The Influence of Gender Differences in Mathematics Anxiety on Mathematics Performance

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ABSTRACT

Mathematics anxiety is a recurrent issue that has profound effect on students, particularly females. This study is aimed at exploring the effect of gender differences in mathematics anxiety on mathematics performance among students in some selected Senior High Schools (SHS) in Ghana. A cross-sectional survey was employed as the research design for the study. A total of 370 SHS students (185 males and 185 females) were sampled through Stratified sampling technique. An Abbreviated Mathematics Anxiety rating scale (AMAS) and Mathematics Achievement Test (MAT) were adapted to measure student's anxiety levels and mathematics performance respectively. Means and standard deviations, percentages, independent sample t-test and Pearson correlation coefficient were employed in the data analysis. The results showed a notable gender-based variations (high, moderate and low) with both males and females exhibiting high prevalence of moderate levels in mathematics anxiety. Further, the study found disparities in the performance of the students in the MAT conducted with male students exhibiting a higher level of performance in comparison with the female counterparts. Finally, a moderate negative relationship between students' mathematics anxiety level and their mathematics performance was found. Thus, the higher the levels of mathematics anxiety, the lower the mathematics performance and vice versa. Therefore, efforts to reduce mathematics anxiety should be directed towards both males and females, with specific attention given to addressing the unique experiences of female. Implications for practice, policy and further research are discussed.

INTRODUCTION

The importance of mathematics as a taught course in educational establishment (basic, high, college and tertiary) is a critical tool for social advancement especially in the disciplines of technology, medicine engineering and philosophy (Asomah et al., 2024a). Hence, the introduction of mathematics as a compulsory course of study in pre-tertiary educational institutions worldwide of which Ghana is not in exempt (Abreh et al., 2018). This is because, the teaching and learning of mathematics is pivotal in the mediation of the individual's capacity to think critically, concisely, resourcefully and knowledgeably (Tella, 2008). Yet, the

learning of mathematics purposed to advance holistic development of students has been characterized by loads of factors (Asomah et al., 2023a).

One of such factors is mathematics anxiety which authors argue has devastating effect on students' ability to learn mathematics especially at the high school level (Kucian et al., 2018). Anxieties in mathematics is considered a dimension of an attitude to mathematics. As such many students cannot comprehend why they experience anxieties in mathematics (Asomah et al., 2018). This could be inferred from the varying definitions that have been ascribed to mathematics anxiety. For instance, Ashcraft, (2002) defined mathematics anxiety as the edginess that ascends when learners are confronted with tasks in mathematics. Further, Ridner et al., (2015) attributed the phenomenon of mathematics anxiety to the negative experiences from a student's mathematics class. Consequently, tests given under time-pressure and the fear of being embarrassed in front of the class were among the conditions that contribute to nervousness in mathematics (Mammarella, et al, 2018).

In the Ghanaian context, mathematics anxiety has been hypothesized predominantly among other factors as the bane of students' abysmal performance especially at SHS (Chief Examiner's Report, West African Examination Council [WAEC], 2021; 2022; 2023). Nonetheless, literature on anxiety is limited especially, in the area of mathematics at the SHS level. Although, elsewhere several studies on mathematics anxiety and student's academic performance (Eden, Heine & Jacobs, 2013; Dowker, Sarkar, & Looi 2016; Devine, Hill, Carey & Szucs 2018; Casad, Hale, & Wachs 2015) have been conducted. Not much attention has been paid to SHS mathematics students in the Ghana. This, notwithstanding, priority in studies related to Ghanaian mathematics education are pivoted on diverse pedagogical approaches (e.g., Agyei et al., 2023; Asomah et al., 2023a), student's attitudes and perceptions (Asomah et al., 2018) and technological integration into the mathematics classroom context (Agyei et al., 2023; Asomah et al., 2024). It is therefore worthy to note that, the anxiety levels of students in the Ghanaian mathematics classroom context, at the SHS level remains least studied in view of their abysmal performance in mathematics at the WAEC examinations (a body with oversight responsibility for mathematics examination at the pre-tertiary level in West Africa) (WAEC, 2023). Hence, the need for the conduct of the current study. This is because in the mathematics classroom context, students experience anxiety especially during examination, recitation and grade distribution (Ferguson et al., 2015).

While gender is linked to anxieties and performance in mathematics (Bieg et al., 2015), its impact on mathematics accomplishment especially as the SHS level in Ghana is yet to be explored to the fullest. To this end, the current study sought to explore the influence of gender differences in mathematics anxiety on students' performance in mathematics at the SHS level in Ghana.

The context of the study

Despite the Ghanaian government's efforts to surge access to institutions of learning and advance quality outcomes, a persistent gender gap exists in the performance of mathematics (Ghanaian Ministry of Education [MOE], 2022). It has been observed that female students consistently underperform in mathematics compared to their male counterparts (Smith et al., 2018). This trend has been linked to mathematics anxiety, which is known to negatively affect students' performance, particularly in examinations (Jones & Johnson, 2016). However, there is paucity n research on the connection between anxiety, gender, and performance among Ghanaian mathematics students (Doe & Johnson, 2020). Research shows that mathematics anxiety is one of the most prevalent forms of academic anxiety and that it affects both genders. Lamb et al. (2017), revealed that the tenseness associated with mathematics is always higher in females in comparison with male students. This was acknowledged by Hembree (1990) in his breakdown of the 186 research papers linked to gender related accomplishments in mathematics.

Other research studies have also indicated that mathematics anxiety impacts academic performance negatively. For example, Beilock and Carr (2005) showed that the higher a student's mathematics anxiety

level, the lower their performance on standardized mathematics tests. Moreover, studies have shown that anxiety in mathematics significantly predicts academic achievement in mathematics (Ma & Xu, 2004; Alkhudairi, 2016). From the foregoing, it is vital that efforts are made to eliminate tendencies that promote the reluctance on the part of students to study mathematics, since its pivotal in the individual's quest to ascend the academic ladder to the tertiary level. As such, the future is closed to both male and females who are incapacitated mathematically. In Ghana, it is a prerequisite for male and females who seek to gain admission into the tertiary institutions to obtain a pass (A1-C6) in mathematics together with some prescribed courses (Ghana Tertiary Education Commission [GTEC], 2024). In 2022, 30.09% of the SHS final year candidates graduated with a weak pass (D7-E8) and an overwhelming 31.58% had F9 (Fail) in Mathematics (West African Examination Council [WAEC], 2022). Thus, 61.67% of the SHS graduands were unable to pursue tertiary education in Ghana.

To a large extent the fear for examinations especially in Mathematics cannot escape scrutiny as one of the causes of such abysmal performance. This lends credence to several reports of examination malpractices among male and females (Chief Examiner's Report, WAEC, 2022). Further, WAEC chief examiners' report specify students' abysmal performance annually in their report although some improvements in the teacher's methodology are equally mentioned (WAEC, 2022). In particular, the report on the performance of male and females at the SHS in 2021 compared with 2020 parades a "Pass" by the learners degenerated by 11%. Thus, 65.71% attained A1-C6 in 2020 and 54.11% in 2021 in mathematics (WAEC, 2021). Thus, this trajectory male and females' inability to advance their education to the tertiary level as a result of their failure in mathematics is worrying. In effect, students who cannot pass mathematics have their future truncated. In consideration of the above, this study places premium on the exploration of gender differences in anxiety and performance in mathematics which impedes students' progress in the learning of mathematics.

Theoretical underpinning of the study

This study draws its theoretical basis from these theories; Deficit Theory, The Debilitating Anxiety Model, The Reciprocal Theory, and the Processing Efficiency Theory. The theory of deficit expresses the notion that, one's poor performance in mathematics is attributable to the individual's anxiety levels (Carey, Hill, Devine, & Szucs, 2016). Similarly, as the deficit model propounded by Tobias' (1985). Further, Carey et al.'s (2016) postulated that, learners whose mathematics prowess are low are likely to exhibit anxieties in mathematics. To this end, irrespective of the source of the problem of poor performance in mathematics, learners are more likely to develop mathematics anxiety. This theory creates conditions that provides clarity as to why low weak students and individuals with learning difficulty develop anxiety in mathematics. Thus, if a learner exhibits tendencies of anxiety in relation to mathematics, its consequent effect will be discrepancies in learning and emotions that are negative towards mathematics (Rubinsten & Tannock, 2010).

Accordingly, it could be asserted that, an individual's deficiency in the learning of mathematics activates anxiety (Carey et al., 2016). Nonetheless, the reverse of such a correlation between occurs. This theory is relevant to this study because the majority of first-year SHS students avoid mathematics-related courses because of their low mathematics performance at the Basic Education Certificate Examination (BECE). In this case, mathematics anxiety has been developed due to their low performance in their previous examination. Further, the Debilitating Anxiety Model suggests the antithesis of the theory of deficit. Thus, an individual's abysmal performance is caused by his/her deficiency in learning and achievement (Carey et al., 2016). This theory is suggestive of a correlation between anxiety and performance as an attributable function of the devastations that results from learning and educing some skills in mathematics. In addition, the theory of deficit asserts that, the acquisition of new skills and comprehension of concepts becomes difficult with the presence of anxiety especially in the field of mathematics.

The theory further provides clarity as to why learners (those with a disability in learning together with emerging students) who experience anxiety in mathematics encounter problems during assessments and tests. Learners with anxiety in mathematics are characterised by physiological related issues when task that mare mathematics in nature are presented to them, particularly those test that are timed (Ashcraft & Moore, 2009; Foley et al., 2017). Thus, students' abysmal performances could be traced to such reactions that are negative. This theory is therefore, grounded in the current study since it provides a comprehensive understanding of the variables employed. Finally, the study is rooted in the reciprocal theory (Carey et al., 2016). This theory avers that, the two theories (deficits and anxiety) impact each other, producing a spiteful cycle of anxieties in mathematics to performance. To this end, it could be said that, there is a circular connection among anxiety, learning, and performance (Foley et al., 2017; Haciomeroglu, 2017). Interestingly, when this cycle starts, anxieties in mathematics impedes knowledge and accomplishment, which, in effect, yields further anxiety around mathematics.

This leads to the introduction of self-defeating manners and tendencies that additionally aggravate the problem. In this way, anxieties in mathematics lead to a declining performance and lesser performance provokes anxieties in mathematics. The final that underpinned this theory is the reciprocal theory. The theory provides a comprehensive outline that shows that, at the commencement of anxieties in mathematics, it has the tendency of reinforcement making it hard to put a stop to it. The relevance of this theory is contingent on this study's focus on the gender differences in mathematics anxiety and mathematics performance of SHS students.

Conceptual Framework

The literature asserts a cyclic bidirectional link amid anxiety and performance in mathematics. An abysmal performance occurs, if a learner encounters anxiety when accomplishing a task in mathematics. Contrariwise, the learner suffers anxiety if the his/her output in mathematics is poor. Thus, making it complicated to comprehend as to the determination of whether the mathematics anxiety or the poor mathematics performance comes first (Carey et al., 2015). Figure 1 provides the conceptual framework of the study.
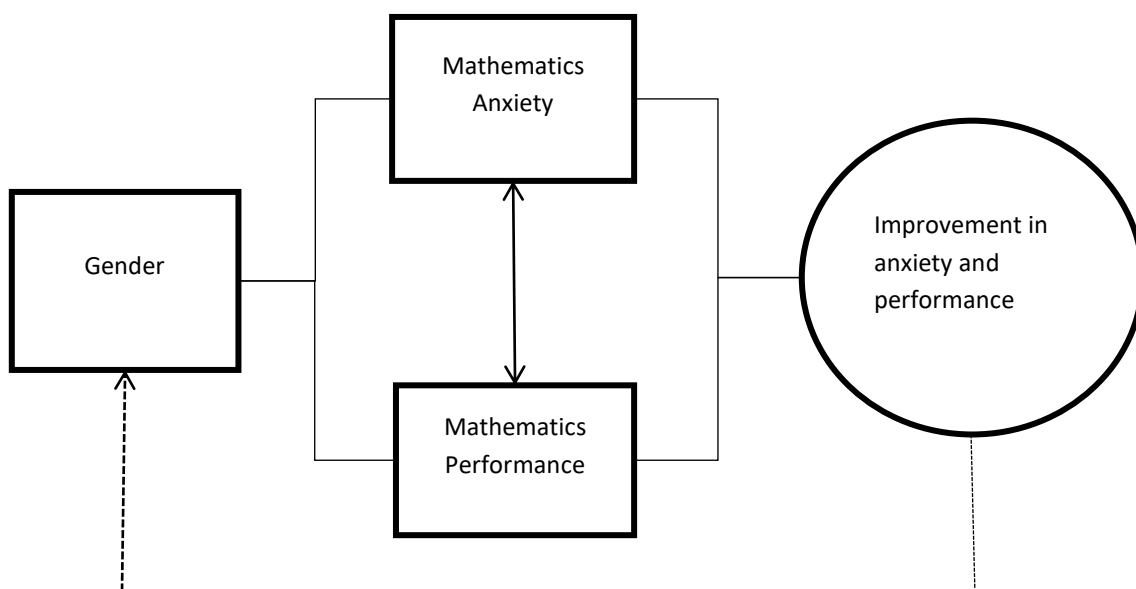

Figure 1. Conceptual framework of the study. (Author's Own Construct, 2024)

Based on the insights from the reviewed literature, a conceptual framework was developed. The conceptual framework portrays the linkages between these attributes anchored on the resolve of the study. The framework indicates the inter-relationship amid gender, anxiety and performance in mathematics. The conceptual framework further portrays cyclical occurrences of anxiety and performance in mathematics. This cyclical mode clearly shows that anxiety can lead to poor performance in mathematics. Contrarywise, if the individual's performance is poor, it can lead to anxiety in mathematics.

Research question

The study will focus is informed by the following research questions:

1. What are the mathematical anxiety levels among SHS students?
2. What are the mathematical performance levels among SHS students?
3. What are the differences in mathematics performance between male and female students in SHS?
4. What are the differences in mathematical anxiety between male and female students in SHS?
5. What is the relationship between student's mathematical anxiety and performance in SHS?

METHODS

Research design

Quantitative research method was employed in collecting and analyzing the data. As it best suited the study in the provision of a rigorous and systematic investigation into "Assessing How Gender Differences in Mathematics Anxiety Influences Performance" (Creswell, 2014). Specifically, a cross-sectional design was employed which intricate the gathering of data at a single point in time during the conduct of the study (Babbie, 2016). This design provided for a snapshot view of the phenomenon under investigation, providing insights into the relationships and patterns that exist between the variables in the study. Finally, the design provided a comprehensive exploration of the research questions by capturing a snapshot of the variables explored (Creswell, 2014).

Sample and participants

South Dayi District is one of the 18 districts in the Volta Region of Ghana where this study was conducted. The district hosts SHS students' population of 4910 (South Dayi District Education Office, 2024). A stratified sampling method was employed to put the schools into four strata. The schools were divided into four distinct strata to ensure equitable representation across varying student populations. Through this stratification process, each stratum was systematically selected to provide a balanced and comprehensive overview of the district's educational landscape.

The stratified sampling technique allowed for a targeted and structured approach to capturing the nuances of gender-specific experiences within the selected SHS (Abreh et al., 2018). In addition, proportionate sampling technique was employed to determine the exact number of students to be selected from each stratum for the purposes of obtaining a representative sample from each school (Digitale, 2018). Hence, in using proportional sampling each school's sample size accurately reflects its contribution to the overall population (Creswell, 2014). Furthermore, within each stratum, a simple random sampling method was utilized to proportionally select male and female students. This approach was crucial in ensuring gender balance within the sample, thus facilitating a comprehensive examination of gender-specific respondents.

In using the Slovin's formula for the determination of the participants ; $n = \frac{N}{1+N(e)^2}$ where $N = Total\ population\ e = Error\ tolerance$, $n = sample\ size$ Thus, for this case N=4910, taking the confidence level of 95% that is with a permissible error of 5%, e=0.05. $n = \frac{4910}{1+4910(0.05)^2}$, $370 = n\frac{4910}{1+4910(0.0025)}$, $n = \frac{4910}{1+12.275}$, $n = \frac{4910}{13.275} = 369.868$, n =370 (approximately). As a result, the study had a total of 370 participants. The authors utilized Slovin's formula for determining the sample size because it allows for the selection of a

representative sample from a population with the desired level of accuracy (Stephanie, 2003). Participants inclusion or exclusion was by permission. Further, anonymity and confidentiality of the participants were guaranteed. The demographic distribution of the students is shown in Table 1.

Table 1. The demographic distribution of the students

Category of respondents	Population(N)	Proportion of respondents	Sample size(n)
SCHOOL A			
Males	897	112	56
Females	602		56
SCHOOL B			
Males	704	84	42
Female	416		42
SCHOOL C			
Males	800		49
Females	500	98	49
SCHOOL D			
Males	671	76	38
Female	320		38
Total	4910	370	370

Instrument

Two main instruments were employed. Thus, the Abbreviated Mathematics Anxiety Scale (Hopko et al, 2003a) and Mathematics Achievement Test (Asomah et al., 2023; WAEC, 2023).

In particular, in using a 5-point scale, AMAS measured anxiety levels of the participants with two factors: Learning MA, an account of students' apprehension in the classroom environment, and Mathematics Evaluation Anxiety, detailing environmental conditions grounding examinations in general (Eden et al., 2013). Further, the administration of the Mathematics Achievement Test (MAT) was occasioned immediately after the administration of AMAS to the respondents in the study.

The MAT was informed by the taught content [Algebra, Circle Theorem, Geometry and Measurement] in the Ghanaian mathematics syllabus for SHS. The respondents were given a duration of an hour for the completion of the test. In ascertaining the content, instrument and facial validity of the test items, professional SHS mathematics teachers as well as experts in the Department of Teacher Education, at the University of Ghana made input in the construction of the test items. The inputs received were incorporated (Creswell, 2014).

Pilot testing of the instrument

Before commencing with the main study, pilot testing of the research instruments was conducted to ensure their reliability and validity in the study's context (Haddaway et al., 2018). In particular, the MAT and MAS were subjected to pilot testing to identify any potential issues with the instruments, including ambiguous or confusing items and question clarity and appropriateness for the target population. According to Perneger et al. (2015), a sample size of 30 is considered reliable as lesser sample sizes may lack the statistical influence to classify predominant themes in a study.

Consequently, a sample size of 40 students participated in the pilot stage of the study. The results of the pilot test indicated a reliability coefficient that were ranged between 0.71- 0.79. The inputs received were incorporated. Thus, the final reliability estimates for the instruments employed in the study were calculated.

(Internal consistency: α = .91; two-week test-retest reliability: r = .86; convergent validity of AMAS and Mathematics Anxiety Rating Scale (MARS) -R r = .87). Hence, the instrument was deemed reliable for the conduct of the study.

Data collection and analysis

Respondents rated their responses on a 5-point Likert scale, ranging from strongly disagree (1) to strongly agree (5). the interpretation of the scores were designated as: 1 indicated the lowest perception, 5 indicated the highest perception, and values below or above 2.5 indicated unfavorable or favorable perceptions, respectively. Descriptive analysis revealed three levels of anxiety (low, moderate, high) among the students, providing insights into the range, frequency, and percentages associated with each level. The MAT was scored out of 100 and graded in line with the standard system employed by the West Africa Examination Council (WAEC, 2021). This enabled a detailed examination of students' performance in the MAT across the four schools.

Further, an independent samples t-test was used in analyzing whether there were statistically significant differences in average mathematical achievement test scores between male and female students (Cohen, 2020). The test scores from both genders were examined to uncover potential discrepancies in performance. Additionally, an independent samples t-test was used to explore the variations in MA levels between male and female students within the SHS, shedding light on gender-based differences. Again, Pearson's correlation coefficient was employed to ascertain the strength and direction of the linear relationship between mathematical anxiety and academic performance (Adu, 2022). This analysis was aimed at elucidating the impact of MA on the academic achievements of the participants within the study. By employing this rigorous statistical analysis, the authors provided a complete thoughtful consideration of the interplay among gender dynamics, MA levels, and academic performance among Ghanaian students in Senior High Schools.

RESULTS AND DISCUSSION

Results

The results of "Assessing How Gender Differences in Mathematics Anxiety Influences Performance" are delineated in this segment. The analysis employed a range of statistical methods and scales to examine the research questions. The results are sequenced under the respective research questions posed in the study.

Research Question 1: What are the mathematical anxiety levels among SHS students?

The essence of the research question lies in understanding the extent and nature of mathematical anxiety experienced by students at the Senior High School level. By this question, the researchers aim to gain insights into the emotional and psychological aspects of students' experiences with mathematics by focusing on anxiety levels. In responding this research question, descriptive statistics was employed in the analysis of the levels of mathematical anxiety among the SHS students. Table 3 shows the results of Students' mathematical anxiety levels among senior high school.

The results in the Table 3 show that respondents agreed (M=2.70, SD=1.50) with the statement "I feel anxious when I have to apply mathematics concepts in problem solving". This suggests that the application of mathematics concepts to problem solving contributes to anxiety for the majority of the students. The students showed agreement (M=3.53, SD=1.34) with the statement "I become anxious when I think about my upcoming mathematics test a day before", This indicates that test-related situations evoke a higher level of anxiety among the students, possibly due to the anticipation of performance evaluation. The students disagreed (M=2.39, SD=1.20) with the statement "I become anxious watching my math teacher work an algebraic equation on the blackboard in math class", This suggests that direct teacher-led activities might not

be a significant source of anxiety for the students. They agreed to the statement "I feel nervous when I am taking a math test" (M=3.34, SD=1.27), notably, this is a common aspect of mathematics anxiety and may be linked to the performance pressure associated with formal assessments. They also agreed (M=3.52, SD=1.28) with the statement "I feel anxious when I am given Geometry homework with lots of difficult questions that I have to submit the next day", this indicates that homework especially in the area of Geometry is of a challenge and contributes to anxiety levels. The students agreed to the statement "I get nervous and confused when my mathematics teaches circle theorems in mathematics class" (M=3.26, SD=1.34), this suggests circle theorems lessons may contribute to heightened anxiety among students. They agreed (M=2.72, SD=1.31) with the statement "An explanation of a concept in math from a colleague makes me anxious", this suggests that peer-led activities may be a significant source of anxiety for the majority. Students agreed (M=3.60, SD=1.28) to the statement "I start to panic after the realization of a surprise test in mathematics lesson", this indicates that unexpected assessments may trigger a higher level of anxiety among students.

Table 1. Students' responses on their Mathematics Anxiety level. (N = 370)

Statements	M	SD	Decision
I feel anxious when I have to apply mathematics concepts in problem solving	2.70	1.50	Agreed
I become anxious when I think about my upcoming mathematics test a day before.	3.53	1.34	Agreed
I become anxious watching my math teacher work an algebraic equation on the blackboard in math class	2.39	1.20	Disagreed
I feel nervous when I am taking a math test.	3.34	1.27	Agreed
I feel anxious when I am given Geometry homework with lots of difficult questions that I have to submit the next day.	3.52	1.28	Agreed
I get nervous and confused when my mathematics teaches Circle theorems in mathematics class.	3.26	1.34	Agreed
An explanation of a concept in math from a colleague makes me anxious.	2.72	1.31	Agreed
I start to panic after the realization of a surprise test in mathematics lesson.	3.60	1.28	Agreed
I feel nervous when I am starting a new topic in mathematics.	2.63	1.30	Agreed
Overall level of mathematics anxiety	3.08	0.63	Agreed

The students agreed (M=2.63, SD=1.30) with the statement "I feel nervous when I am starting a new topic in math", This suggests that the introduction of new topics may be a major source of anxiety for the students. The overall mathematics anxiety Mean (M=3.08, SD=0.63) as registered by the Senior High School students depicts a moderate level of anxiety, indicating that notwithstanding their challenges in the area of Circle theorems, Geometry and their inability to apply concepts to mathematics problem, the student's overall anxiety level is not extreme. Further, in responding to the diverse levels of anxiety exhibited by the students, three levels (low, moderate, high) of anxiety were recorded using the descriptive analysis. In particular, the range, frequency and percentages. Table 4 presents the various levels of anxiety as identified from the perspective of the students.

Table 2. Anxiety levels amid the participants.

Level of mathematics anxiety	Range	Frequency	Percent
Low	9 - 21.00	58	15.7
Moderate	22.00 - 33.00	254	68.6
High	34.00+	58	15.7

The results in table 4 reveal varying levels of anxiety in mathematics among the surveyed students. It is noteworthy that 15.7% (58) of the participants reported a low level of mathematics anxiety, while a substantial 68.6% (254) experienced a moderate level. Additionally, 15.7% (58) of the students reported a high level of m anxiety in mathematics. These findings illuminate the varied experiences students have with mathematics anxiety. The high prevalence of moderate anxiety levels aligns with the broader trends highlighted in Table 4, affirming that, on average, students tend to experience a moderate level of anxiety in their mathematical pursuits.

Research Question 2: What are the mathematical performance levels among SHS students?

This research question sought to examine the levels of mathematical performance among SHS students. The main objective was to investigate and gain a thoughtful consideration of the proficiency of students in mathematics within SHS in Ghana. To address this research question, a Standardized Mathematics Achievement test was conducted among the respondents. The results, were analyzed using the standard grading system employed by the West Africa Examination Council (WAEC) to assign grades ranging from A1 to F9. This was purposed to make an informed analysis of the students' performance in the mathematics achievement test. Table 5 depicts the performance of the students after the conduct of the exams.

Table 3. Mathematical performance among SHS students

Grade	Frequency	Percent
A1-Excellent	127	34.3
B2-Very Good	31	8.4
B3-Good	23	6.2
C4-Credit	28	7.6
C5-Credit	33	8.9
C6-Credit	41	11.1
D7-Pass	21	5.7
E8-Pass	26	7.0
F9-Fail	40	10.8

The analysis of SHS students' performance in mathematics reveals a diverse spectrum of achievements. Notably, a substantial 34.3% of students demonstrated exceptional prowess, securing the coveted A1 grade, indicative of excellent performance. This highlights a commendable proficiency among a significant portion of the student body. Additionally, 8.4% of students achieved a B2 grade, signifying a very good level of competence, while 6.2% attained a B3 grade, reflecting a commendable performance level. These percentages underscore the presence of a portion of students performing well above the average mark. Moving to the credit category, encompassing C4, C5, and C6 grades, 7.6%, 8.9%, and 11.1% of students, respectively, fall within this range.

This group represents a diverse set of performances, indicating a considerable number of students meeting the minimum credit requirements. Passing grades, represented by D7 and E8, collectively account for 12.7% of students. While 5.7% received the D7 grade, a modest 7.0% secured the E8 grade. These results highlight a segment of the student population that, while not excelling, managed to meet the passing

criteria. Unfortunately, 10.8% of students received the F9 grade, indicating a failure to meet the required standards. This segment warrants attention and intervention to address the challenges hindering their success in mathematics. In all, the performance of the respondents with regards to mathematics as analysed indicates variations on the part of the participants in the Mathematics Achievement Test conducted in the study.

Research Question 3: What are the differences in mathematics performance between male and female students in SHS?

The essence of the research question lies in understanding and addressing potential variations as established in the mathematics achievement test based on gender. By investigating this question, the researcher aims to gain insights into any gender-based differences in mathematical performance, which can have implications for educational equity and instructional practices in the Senior High Schools. The independent samples t-test is widely recognized as the most reliable statistical tool for assessing the disparities in mathematics performance amid male and female students in SHS. By employing this robust statistical method, the researcher ascertained whether there exists a statistically significant differences in the average mathematical achievement test scores between male and female students. In order to achieve this, the mathematical achievement test scores of both male and female students from the study participants were analyzed as captured in table 6.

Table 4. Differences in mathematics performance amid male and female students in SHS.

Variable	Gender	N	Mean	SD	*t*	df	*p*
Mathematics performance	Male	185	64.50	17.51	5.05	368	.000
	Female	185	59.90	16.27			

***Significant independent t-test at 0.05 level 2-tailed*

The results show that a significant difference [t (368) =5.05, p< .001] exists in mathematical performance between male and female students. The results demonstrate that male students (M=64.50, SD=17.51) performed better in mathematics than female students (M=59.90, SD=16.27). These findings imply that, on average, male students outperformed their female counterparts in the realm of mathematics. This statistical discrepancy suggests a gender-based variation in mathematical achievement, with male students exhibiting a higher level of performance in comparison with the female counterparts.

Research Question 4: What are the significant differences in mathematical anxiety between male and female students in SHS?

The research question sought to determine the extent of variation in levels of the mathematical anxiety amid male and female students at the senior high school. Specifically, the research question seeks to identify and quantify any statistically significant differences in the levels of mathematical anxiety experienced by male and female students within this educational context. By addressing this research question, the study aims to provide insights into potential gender-based variations in mathematical anxiety, ultimately contributing to a deeper understanding of how mathematical anxiety manifests differently among male and female students in the senior high school setting.

Table 5. Differences in mathematical anxiety between male and female students in Senior High Schools.

variable		Gender	N	M	SD	*t*	*df*	*p*
Overall Level	Anxiety	Male	185	3.00	.71	-2.28	342.392	.003
		Female	185	3.15	.53			

*N = 370 *P < 0.05*

The outcomes of the analysis reveal a significant difference [t (342.392) = -2.28, p= .003] in mathematical anxiety between male and female students. The statistical analysis indicates that female students (M=3.15, SD=0.53) exhibit higher levels of mathematical anxiety in comparison with the males (M=3.00, SD=0.71). These findings suggest that, on average, female students experience a greater degree of anxiety in the context of mathematics than their male counterparts. The observed difference in mean scores underscores a notable gender-based variation in the emotional response to mathematical challenges within this studied population. These variations in anxiety could be attributable to the disparities in the performance of the students in the senior high schools based on gender.

Research Question 5: What is the relationship between student's mathematics anxiety and performance in SHS?

This research question sought to explore the potential influence of mathematics anxiety on students' academic performance in the context of senior high schools. This research question seeks to investigate whether there is a correlation between students' anxiety towards mathematics and their actual performance in this subject at the senior high school level. To investigate this research question, the researcher used a correlation analysis. Specifically, the Pearson's correlation coefficient was employed to measure the strength and direction of the linear relationship between mathematical anxiety and academic performance. Table 8 shows the relationship that exist between the mathematical anxiety and academic performance at the senior high school level.

Table 6. Relationship between student's mathematical anxiety and performance in Senior High Schools.

			Overall Anxiety Level
Students' Achievement	Mathematics	r	-.053
		p	.309
		N	370

**. Correlation is significant at the 0.05 level (2-tailed).

The findings show that a moderate negative relationship exists between students' mathematical anxiety level and mathematics performance [r (368) = -.053, p= .308]. This finding implies that, based on the data collected, that higher levels of anxieties in mathematics are linked with lower performance in mathematics or vice versa.

Discussions

The discussions in connection with the results of the study presented in line with the research questions. Thus, in relation to the mathematical anxiety levels among male and female senior high school students. The findings of the study revealed varied facets of anxieties in mathematics among students. Notably, quite a number of students do not find the utilization of the multiplication table in class to be a significant source of anxiety, suggesting a level of comfort with this tool. However, the anticipation of upcoming mathematics tests stands out as a prominent trigger for heightened anxiety, underscoring the stress associated with formal assessments. Interestingly, direct teacher-led activities, such as solving algebraic equations on the blackboard, do not appear to be a major contributor to student anxiety. This suggests that the mode of instruction, at least in this context, does not evoke substantial apprehension. On the contrary, the occurrence of nervousness during formal assessments, as expressed by the students, aligns with the conventional understanding of mathematics anxiety, pointing to the pressure associated with performance evaluation.

This finding is supported by a study conducted by Luttenberger et al. (2018) titled "The role of teacher-led instruction and supportive feedback in mathematics anxiety." The researchers used a sample of

120 undergraduate students from a German university and found that teacher-led instruction was not associated with higher levels of anxieties in mathematics amid students. Again, a study by Suinn and Edwards (1982) showed that the anxiety of students was negatively affected by timed exams. This supports the current findings that performance evaluation is a significant contributor to mathematics anxiety. Homework, particularly when perceived as challenging, emerges as another significant contributor to anxiety levels among students. This underscores the vitality in considering the nature and complexity of assigned homework within broader context of mathematics anxiety.

In support of the current findings, a study conducted by Austin et al. (2018) to assess the influence of homework quality on mathematics anxiety found that students perceived challenging homework as a significant contributor to their mathematics anxiety levels. Furthermore, Austin et al., (2018) highlighted that students who felt overwhelmed by difficult homework assignments were more likely to experience heightened anxiety in mathematics. The finding of the current study resonates with the study of Shernoff et al. (2003), which explored student interaction in high school classrooms from the perspective of flow theory. They observed that peer-led activities, where students explain mathematical problems to each other, can create a more comfortable and confident learning environment, diminishing mathematics anxiety. It further discussed how these collaborative learning experiences foster a sense of belonging and support among students, thus reducing anxiety levels. Unexpected assessments, specifically surprise tests, emerge as potent triggers for panic and heightened anxiety levels among students.

This highlights the impact of unpredictability on emotional responses and suggests the need to consider assessment structures in minimizing anxiety. The findings align with a study conducted by Hembree, R. (1988). Hembree, R. (1988) accessed the causes, effects, and treatment of test anxiety of 500 high school students and found that unexpected assessments, especially surprise tests, can trigger panic and heightened anxiety levels among students. Additionally, the study emphasized that the fear of being evaluated without prior preparation greatly contributes to test anxiety.

Contrary to expectations, the introduction of new topics in mathematics does not seem to be a major source of anxiety for the students. This implies a certain adaptability and readiness to engage with novel content without significant apprehension. The finding contradicts the findings of a study conducted by Ashcraft and Moore (2009). The researchers explored mathematics anxiety and the affective drop in performance of 250 high school students and found that the introduction of new topics in mathematics can lead to increased mathematics anxiety among students. It highlighted that the unfamiliarity and complexity of new mathematical concepts can overwhelm students, resulting in heightened anxiety levels and a decline in performance. While specific situations such as test anticipation, challenging homework, and surprise assessments contribute to elevated anxiety levels, the overall mean score indicates a moderate level of mathematics anxiety among the students. The study further revealed that a moderate level of mathematics anxiety was prevalent among the majority of the students. This further supports the overall mean score in this study, which indicates a moderate level of anxieties in mathematics amid the students.

On the mathematical performance levels among Senior High School students, the findings indicate a wide range of performance levels amid SHS students in mathematics. On the positive side, a significant portion of students demonstrated exceptional proficiency and achieved excellent grades (A1) or very good grades (B2). This highlights the presence of strong mathematical skills among a considerable number of students. Moreover, a notable proportion of students attained commendable grades (B3) or met the minimum credit requirements (C4, C5, C6). This signifies that there is a diverse set of performances, indicating a significant number of students performing above the average mark and meeting the necessary standards.

However, it is concerning that a portion of students received passing grades (D7, E8) or failed to meet the required standards (F9). This calls for the need for intervention and support for these students to address the challenges confronting them in mathematics. Overall, the implications of these findings suggest

the need for targeted interventions and educational strategies to support students who are struggling in mathematics. It is therefore, speculated in the current study that, the provision of additional resources, teaching methods, or personalized support to help improve their performance cannot be over-emphasized.

Concerning the significant differences in mathematics performance between male and female students in senior high schools, the study revealed that, male students perform better in mathematics compared to their female counterparts. The standard deviations obtained, reflect the spread of scores within each group, highlighting the variability of performance among male and female students. Further, the t-value of 5.05 indicates a substantial difference in the mean scores between male and female students. This suggests a statistically significant result, indicating that the observed difference in performance is unlikely to have occurred by chance. The finding of the current study resonates with the study of Hyde et al., (2014) which explored the trends in gender differences in mathematical performance and found that these differences have been diminishing in recent years. They observed that females have made significant strides in mathematics achievement over the past few decades. However, despite this progress, disparities still exist, with males tending to outperform females on average in mathematics. Further, a meta-analysis conducted by Lindberg et al., (2016) examined mathematics assessments worldwide and revealed that males generally perform better than females.

Moreover, they noted that the gender gap tends to be more pronounced in higher-income countries. These results align with previous studies, reinforcing the notion that there is an enduring gender gap in mathematics performance. Another study conducted by Kaili and She (2016) delved into the factors underlying gender differences in mathematics performance. Their research indicated that cognitive and non-cognitive factors contribute to these disparities. Specifically, they found that males often exhibit higher levels of spatial ability and self-confidence in mathematics, which may contribute to their advantage in performance. These findings suggest that multiple factors may be at play in shaping gender differences in mathematics performance.

In view of the significant differences in mathematical anxiety between male and female students in Senior High School, the study revealed that there is a statistically significant variation in anxiety levels amid male and female students. Thus, there is a significant difference in anxiety levels between male and female students within the sample. The finding in the current study is consistent with the research of Lindberg and Hyde (2016) which found that, gender differences in mathematical anxiety are consistent across cultures, with females reporting higher levels of anxiety than males. Similarly, Pekrun, Elliot, and Maier (2009) found that females exhibited higher levels of mathematics anxiety compared to males across grades 5 through 10. The present study's findings align with these previous studies, indicating that gender differences in mathematical anxiety are prevalent across various educational levels and contexts.

Additionally, a study by Wigfield and Meece (1988) found that females tend to have lower self-efficacy beliefs in mathematics than males, which may contribute to higher levels of anxiety. This underscores the importance of addressing and building self-efficacy beliefs in mathematics among females to mitigate anxiety and promote optimal learning outcomes. It is worth noting that the magnitude and direction of gender differences in mathematical anxiety may vary based on factors such as the type of sample used and cultural differences. For instance, a study by Fernandez-Ballesteros et al. (2002) revealed no significant gender differences in mathematics anxiety among Spanish university students. Similarly, a study by Adamuti-Trache and Sweet (2010) projected that gender differences in mathematics anxiety were significant among Canadian university students but not among Canadian high school students. In conclusion, the present study's findings support the consistent gender differences in mathematical anxiety found across cultures and educational levels. Understanding and addressing gender-related factors that contribute to mathematics anxiety may be crucial in promoting gender equity and enhancing students' mathematical confidence and performance.

Finally, on the relationship between a student's mathematical anxiety and performance in Senior High Schools, the results revealed a moderate negative relationship between the two variables, indicating that higher levels of mathematical anxiety are associated with lower mathematics performance or vice versa. Several studies have examined the relationship amid anxiety and academic performance, including mathematical performance. Consistent with the current findings, Beilock et al., (2010) explored the association amid anxieties in mathematics and performance in undergraduate students. With the sample size of 69, the researchers found that students who experienced high levels of mathematics anxiety performed worse on math tests than those with lower levels of anxiety. Similarly, the meta-analysis by Hembree (1990) reviewed 186 papers that scrutinized the link amid anxieties in mathematics and performance in students from grade school to college. The total sample size of the meta-analysis was over 15,000 participants.

It revealed a negative link amid anxieties in mathematics and achievement. One potential explanation for the negative relationship amid anxieties in mathematics and performance could be the negative effects of anxiety on working memory. Working memory is critical for solving mathematical problems, and anxiety has been shown to impair working memory performance (Eysenck et al., 2007). Another explanation could be that individuals with high anxiety tend to avoid or procrastinate when faced with mathematics tasks, leading to lower performance (Beilock & Carr, 2005). However, not all studies have found a negative relationship amid anxieties in mathematics and performance. For instance, a study by Wu et. al., (2012) found that while anxieties in mathematics negatively correlated with performance, the relationship was weak.

CONCLUSIONS AND IMPLICATIONS

This study focuses on exploring the gender differences in mathematics anxieties in view of their mathematics performance among Ghanaian SHS students. A quantitative research approach was employed, with a sample of 370 senior high school students selected through stratified sampling technique. The study addressed five research questions related to mathematics anxiety levels, mathematics performance levels, differences in performance between male and female students, differences in mathematical anxiety between male and female students, and the relationship between mathematical anxiety and performance. The findings indicate significant gender disparities, with males outperforming females in mathematics performance while females experience higher levels of anxiety. Thus, the surveyed students exhibited varying levels of mathematics anxiety, with a substantial majority experiencing a moderate level.

Further, the study also found that the performance of the students in showed variations in the Mathematics Achievement Test conducted. Again, disparity in mathematical achievement based on gender, with males displaying a greater level of proficiency compared to females were revealed in the current study. Additionally, a notable gender-based variation in the mathematics anxiety level of secondary school students in the South Dayi District were recorded. Finally, the study found that there was a moderate negative relationship between students' mathematics anxiety level and mathematics performance. Therefore, this implies that the higher the levels of anxieties in mathematics, the lower the mathematics performance, and vice versa. Implied in the study, are strategic approaches such as the provision of additional support to female students to reduce anxiety, and creating a more inclusive teaching approach that does not reinforce gender stereotypes. This could provoke improvement in female students' overall performance.

Limitations and further research

The work was exclusive to public SHS students in the South Dayi District. Hence, the deficit in the generalization of the findings of this research over all SHS. Based on the findings in the study, further research should explore the factors underlying the gender-based disparities in mathematics performance and anxiety levels. This could involve investigating the impact of societal stereotypes and expectations on males and females, as well as differences in teaching approaches and learning styles.

Conflicts of Interest

The authors declare no conflicts of interest.

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Data availability statement

As a result of the anonymity and confidentiality of the participants in this study, the supporting data are exclusively available@ rkasomah@ug.edu.gh

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