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GENDER DIFFERENCE IN MATHEMATICS PERFORMANCE AMONGST SENIOR HIGH SCHOOL STUDENTS IN THE UPPER WEST REGION (UWR), GHANA

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ABSTRACT

Gender differences in mathematics performance have long been a concern for parents and policymakers in Ghana, particularly in the Upper West Region (UWR). This study examined these differences among high school students using an explanatory sequential mixed-methods design. Stratified and simple random sampling techniques were used to select 350 participants from four different Senior High Schools (SHS) within the UWR for the survey, while four teachers were selected using purposive sampling. A mathematics test, questionnaires, and interviews were the primary data collection tools. Quantitative data were analyzed using descriptive and inferential statistics, while qualitative data were analyzed thematically. The results revealed no statistically significant difference between female and male mathematics performance [$t(348) = -1.44$, $p = .153$, $p > .05$]. Additionally, factors such as societal expectations, stereotype threat, cultural norms, learning environment, and teaching methods were identified as potentially contributing to the differences in female and male mathematics performance. It was recommended that an inclusive learning environment, teaching practices, and curriculum design be created to allow students, regardless of gender, to participate effectively in mathematics classes.

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INTRODUCTION

The rapid advancement of technology has led to the emergence of novel areas of research and analytical tools, such as Big Data, artificial intelligence, engineering modeling, software architecture, and more. As a result, there is a greater need than ever for professionals, both male and female, who possess the strong mathematical background required for these positions (Belloum et al., 2019). Nonetheless, women are still overrepresented in lower-paying jobs and underrepresented in these professional roles (Adams et al., 2019). Understanding and addressing gender differences in arithmetic ability is essential for establishing equitable opportunities and fostering educational excellence for all students in Ghana, a West African nation renowned for its commitment to education (Muhawenimana & Mutarutinya, 2023).

Gender disparities in mathematics performance have garnered significant attention and concern in educational research worldwide (Musimenta, Adyanga, & Sekiwu, 2020). Battey (2013) argued that gender remains a divisive characteristic for researchers, which impacts mathematics education. Identifying the causes of these discrepancies is difficult because cognitive, social, and cultural factors can influence an individual's development (Pina et al., 2021). As a result, it is challenging to directly link gender inequality in the workforce to childhood mathematical ability. However, if this gender disparity were innate, it might manifest during childhood, making it crucial to determine whether this is the case and take appropriate action to prevent future discrimination against women (Pina et al., 2021). Gender gaps should eventually decrease as society becomes more progressive and inclusive, supporting the theory that sociocultural influences impact mathematical ability (Lindberg et al., 2010).

Empirical evidence from studies examining the impact of socio-cultural factors, informed by socio-cultural theory, on gender disparities in mathematical ability has been presented. Research conducted in various countries (Cvencek et al., 2011; Lindberg et al., 2010) has shown that countries with higher levels of gender equality and lower levels of gender stereotyping have smaller gender gaps in mathematics achievement. This aligns with the idea that gender disparities in mathematics are primarily shaped by socio-cultural factors, such as stereotype threat, social norms, and beliefs (Ajai & Imoko, 2015; Master & Meltzoff, 2020). Parents' beliefs about gender differences in math ability influence their children's achievement and attitudes toward mathematics. Children of parents who endorsed gender

stereotypes performed worse and had lower self-concepts in mathematics compared to children of parents with more egalitarian beliefs (Gunderson et al., 2012; Hyde et al. ,1990).

The expectations and values that learners attach to mathematics influence their performance. Pupils are more likely to select math-related activities and perform better academically if they have stronger expectation beliefs and task values (Wigfield & Eccles, 2000). According to Else-Quest et al. (2010), girls and boys did not significantly differ in their mathematics achievement when expectation beliefs and task values were considered in their investigation of gender differences in mathematics performance. This suggests that, rather than innate cognitive abilities, gender variations in mathematics performance can at least partially be related to differences in motivational factors. Expectancy beliefs, task values, and academic achievement were found to be positively correlated in Usher and Pajares's (2008) meta-analysis across several domains. This suggests that these motivational elements are important for students' academic success.

According to studies conducted by Stoet and Geary (2018) on gender performance in mathematics across 69 nations, men outperformed women on average. However, the study also showed that gender differences varied greatly between nations. They proposed that these differences were influenced by educational and cultural factors. In Ghana, male students in senior high schools outperform female students in mathematics, according to a study by Anokye-Poku and Ampadu (2020). They suggested that policies should be developed to reduce the effects of factors such as gender stereotypes, societal expectations, and issues with self-confidence that contribute to the performance gap between men and women in mathematics.

The gender disparities in mathematical proficiency among Ghanaian senior high school students were examined by Asante (2010). The study explored the factors leading to significant disparities in performance between male and female students in mathematics. The results show that male students outperform female students in mathematics, indicating a considerable gender disparity in achievement. Asante believed that this inequality is caused by cultural and societal factors, including gender stereotypes and the lack of opportunities available to girls. A comparative study of male and female distance learners' mathematics achievement by Armah, Akayuure, and Armah (2021) revealed statistically significant differences in achievement between male and female distance learners in each of the three

years, with males attaining higher grades than their female counterparts. The authors recommended that teacher education colleges offering distance programs should take note of the gender disparity in mathematics achievement and implement policies to encourage female students to continue with the subject.

While several studies indicate that men outperform women in mathematics, a study conducted in the Cape Coast Metropolis of Ghana in 2023 by Efa and Frimpong on the impact of gender on senior high school students' performance and perception of Core Mathematics found a significant gender difference in students' mathematical performance, favoring females. A notable difference in the performance of males and females in mathematics was also found in research by Tetteh, Wilmot, and Ashong (2018), which examined gender differences in mathematics performance among pre-service teachers in the Brong-Ahafo region of Ghana, with females scoring higher.

A meta-analysis of a study by Lindberg et al. (2010) on gender and performance in mathematics revealed no gender disparities and supported the idea that men and women perform similarly in the subject. The study suggested that any gender differences could be attributable to unrelated factors. They concluded that, to combat misconceptions about supposed female inferiority in math, it is imperative that these findings be widely shared (Lindberg et al., 2010). Male and female students did not significantly differ in academic performance, according to Ajai and Imoko's (2015) study on gender differences in mathematics achievement and retention scores in Nigeria. This suggests that male and female students are capable of competing and working together in mathematics. Furthermore, this result demonstrated that performance is determined by orientation rather than gender. These findings have been corroborated by more recent research (Kersey et al., 2018; Scheiber et al., 2015; Voyer & Voyer, 2014), with some studies limiting the variations to a small number of tasks (Hutchison et al., 2019).

The issue of gender differences in mathematics performance has been a major concern for parents and policymakers in Ghana. Although studies conducted by researchers in other parts of Ghana (Armah et al., 2021; Efa & Frimpong, 2023; Tetteh, Wilmot, & Ashong, 2018) demonstrated that gender disparities exist in mathematics performance, there is not enough evidence to show the disparity between genders in senior high school (SHS) mathematics performance in the Upper West Region. The region is a patriarchal society dominated by rural

settlements, with agriculture being the major economic activity. Males' dominance in education over females in the region, particularly in mathematics, has raised concerns over the years. Unfortunately, there is not enough empirical evidence to support this notion. This study, therefore, sought to investigate gender differences in mathematics performance among SHS students in the Upper West Region. The study examined how male and female senior high school students performed differently in mathematics and the potential factors that contribute to this variation. Teachers' opinions on possible causes affecting these discrepancies were also investigated in this study.

METHOD

The study used an explanatory-sequential mixed-methods approach, combining quantitative data collection and analysis with qualitative insights from teachers. Creswell and Creswell (2018) indicated that this method involves collecting and analyzing quantitative data first, followed by qualitative data. This design allows for a comprehensive examination of gender differences in mathematics performance and provides a deeper understanding of the factors contributing to these disparities (Creswell & Creswell, 2018).

The population refers to the entire group of individuals with the same characteristics as the study sample (Yarkwah & Donkor, 2019). A target population, according to Creswell and Creswell (2018), is any group of individuals who have the observable traits that a researcher is interested in. In addition to the heads of the mathematics and ICT departments from various schools in the Upper West Region, the target population included all form-two senior high school students.

First, four senior high schools were chosen from among the many schools in the region using stratified sampling. The Ghana Education Service has classified senior high schools into various strata (A, B, C, and D) based on academic performance, population, and available infrastructure. A simple random sampling method was used to select the four schools that participated in the study from each stratum. The second-year students who took part in the study were also chosen through a simple random sampling procedure. Since the Heads of the Mathematics and ICT Departments of the four chosen schools had in-depth classroom experience in mathematics, they were purposefully selected for the interview. A total of 354 students and 4 teachers from the target population were selected, making up the sample size for the study.

A questionnaire, mathematics test, and interview were employed to collect data from the 350 students and the four teachers. The standardized mathematics test, constructed based on Bloom (1956) taxonomy, was administered to all student participants. The test was designed to assess various math skills and concepts covered in aspects of algebra and geometry, and was intended to be unbiased toward any gender. A questionnaire, based on a five-point Likert scale (1 – strongly disagree [SD], 2 – disagree [D], 3 – neutral [N], 4 – agree [A], and 5 – strongly agree [SA]), was administered to all student participants. The questionnaire items were constructed to explore their perspectives on gender differences in math performance and potential factors contributing to the disparities.

Semi-structured interviews were conducted with a subset of teachers to gain in-depth insights into their perspectives on potential factors contributing to gender differences in mathematics performance. Open-ended questions were given to the selected teachers to respond to and express their views. To test the reliability of the items, a pilot study was conducted, which yielded a Cronbach's alpha value of 0.75, indicating high reliability. The test items were exposed to experts in mathematics and colleague researchers to gather their input in order to check the content and face validity.

The researcher first sought permission from the headmasters of the selected schools. The researcher then met with the teachers and students through the assistance of the various Heads of the Mathematics and ICT Departments to brief them on the aim of the study and what was expected of them. The researcher established a mutual understanding with both teachers and students and assured them that their identities and responses would be kept anonymous and confidential. Thereafter, the researcher, along with some teachers, administered the questionnaires to the students. The completed questionnaires were collected as soon as they were completed by the respondents, ensuring a 100% response rate. After the questionnaires were collected, the mathematics test was administered for 1 hour and 15 minutes. The mathematics test items were constructed by the researcher based on the approved Ghana Education Service syllabus.

The researcher, personally, conducted the interview sessions with the Heads of Mathematics and ICT Departments of the selected schools to help explain the data obtained in the quantitative stage. After each interview, the researcher expressed appreciation to the interviewee for their cooperation and participation.

After collecting, marking, and scoring the data from the mathematics test, the scores were coded based on the West African Examination Council (2023) grading system, as shown in Table 1. The grades ranged from A1 to F9 but were coded into numerical values.

Table 1. Code of Grading System

Marks	80-100	75-79	70-74	65-69	60-64	50-59	45-49	40-44	0-39
Grades	A1	B2	B3	C4	C5	C6	D7	E8	F9
Code	1	2	3	4	5	6	7	8	9

Quantitative data from the mathematics test and survey were analyzed using descriptive statistics (means, standard deviations, frequency, and percentages), while inferential statistics (t-test) were employed to analyze female and male differences in mathematics performance using SPSS software. Qualitative data from the interviews with teachers were analyzed using thematic analysis. The responses from the interviews conducted with the teachers were coded and categorized to identify recurring themes related to female and male differences in mathematics performance and teachers' perspectives on factors contributing to differences in female and male mathematics performance.

RESULT AND DISCUSSION

This section presents the results and discussion concerning the purpose and the research questions formulated for the study. The analysis of the data is presented in two sub-sections. The first section presents the results of the respondents according to the research questions and hypotheses formulated, while the second section discusses the results of the study.

Demographic Information of the Respondents

To explore the gender and ages of the participants, the questionnaire included items that sought the participants' biodata. Descriptive statistics (frequency and percentage) were applied to the respondents' responses, as shown in Table 2. The data from Table 2 indicate that out of the 350 respondents, 46.86% were female and 53.14% were male, with the majority of them within the age range of 17–20.

Table 2. Descriptive Statistics of Demographic Information of Participants

Age Range	Gender		
	Female (%)	Male (%)	Total (%)
12 – 16	7(2)	9(2.57)	16(4.57)
17 – 20	131(37.43)	139(39.71)	270(77.14)
21 and above	26(7.43)	38(10.86)	64(18.29)
Total	164(46.86)	186(53.14)	350(100)

Gender Differences in Mathematics Performance Amongst SHS Students in the UWR.

The results in Table 3 show the performance of female and male students in the standardized mathematics test.

Table 3. Female and Male Performance in the Mathematics Test

Gender	N	Mean	SD	t-value	Df	Sig (2-tail)
Females	164	6.87	3.43	-1.44	98	0.15
Males	186	5.95	2.59			

The results in Table 3 indicate that the mean score for female students was (M=6.87, SD=3.43) while the mean score for male students was (M=5.59, SD=2.59). However, the results in Table 3 further revealed that there was no statistically significant difference ($p > .05$) between female and male students' performance in the mathematics test, $t(348)=-1.44$, $p=.153$. These results reaffirm studies suggesting that both female and male mathematics performance is similar (Ajai & Imoko, 2015; Kersey et al., 2018; Lindberg et al., 2010). However, the results did not align with literature suggesting that females perform better than males in mathematics (Abubakar, 2010; Efa & Frimpong 2023; Erdoğan, Baloğlu, & Kesici, 2011; Tetteh et al., 2018) or other studies suggesting that males outperform females in mathematics (Anokye-Poku &Ampadu, 2020; Asante, 2010; Armah et al., 2021; Stoet & Geary, 2018).

Based on interviews with teachers regarding their views on female and male mathematics performance, the teachers recognized that males' performance in mathematics is better than females'. However, they revealed that the disparity gap is becoming narrower as attention is being focused on issues of gender equity and social inclusion. This is reflected in the conversation between the researcher and the teachers:

Researcher: *What are your observations regarding female and male performance in mathematics in your school?*

Teacher A: *"Male comprehension of mathematical concepts is more thorough than female comprehension. Nonetheless, as a result of students' subpar BECE performance, both male and female math performance at SHS is declining. In some classes, females dominate in mathematics than males."*

Teacher B: *"Males perform better than females, especially in science and mathematics. In recent times, females are picking up and beginning to be more involved in mathematics and science related activities as evidence in the National Science and Mathematics Quiz (NSMQ)."*

Teacher C: *"Mostly male students love mathematics than females and therefore they perform better than female students. It is worth noting that many students (males and females) do not*

generally pay particular attention to their studies, and therefore perform poorly in mathematics."

Teacher D: *"Both genders are not serious with learning, and they generally perform poorly in mathematics. There are some instances where female students do better than male students in a class and vice versa."*

Although the independent t-test did not yield statistically significant results, the qualitative insights gained through interviews provided valuable context and shed light on why the disparity in male and female mathematics performance is not significant.

Contributing Factors to Gender Differences in Mathematics Performance Amongst SHS Students in the UWR.

This research question was developed to explore the perceived factors that contribute to female and male mathematics performance. Based on the five-point Likert scale (see the Method section), the means were interpreted as follows: SD in the point range of 1 – 1.80, D 1.81 – 2.60, N 2.61 – 3.40, A 3.41 – 4.20, and SA 4.21 – 5.00 (Pimentel, 2010). Table 4 displays the results of applying descriptive statistics to the participants' responses.

Table 4. Factors that Contribute to Females and Males' Mathematics Performance

Statements	Responses							
	SD(%)	D(%)	N(%)	A(%)	SA(%)	M	STD	I
Mathematics teachers' different expectations to one gender over the other in their classes can contribute to females and males' performance in mathematics.	68(19.4)	81(23.1)	27(7.7)	82(23.4)	92(26.3)	3.41	1.51	A
My math teacher provides more attention or support to one gender over the other.	86(24.6)	78(21.4)	18(5.1)	111(31.7)	60(17.1)	2.95	1.48	N
I experience anxiety specifically related to gender whilst studying or performing mathematics.	31(8.9)	57(16.3)	22(6.3)	153(43.7)	87(24.9)	3.59	1.26	A
Access to math-related resources and support based on gender can have impact on females and males' performance in mathematics.	36(10.3)	43(12.3)	10(2.9)	144(41.1)	117(33.4)	3.75	1.31	A
The classroom environment can have a significant impact on gender performance in mathematics.	36(10.3)	72(20.6)	35(10.0)	109(31.1)	98(28.0)	3.46	1.36	A
Parental expectations and beliefs about gender and math ability can shape children's attitudes and performance.	39(11.1)	64(18.3)	30(8.6)	130(37.1)	87(24.9)	3.46	1.34	A
The underrepresentation of women in math-related fields and careers can impact their aspirations and performance in mathematics.	47(13.4)	58(16.6)	48(13.7)	122(34.9)	75(21.4)	3.34	1.34	N
Cultural and societal beliefs about gender roles and expectations can influence students' attitudes and opportunities in mathematics.	40(11.5)	43(12.3)	24(6.9)	120(34.3)	123(35.1)	3.47	3.36	A

Note: SD= Strongly Disagree; D= Disagree N= Neutral A= Agree; SA= Strongly Agree; M= Mean; STD= Standard Deviation; I= Interpretation.

It is evident from Table 4 that, apart from the statements "My math teacher provides more attention or support to one gender over the other" (M = 2.95) and "The underrepresentation of women in math-related fields and careers can impact their aspirations and performance in mathematics" (M = 3.34), where a greater percentage of the respondents remained neutral on factors that influence gender differences in mathematics performance, the

majority of respondents largely agreed that the rest of the statements are potential factors contributing to differences in female and male mathematics performance, with mean values ranging from 3.41 to 4.20.

On the factors contributing to female and male differences in mathematics performance, the teachers interviewed generally identified various factors that may contribute to gender differences in mathematics performance. Factors such as societal expectations, stereotype threat, learning environment, teaching methods, and cultural norms were revealed as some of the factors contributing to the difference in mathematics performance between females and males, as indicated in the conversation below.

Researcher: *What factors contribute to the difference in female and male performance in mathematics in your school*.

Teacher A: *"In African societies, traditional definition of male and female duties at home makes many to perceive the best place for the female is the kitchen and not school. Females generally are faced with a lot of challenges such as financial problems, physical and sexual harassment than their male counterparts. Besides males are psychologically stable in learning more than females are."*
Teacher B: *"Fear, inadequate practice and study influence male and female mathematics performance. Lack of quality mathematics teachers, and genetical roles for the girls from basic school level where they don't get much time to study as compared to boys follow them to the SHS."*
Teacher C: *"The love for the subject; some are having the perception that mathematics is difficult. Some female students think that is only males who can perform when it comes to mathematics."*
Teacher D: *"Societal and cultural expectations, including traditional gender roles, may influence students' academic performance and career choices. Family socioeconomic status, parental involvement in education, and family structures can play a significant role in female students' academic performance."*

Findings from both the quantitative data from students and the qualitative data from teachers on potential factors contributing to female and male performance in mathematics indicated societal expectations, stereotype threat, learning environment, teaching methods, and cultural norms as variables contributing to the potential difference in mathematics performance. These findings were consistent with those of Anokye-Poku & Ampadu (2020) and Stoet & Geary (2018).

In this explanatory sequential mixed-methods study, the independent t-test did not reveal a statistically significant difference in mathematics performance between female and male students. However, the qualitative insights gained through interviews provided valuable

context and highlighted potential factors contributing to the gender differences in mathematics performance. These findings underscore the importance of considering multiple dimensions in understanding and addressing gender disparities in mathematics education.

Based on the findings of this study on female and male performance among senior high school students in the Upper West Region, Ghana, the study recommends that an all-inclusive learning environment, teaching practices, and curriculum design should be created to allow students, regardless of their gender, to participate effectively in mathematics classes. Additionally, a guidance and counseling mechanism should be established to eradicate the negative effects of social expectations, stereotype threats, and cultural norms against any particular gender.

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