Efficacy, Self-Motivation by the female students to study mathematics, Socio-economic Status of the Parents and the Social Environment in which the female students find themselves. One of the key informants explained the phenomenon as this:

“In a setting where culture prescribes roles for men and women and women are supposed to be doing less herculean tasks, mathematics which many students perceive as a difficult subject is seen by many female students as a male affair and so they remain apathetic to the teaching and learning of mathematics”

Another also explained:

“From my experience, several factors combine to affect students' mathematics performance and in terms of the girl child, it is even more complicated. Apart from the teacher efficacy, gender stereotypes, and parents' socio-economic backgrounds that generally affect students' performance in mathematics, female students are further affected by the cultural practices and beliefs held about women in their localities. Many still believe that a woman is supposed to be married and be taken care of by a man, give birth and take care of the house when the husband leaves for work. These tasks do not need complex mathematics and so female students from such cultures and with such beliefs may express little interest in mathematics”

One of the key informants further explained the phenomenon as this:

“when students perceive that they may need to pass a particular subject to transition to the next level, they will be more motivated than when they perceive they may not need the subject to



transition or even to be successful in their chosen careers. Motivation, is a key determinant of performance levels”

According to the findings of both qualitative and quantitative evaluations, the social environment, gender stereotype, teacher efficacy, self-motivation, and socio-economic status of parents all have an impact on students' mathematical performance. Below are the detailed discussions.

DISCUSSION

Discussions for the various objectives were done after the analysis.

The Social Environment and Female Students' Performance in Mathematics

The study found that the social environment of female students was significant in determining their performance in mathematics. This means that the people that female students interact with affect their levels of performance in mathematics. This is because when female students do not see women engineers, constructors, technicians, masons, architects or even sound technicians among the people they interact with, they are less motivated to venture into those areas. They pick interest in what the people they interact with value most. This will mean that the female students in a society where marriage and childbearing are prioritised over higher education will also be keener on getting married and giving birth than they will be in taking up courses that will earn them professions such as astronauts, engineers, medical doctors or industrial technicians. These are the professions that require that one acquires arithmetic or mathematical skills. Female students who find themselves in societies where other women are in these professions will be motivated to study and also be like them but those who find themselves in societies where such careers are not valued among women and are not also common among women, will be less motivated to study mathematics and this will translate into low performance in mathematics. This is consistent with the findings of Tesfa (2017) when they investigated the factors that inform female students' decisions to choose certain courses at the University. Silomba (2015) also found that female students who came from villages where education was less valued performed poorer in mathematics than those who came from urban and peri-urban areas where more women were educated and educated women were highly valued.

Self-Motivation and Female Students' Performance in Mathematics

The study found that self-motivation was a strong determining factor in the performance levels of female students in mathematics. This is consistent with the Expectancy Value Theory. Students will be self-motivated and put in more effort if they feel the results of their efforts will be positive and valuable. When students are self-motivated, they become more academically engaged and their performances keep improving over time. Despite the cultural inhibitions and gender stereotypes that have contributed to creating the impression that women do not need higher education or do not need to venture into certain professions, some women are beginning to realise that they can fit everywhere provided the structures that inhibit their progress and competencies are removed. This translates into self-motivation to put in efforts in learning subjects that they will need to gain admission into those courses that were, hitherto, viewed as male professions. This motivation is making women improve their performances in



science and maths-related courses. This finding is consistent with the finding of Zakharov et al. (2016) when they investigated the factors of poor female performance in science subjects and found that self-motivation was closely associated with female students' performance in science. Obi and Obi (2019) also found in Zambia that females who were self-motivated performed better in quantitative courses than those who were not self-motivated.

Gender Stereotypes and Female students' Performance in Mathematics

The study found that gender stereotype was one of the main factors affecting female students' performance in mathematics in Northern Ghana. This means that the conception of womanhood, what a woman should do, what tasks or professions are fit or not fit for women and the nature of tasks women are to perform inform female students about where and in what course to channel their energies. Northern Region is still largely patriarchal and gender role differentiation is still very pronounced even now. Female students are made to believe that higher education and especially complex courses like the physical sciences and technical courses should be left for men. Women just need a little formal education that may be just enough to get them a less demanding job so that they can have time to cater for their children, and their husbands and do housekeeping. This means that they do not need to bother themselves much with subjects that may be exclusive requirements for the physical sciences. This makes them reluctant about choosing mathematics-related courses and even when they do, they are negligent about their performances. These translate into poor female performance in mathematics. This finding corroborates that of Thakare et al. (2016) when they found that female students in North-Western Nigeria cared less about their academic performance because they were made to believe that higher education was not necessary for women. Silomba (2015) also made similar findings in Congo when they investigated differentiated performances of male and female students and found that gender stereotypes intersected with high youth unemployment to inform apathy in educational attainment by female students. This also resonates with the Expectancy Value Theory which was adopted as an analytical framework for this study as it explains that people will put more effort into performing tasks only when they perceive that the efforts will bring positive results at the end of the day. If girls believe that mathematics will yield value for them at end of their studies, they will put more effort into passing the subject.

The Socio-economic Status of Parents and their Female Wards' Performance in Mathematics

The study further identified the socio-economic status of parents of female students as a determining factor of female students' performance in mathematics. This means that female students who come from poor families are less likely to perform better in mathematics than those who come from well-to-do families. This is because those who are economically well off may hire a mathematics teacher for their girl child, send them to early childhood education programmes, afford to pay for extra tuition, buy all the needed reference materials and provide the girl child with all her basic needs thereby making her concentrate on her academic work leading to improved performance. The girl from a poor home, however, apart from not getting an opportunity to have a private teacher or attend extra tuition, may be distracted because her basic needs are not met. In some cases, she may be forced by economic conditions to fall into the hands of sex predators which can only further distract her attention from learning subjects that are attention demanding like mathematics. This will mean low performance in such subjects. This is consistent with the findings of Oviawe (2016) when they investigated the



factors that intersect to affect students' academic performance in Austria. Robert and Owan (2019) also investigated the causes of poor academic performance by Senior High School female students in Columbus and found that the socioeconomic background of students was statistically significant in explaining their performances.

Teacher Efficacy and the Mathematics Performance of Female Students

Teacher Efficacy was also found by this study to be a significant determinant of female students' performance in mathematics. This means that the extent to which the teacher demonstrates content mastery with confidence and precision and the extent to which the teacher is able to explain the methods and steps involved in solving mathematical equations affect female students' performance in the subject. This may affect students of all genders equally but because society has always discriminated against women, they have come to see themselves as inferior to men and the extent to which they may ask questions in class for further classification should the teacher sound vague is limited compared to the boys. The culture also makes it difficult for female students to engage mathematics teachers who are mostly men outside the formal lesson period. These combine to affect female students' performance in mathematics. This is consistent with the findings of Mazana et al. (2020) and Ndalichako (2014) who found in Nairobi and Lagos respectively that teacher efficacy is crucial in determining students' academic performance. Musili (2015) also found that teachers' competence translates into students' academic performance

Implication to Research and Practice

While researchers have adequately investigated the factors that affect students' performance in mathematics, the extent to which these factors specifically affect the female gender in a unique way within a patriarchal system like the Northern Region, to the best knowledge of the researchers, has received less academic attention. This study contributed to the existing literature on gender studies by assessing the specific factors that affect female students' performance in mathematics.

CONCLUSION

Female students' performances in mathematics in the Northern Region as indicated in their terminal and WASSCE examinations have been consistently poor. While in some schools the performances were poor across gender groups, at each instance, men performed better than girls. This study found that such discrepancies are informed by gender stereotypes where women are assigned fixed roles in societies and so do not see the need to put much effort into subjects that may not be relevant to their assigned roles.

The male-dominated classroom is sometimes not a positive environment for the girl child. There are few female mathematics teachers; the number of boys in the classroom is also more than that of girls. This male dominance could be intimidating and also could prevent the females from sharing their personal women-related difficulties which could be preventing them from engaging actively in academic activities.

Apart from these, there are other factors that place the girl child at a disadvantage; girls are expected to get married before their eighteenth birthday as prescribed by their religion and



culture, and girls are supposed to be more concerned about childbirth and home keeping than they should be about their academic performances. Girls would have to make the dishes, sweep the compound, and prepare their younger ones for school before setting out for school while their male counterparts are excluded from doing any of these. After school hours, the girls are expected to assist in cooking the evening meals. If they are lucky to be exempted, they may be sent to do shopping or to make some sales before they retire for the evening. These housekeeping activities impede their time to engage in academic activities. This translates to low performances, particularly in subjects that require absolute attention and concentration like mathematics.

FUTURE RESEARCH

The study found that gender stereotypes strongly affect female students' performance in mathematics, it is therefore recommended that the Ministry of Culture and Tourism will work closely with the Northern Regional House of Chiefs to modernise and streamline certain practices and beliefs that tend to hamper the academic engagement and general development of the girl child in Northern Region.

The study also found that the social environment in which the female students find themselves has low numbers of female mathematics teachers, which affects the performance of female students in the subject in the Northern Region. It is therefore recommended that the Ministry of Education, through the Ghana Education Service may identify, train and deploy female mathematics teachers across schools in the Northern Region so as to increase the presence of female teachers who teach the subject. This will address the male dominance in the classroom and also enable female students to freely express themselves on personal women-related issues that tend to affect their levels of academic engagement.

The study further found that teacher efficacy affects female students' performance in mathematics because the extent to which the teacher demonstrates content mastery with confidence and precision and the extent to which the teacher is able to explain the methods and steps involved in solving mathematical equations affect female students' performance in the subject. This may affect students of all genders equally but because society has always discriminated against women, they have come to see themselves as inferior to men and the extent to which they may ask questions in class for further classification should the teacher sound vague is limited compared to the boys. It is recommended that the Ministry of Education and the Ghana Education Service will work together to ensure that qualified and trained mathematics teachers, that are needed for the teaching and learning of mathematics are provided in adequate numbers to all Senior High Schools in the Northern Region.

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