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Research

Effect of test anxiety on students' academic performance in mathematics at the senior high school level

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Abstract
The study explored the sources of mathematics test anxiety that affect students' performance, the level of mathematics test anxiety among senior high school students, the effect of test anxiety on students' academic performance in mathematics, and gender differences relating to test anxiety among students. The researchers used a descriptive survey design with a quantitative methodology. Multi-stage sampling technique (stratified and simple random) was used to select a sample size of 66 students from public senior high schools in the Cape Coast Metropolis. Data was collected using the test anxiety scale, a self-developed mathematics achievement test and a questionnaire. Data were analysed using both descriptive and inferential statistics. The study found that factors such as misunderstandings of mathematical concepts, fear of failure and embarrassment, exam preparedness, quality of mathematics instruction, and others significantly contribute to students' anxiety while taking mathematics assessments. The results showed a significant negative correlation between anxiety levels and academic performance. Female students were found to have higher levels of test anxiety compared to male students. Teachers should prioritise improving students' comprehension of mathematical concepts and create a nurturing learning atmosphere that promotes experimentation and minimises the fear of making mistakes.

Keywords Academic performance · Anxiety · Gender · Mathematics · Students · Test anxiety

1 Introduction

Dowker et al. [16] conducted a review of the impact of mathematics anxiety over the previous 60 years of mathematics education on students' mathematical understanding and areas requiring further research. Their research consistently reveals that mathematics fear has impacted students' mathematical proficiency. It is now absolutely essential to take action to reduce the potential negative effects that mathematics anxiety may still have on children's future arithmetic learning outcomes. We believe that in order to assist students in scaffolding their mathematical learning, math teachers should consider implementing more innovative teaching strategies. Research indicates that mathematics anxiety negatively affects students' learning outcomes [19, 27]. Self-regulated learning, however, improves pupils' mathematical literacy. Even among children who excel at an advanced level in mathematics, concern about the subject matter may impede their proficiency and control over it.

According to Foley et al. [17], mathematics anxiety is defined as fear or apprehension of mathematics, which is often characterized by feelings of unease, concern, or dread that impede an individual's performance in mathematical tasks. A substantial body of research has yielded empirical support for the proposition that a threshold effect of test anxiety on

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academic performance is present among students across different age groups. Ortner and Caspers [46] argue that there is evidence that a relatively low level of anxiety has the potential to improve academic outcomes. Scholars have focused considerable attention on the phenomenon of test anxiety, tracing its origins back to the early 1900s.

The research conducted by Yousefi et al. [45] and Kavakci et al. [24] has revealed that test anxiety presents a significant barrier to the attainment of academic objectives among secondary school students. The presence of these challenges hinders individuals from attaining a desirable level of academic achievement. The prevailing phenomenon can be attributed to the presence of test anxiety. Test anxiety is a psychological factor that has been recognised as a significant impediment to students' academic performance [28, 32]. In recent years, there has been a relative lack of exploration in the literature regarding the potential facilitative role of test anxiety despite the considerable amount of research conducted on the detrimental effects of anxiety on performance [15, 37].

Assessment results are of great importance in modern society as they serve as a measure for evaluating and setting standards in academic endeavours, professional positioning, and advancement. The pervasiveness of test anxiety is extensive and seems to be on the rise, potentially attributable to the heightened frequency of assessments and the significance attached to them [35]. The phenomenon of test-taking has gained significant prevalence in contemporary society, affecting individuals across various educational tiers. In contemporary times, there has been an increase in the frequency of assessments and evaluations that students are mandated to undergo, commencing from their early years in kindergarten and persisting until they complete high school. Akanbi [3] asserts that it is common for students to experience a certain level of anxiety in testing situations. However, there exists a subset of students who encounter difficulties in managing their anxiety, leading to the manifestation of more pronounced symptoms. Akanbi [3] asserts that the adverse consequences of this phenomenon are evident in the students' examination results, thereby impeding their educational development and advancement. Test anxiety is a widely recognised phenomenon that affects individuals of different age groups and genders. It is particularly prevalent among those who undergo evaluation, assessment, and grading based on their competencies or accomplishments [29]. Leder [27] has also examined how gender influences mathematics education and the need for innovative pedagogies that support equity in the subject. This will present chances for female students to pursue employment in STEM fields.

The study conducted by Mahalingam and Md Yunus [31] revealed a significant relationship between the attitude profile of secondary school students towards mathematics and various factors, including the type of residence, gender differences, and study interest. The findings of the study suggest that individuals who experience anxiety in mathematics may not be adequately prepared for tests. This is supported by their tendency to engage in last-minute cramming, ineffective time management, disorganised handling of textual information, suboptimal study habits, and apprehension about their past exam performance compared to their peers. Additionally, these individuals also express concerns about the potential negative consequences of failing [47]. Penberthy [47] posits that the existence of test anxiety can exert a detrimental impact on students, manifesting as heightened nervousness and difficulties in comprehending and interpreting examination prompts. The issue mentioned above relates to the difficulty of remembering relevant keywords and concepts when answering essay prompts. This can lead to less-than-optimal performance on exams, even if the student understands the material. The prevalence of test anxiety in contemporary society is not surprising, given the considerable role that tests have assumed and the consequential anxiety they elicit. In a study conducted by Gbolagade et al. [20], a significant influence on students' apprehension towards mathematics was observed. This apprehension was found to be associated with multiple factors, including the perceived incompetence of mathematics instructors.

Dortuo [15] posits that students who encounter test anxiety often experience a sense of being overwhelmed and harbour feelings of self-doubt regarding their ability to perform. Individuals who demonstrate elevated levels of test anxiety undergo a state characterised by increased levels of tension, fear, and apprehension when confronted with evaluative circumstances. They perceive these situations as threatening. Certain individuals display a decrease in self-esteem and hold a negative view of themselves. In evaluative situations, it is common for individuals to encounter emotions characterised by powerlessness and ambiguity frequently. Ansi-Danso et al. [5] found that these students' academic performance is noticeably below average. Dortuo [15] asserts that a prevalent issue observed among students is the manifestation of anxiety in the context of mathematics tests or examinations. Legese [28] conducted a study with the aim of investigating the impact of test anxiety on the academic performance of university students. The research findings suggest that there exists a negative correlation between the academic performance of university students and their level of test anxiety. The primary objective of this study is to examine the potential impact of test anxiety on the academic performance of a selected group of senior high school (SHS) students. According to Cizek and Burg [9], a significant number of students experience test anxiety and inadequate study skills when confronted with challenging academic assignments.

Wahid et al. [44] assert that a notable proportion of students encounter anxiety, thereby presenting a substantial threat to their academic achievement and involvement. Moreover, it has been observed through empirical research that anxiety has a detrimental impact on academic performance, not only in primary education but also in secondary and tertiary educational contexts. The study conducted by Al-Atram [4] sought to investigate the association between anxiety levels and academic performance. After analysing the findings, it was observed that students who experienced high levels of anxiety demonstrated enhanced performance on the non-stressful examination. Conversely, students with low levels of anxiety exhibited superior results when exposed to the traditional condition. The study conducted by Daniel et al. [12] reveals that certain students may encounter anxiety when they are compelled to exhibit their knowledge through methods that do not correspond with their preferred approaches. In the context of academic assessments, it is worth noting that a specific group of students may experience heightened levels of anxiety when faced with the requirement of completing written examinations. Some individuals may experience feelings of anxiety in relation to oral examinations. According to Gonzalez-Saenz de Tejada et al. [21], various forms of assessment have the potential to induce anxiety among students. The results of the studies indicate that the presence of anxiety exerts a detrimental influence on an individual's performance.

Devine et al. [13] research findings indicate that students in secondary school commonly experience a phenomenon referred to as mathematics anxiety (MA). Furthermore, according to the findings of Ünal-Karagüven [43], gender may have a significant influence on the development of test anxiety. According to Akanbi's [3] study, there is evidence suggesting that females display elevated levels of test anxiety when compared to males. In a study conducted by Cizek and Burg [9], the objective was to investigate the impact of test anxiety on female students. The study's results indicate that test anxiety has a notable impact, specifically during the middle school and early high school stages. In contrast, the influence of test anxiety is observed to be comparatively less pronounced in the elementary years and at the tertiary level. Devine et al. [13] conducted a study that yielded a significant finding indicating that girls demonstrated higher levels of mathematics anxiety (MA) in comparison to boys. Furthermore, the results of the investigation suggest a significant correlation between elevated levels of MA and diminished mathematical proficiency. Furthermore, the research findings suggest that there was no noticeable discrepancy in mathematical ability between genders despite the fact that female participants reported experiencing higher levels of anxiety related to mathematics. The results of this study suggest that females may exhibit greater levels of academic performance in the field of mathematics in comparison to males. However, it is conceivable that the presence of significant levels of mathematics anxiety could have hindered their academic performance. The research conducted by Asikhia [6] revealed that gender was a notable factor in the expression of mathematics anxiety among student participants. In the study, it was observed that male students exhibited a more pronounced decrease in mathematics anxiety in comparison to their female counterparts.

Numerous factors have been identified as potential determinants of test anxiety among students. MacDonald et al. [30] conducted a study aimed at identifying various factors associated with the manifestation of test anxiety. Multiple factors contribute to the challenges that are associated with test applications. One factor that can influence the perception of these assessments is the presence of negative attitudes among teachers. Furthermore, the attitudes of students towards the process of learning can also exert a substantial influence. Another factor to consider is the issue of test invalidity, which can undermine the effectiveness of these evaluations. Fear of negative evaluation, stemming from past negative examination experiences, further compounds the difficulties associated with test applications. Time limitations, as well as the presence of challenging course content, are additional factors that contribute to the complexity of this process. Lastly, parental expectations can also exert pressure on students, adding to the overall challenges of test applications. An extensive review of existing literature indicates that international academic communities have carried out a significant amount of research regarding the impact of test anxiety on students' academic performance. However, it is crucial to emphasise that there is a paucity of literature that specifically addresses this issue within the context of Ghana.

Given the current concerns surrounding the condition of public education and the increasing reliance on test scores as a measure of academic achievement, a significant group of twelfth-grade students is experiencing elevated levels of test anxiety, specifically in the field of mathematics. The current body of literature suggests a dearth of comprehensive research on the origins of mathematics test anxiety and the prevalence of mathematics test anxiety among senior high school (SHS) students in the Cape Coast Metropolis. In addition, a number of studies have been conducted to investigate the impact of test anxiety on students' academic achievement. Nevertheless, a significant gap exists in the current body of research that focuses on examining the correlation between test anxiety, gender, and academic achievement in the field of mathematics among student populations. The main aim of this study is to rectify the lack of geographical representation of this phenomenon.

1.1 Research questions

1. What are the sources of Mathematics test anxiety that affect students' performance?
2. What is the level of Mathematics test anxiety among senior high school students?
3. What is the effect of test anxiety on students' academic performance in mathematics?

1.2 Research hypothesis

H_0: There is no statistically significant difference between male and female SHS students' Mathematics test anxiety levels.

1.3 Significance of the study

The main aim of this study is to investigate the impact of test anxiety on students' academic achievement, highlighting the necessity for proactive interventions by educators, school administrators, and parents to address this issue effectively. The research results can provide valuable insights that can guide both practice and future studies in mathematics education. Instructors can utilise the results to create specific teaching approaches that target students' misconceptions of mathematical ideas, anxiety about failing, and readiness for examinations. Through the creation of nurturing learning environments and impactful teaching methods, educators can reduce students' stress and improve their performance in school. Educational institutions can utilise the research results to create specialised support services for helping students cope with test anxiety. This may involve providing counselling, workshops on time management, and support programs focused on reducing anxiety and enhancing overall well-being. By acknowledging the gender disparities in test anxiety, educators can create interventions and support systems that are more attuned to the needs of female students. Offering specific resources and support services can reduce test anxiety and encourage gender equality in math education.

The results can serve as a basis for additional research on the root causes and mechanisms of test anxiety in mathematics education. Future research can investigate further elements that contribute to anxiety, including cultural factors, individual variations, and the effects of teaching strategies. Researchers can utilise the results to create and assess interventions focused on decreasing test anxiety and enhancing performance in mathematics. One may delve into the effectiveness of cognitive-behavioural strategies, mindfulness techniques, and social-emotional learning programs in reducing test anxiety. Long-term studies can investigate the effects of test anxiety on students' academic paths and educational achievements. Exploring the development of test anxiety over time and its impact on academic and career success can help in designing specific interventions and support systems.

2 Literature review

2.1 Components of test anxiety

In order to improve mathematical teaching and learning, Buckley and Sullivan [8] investigated how to use educational and psychological perspectives to analyze ways to reconsider anxiety and uncertainty in the mathematics classroom. They discussed the links between anxiety and uncertainty. Anxiety and uncertainty may not seem connected, but they do affect one another. Uncertainty triggers anxiety, and anxiety intensifies uncertainty. They proposed two solutions to mitigate the negative impact of math anxiety on learning. They suggested that teachers use emotion regulation strategies to help kids become more adept at managing their negative emotions. Secondly, they proposed that adopting a pedagogical strategy of embracing challenge in the classroom can help normalise uncertainty and encourage more positive affect and engagement with mathematics. To assist pupils in solidifying their knowledge, they recommended implementing innovative teaching techniques. Rather than aiming to eliminate anxiety, teachers may focus on teaching students how to manage their anxiety in order to promote more positive mathematics learning and the development of mathematical resilience. Sharma [42] posits that physical manifestations, such as increased muscle tension, sweat on the hands, and trembling, can serve as indicators of emotional states. Emotional arousal typically peaks immediately before an examination and rapidly diminishes upon its conclusion.

According to Keogh et al. [25], individuals who experience test anxiety may need to exert extra effort to achieve similar levels of performance compared to those who do not experience such anxiety. Nevertheless, individuals who experience test anxiety have the potential to achieve satisfactory performance if they can proficiently regulate their anxiety levels.

Several studies have provided evidence that the factor of concern plays a more significant role in the development of test anxiety and subsequent academic underperformance in comparison to other aspects of test anxiety [25]. Wine (as cited in [42]) posits that individuals tend to allocate their attention between the salient aspects of a test that are pertinent to the task at hand and extraneous cognitions such as anxiety and self-assessment. Research has indicated that the occurrence of excessive thoughts while engaging in test-taking activities can detrimentally affect the academic performance of students. These distracting thoughts divert their attention away from the task requirements, thereby hindering their ability to perform optimally on the test.

2.2 Factors causing test anxiety

Literature has emphasized the importance of cognitive interference and attentional factors in the domain of test anxiety [2, 18]. The authors proposed that self-preoccupied cognitions, regardless of their varied content, share a common characteristic of diminishing on-task behavior during testing by redirecting attention away from pertinent cues. Diverting attention can potentially lead to misinterpretation of perceived cues. Anxiety-related self-preoccupations refer to a heightened state of worry concerning an individual's perceived deficiencies and limitations. Teachers who have higher mathematics anxiety are associated with lower mathematics achievement [39]. Additionally, they are concerned about their perceived lack of ability to manage these challenges effectively. The phenomenon of test anxiety can be ascribed to the misinterpretation of events rather than being solely contingent upon the inherent nature of the perceived danger. Pierce et al. [38] delineated the cognitive processes that transpire amidst anxiety-provoking circumstances as follows:

1. The present situation is widely regarded as challenging, requiring significant effort, and potentially threatening.
2. The individual evaluates their level of effectiveness or competence as inadequate to tackle the given task.
3. The focus of individuals is primarily centred on their inadequacies and the unfavourable consequences that arise as a result.
4. The presence of an abundance of self-deprecating thoughts has the potential to hinder the cognitive processes that are essential for the successful completion of tasks.
5. The individual demonstrates a cognitive anticipation of a negative result and the subsequent decrease in social regard from others.
6. The attention of individuals experiencing anxiety is often consumed by self-consciousness, a sense of helplessness, and the expectation of unfavourable outcomes.
7. There is an increasing amount of empirical evidence suggesting that individuals who experience test anxiety not only tend to be easily distracted by negative self-evaluative thoughts but also demonstrate an elevated susceptibility to distraction in a broader sense [25].

Boaler [7] conducted a study that found that, in addition to worry, distraction susceptibility is also a significant predictor of test anxiety. Observations show that susceptibility to distractions, even those not inherently threatening, significantly disrupts performance during tests. Distraction has a notable impact on test performance, even in situations where the cues are not perceived as threatening. Some individuals may encounter challenges in obtaining desirable outcomes on examinations due to their limited ability to efficiently filter out irrelevant information, whether it originates internally or externally. Ding [14] explores the significance of familial and interpersonal factors within the domain of test anxiety. Ding posits that the development of an internal locus of control in children is subject to various influences, such as parental child-rearing practices, standards, and expectations, as well as feedback and support systems.

Students who experience test anxiety often encounter cognitive interference, which is believed to be caused by the emergence of feelings of hopelessness and fear of failure resulting from a deficiency in internal locus [10]. The volume of academic literature pertaining to the subject of test anxiety has witnessed a notable decrease subsequent to its zenith in the 1980s. The rationale behind this phenomenon can be ascribed to the prevalent tendency of linking test anxiety with other interconnected concepts, including exam anxiety, performance anxiety, and anxiety specifically related to mathematics or statistics, as highlighted by Ünal-Karagüven [43]. Despite the decrease in research productivity, the preceding decade has observed significant advancements. Educators are well-acquainted with students who exhibit exceptional intellectual abilities and demonstrate great potential for academic success. Nevertheless, it is not an uncommon occurrence for these students to concurrently encounter elevated levels of anxiety and apprehension, particularly when faced with assessment periods. Pierce et al. [38] posit that a subset of students

may exhibit a heightened fixation on the potential adverse consequences associated with their anticipated failure, resulting in harmful cognitive patterns.

2.3 Evidence of test anxiety in secondary school students

Hembree [23] asserts that test anxiety has a negative impact on academic performance in diverse educational settings. The detrimental impact of test anxiety on the academic achievement of adolescents has been established in the research conducted by Yousefi et al. [45]. The aforementioned impact is evident through the manifestation of diminished learning abilities and hindrances in attaining outstanding academic achievements. The study conducted by Xiao [48] revealed an inverse correlation between test anxiety and test performance among Chinese senior high school students.

Ünal-Karagüven [43] conducted a study that revealed a significant proportion of high school students in Saghez City, located in the Kurdistan province, experienced test anxiety. The findings of the study indicate that a considerable proportion of male students (37%) and female students (53%) experienced the impact of this phenomenon. Yousefi et al. [45] reference Mozaffari's research to underscore the pervasiveness of test anxiety within the population of high school students in Sanandaj. The findings of the study indicate that a significant percentage of students, namely 60% of Shayeds and 50% of non-Shayeds, reported instances of test anxiety. The study conducted by Oladipo and Oqungbamila [36] aimed to investigate the association between academic levels and students' faculty as determinants of test anxiety among Nigerian students. The study's findings suggest that test anxiety is a pervasive phenomenon unaffected by students' academic level or faculty affiliation. The claims mentioned above provide support for the presence of test anxiety in senior high schools and the subsequent distress encountered by students. Despite the recognition of the issue, there is a lack of intervention programmes or research efforts aimed at addressing it, particularly within the Ghanaian context.

2.4 Symptoms of test anxiety

Scaini et al. [41] conducted a study to document the various manifestations of test anxiety. These manifestations were found to encompass physical, behavioural, and cognitive markers. The potential physical manifestations may include a range of possible bodily expressions:

1. The individual may exhibit a range of physical symptoms, including but not limited to muscle tension, headaches, stomach discomfort, nausea, rapid heart rate, irregular breathing, and dizziness.
2. Excessive perspiration on the palms of an individual's hands is a condition that involves an abnormal increase in sweat production in this specific area of the body.

The potential signs of behaviour can encompass:

1. The topic under investigation is the phenomenon of procrastination and test avoidance.
2. The phenomenon of excessive studying or cramming, when combined with insufficient nutrition, can result in detrimental effects on both academic achievement and overall well-being.
3. Sleep disorders are a common phenomenon that affects a significant portion of the population. These disorders encompass a range of conditions that disrupt normal sleep patterns and can have detrimental effects on an individual.
4. The state of being incapable of achieving relaxation and experiencing fatigue.

Possible indicators of cognition may comprise:

1. A pervasive sense of negativity or self-defeatism characterises the discourse.
2. Individuals may encounter heightened levels of anxiety and enduring apprehension, along with challenges in retrieving information during examinations.
3. One prevalent obstacle that individuals may face pertains to the difficulty in proficiently organising and expressing their thoughts.

3 Methods

3.1 Research design

The study utilised a descriptive survey design based on the quantitative approach to examine students' academic achievement and test anxiety in the subject of Mathematics within a specific sample of senior high schools in the Cape Coast Metropolis. One notable advantage of this approach was its ability to elicit a substantial volume of feedback from a wide range of individuals [11]. Additionally, the approach mentioned above provided a more accurate depiction of historical events and endeavoured to elucidate individuals' perspectives and actions based on empirical data gathered during a specific temporal juncture.

3.2 Population, sample and sampling procedure

The study's population comprised two public senior high schools, selected from a total of ten public senior high schools situated within the Cape Coast Metropolis. The study included a sample size of 1600 first-year students from two public Senior High Schools, as reported by the respective headmasters and headmistresses of the schools. The focus of the study primarily revolved around first-year students who had recently concluded their Basic Education Certificate Examination (BECE). This study aimed to examine the influence of anxiety on academic performance. The study employed a random sampling technique to select participants from the population of Visual Arts students. The accessible population for this study comprised 80 first-year Visual Arts students who were selected from two public senior high schools using a random sampling technique. The sample size for this study was determined by selecting two schools at random from the available population. The sample consisted of 80 first-year Visual Arts students. The sampling procedure utilised a multi-stage sampling technique. First, the researchers utilised a stratified sampling approach, specifically employing a proportional allocation method to guarantee fair representation of participants from every educational institution. To address the issue of potential sampling bias, a random number generator in Excel was utilised to select two schools from a pool of ten schools situated within the Cape Coast Metropolis. In addition, a single course was chosen from the available selection of six courses offered at the two senior high schools. The courses were sequentially labelled from 1 to 6 using the Excel software. Based on a simple random selection process, the Visual Arts course was chosen subsequent to a statistical analysis.

The determination of the sample size for the study was conducted using a sample size determination table developed by Krejcie and Morgan [26]. Based on the data presented in the table pertaining to sample size determination, it can be deduced that a population size of 80 is linked to a sample size of 66.

3.3 Data collection instruments

The study employed three distinct sets of instruments: the TAS, which was originally devised by Sarason [40] to assess the levels of test anxiety experienced by students before, during, and after examinations, the mathematics achievement test (MAT), which was used to gauge their mathematical achievement, and a self-developed questionnaire which was used to determine sources of students' anxiety. The data collection instrument employed in this study comprised four distinct sections, denoted as sections A, B, C, and D. Section A is specifically devoted to the collection and analysis of demographic data pertaining to the participants involved in the study. Section B of the study involves the implementation of an achievement test with the objective of assessing the academic performance of the students. In contrast, Section C centres its attention on the utilisation of particular instruments that have been specifically designed to evaluate the extent of test anxiety experienced by students. Finally, Section D encompasses the incorporation of factors that have been identified as contributing to the formation and intensification of test anxiety among students.

The TAS is composed of a comprehensive set of 37 items. Participants are kindly asked to express their concurrence by selecting the suitable response option, signifying the relevance of the emotions they encounter prior to and subsequent to an examination or test, as delineated in the statement. The evaluation of each element on the TAS was conducted utilising a five-point Likert scale ranging from strongly disagree (1) to strongly agree (5). The

scale is designed to evaluate the psychological and physiological conditions experienced by students during or following an examination, employing a self-report approach. The cumulative score achieved by the participants serves as an indicator of their level of anxiety related to examinations. The examination of the reliability and validity of the adapted TAS questionnaire was conducted in a previous study by Hatami and Ardalan [22].

The evaluation of the students' mathematics achievement was carried out by employing the MAT. The MAT consisted of a total of 30 questions derived from the previous examination papers administered by the West Africa Examinations Council (WAEC). The assessment of factors contributing to test anxiety was conducted using a questionnaire consisting of ten items. The items employed in this study were internally generated and evaluated using a 5-point Likert scale, where respondents were asked to indicate their level of agreement on a scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

3.4 Validity and reliability of the instrument

The evaluation of the face validity of the instruments was performed by experts after their creation, aiming to determine their effectiveness in measuring the intended constructs. The assessment of questionnaire reliability was conducted through the utilisation of Cronbach's Alpha coefficient, whereas the reliability of the achievement test was evaluated using KR-20. The TAS, achievement test, and factors contributing to test anxiety all demonstrated reliability coefficients equal to or exceeding 0.7, indicating that the data collection instruments exhibit a high level of excellence, particularly in the context of high-stakes testing.

3.5 Data collection procedures

After receiving approval, an introductory letter was sent to the Headmasters and Headmistresses of the two senior high schools located in Cape Coast Metropolis. The purpose of this correspondence was to formally request permission and establish a positive relationship with the potential study participants. The current study encompassed a thorough and explicit elucidation of the research's objectives and importance to both the participants and the pertinent educational authorities. Participants were given thorough information regarding the voluntary nature of their participation in the research and were informed of their right to withdraw from the study at any point during its duration without facing any obligation or penalty. The researchers themselves administered the instruments to the participants in their respective classrooms. The students were provided with guidance and given a total of 60 min to complete the assigned instruments. Concurrently, the distribution of instruments was carried out among the students.

3.6 Data processing and analysis

The analysis of the initial research question was conducted utilising descriptive statistics (means and standard deviations). Since data was collected using a 5-point Likert scale, a reference-point mean of 3.0 was used for decision-making. Mean values less than 3.0 revealed that the respondents disagreed with the statements, whereas mean values greater than 3.0 indicate that the respondents agreed with the statements. Again, standard deviations were used to supplement the mean results to determine how closely related or far apart the respondents' views were from each other when either agreeing or disagreeing on an item. Standard deviation values closer to zero (<1) signify that the responses align closely with the mean, suggesting the respondents' views are not far from each other. Conversely, standard deviation values far away from zero (≥1) indicate that responses deviate further from the mean, reflecting variations in the views of the respondents.

The analysis of the second research question was conducted utilising the cut-off thresholds as specified by Sarason [40]. The range of scores encompasses a spectrum from 1 to 185, wherein specific cut-off points have been delineated as follows: A score below 60 is indicative of low levels of test anxiety, whereas a score within the range of 61 to 100 suggests the presence of moderate anxiety. Scores that surpass the threshold of 100 are suggestive of a significant level of anxiety. Therefore, individuals who achieve a score of 60 or lower on the test can be categorised as exhibiting low levels of test anxiety. Conversely, those who achieve scores ranging from 61 to 100 demonstrate moderate levels of anxiety during testing. Additionally, individuals whose scores surpass 100 are categorised as experiencing severe anxiety.

The analysis of the third research question was conducted using simple linear regression. The analysis entailed the application of regression analysis, which was performed using data obtained from the TAS and the achievement test. The study used SPSS (version 26) software to conduct a basic linear regression analysis in order to ascertain the relationship between anxiety and academic performance. The present study aims to examine the relationship between the

Table 1 Demographic characteristics of respondents

Variables	Subscale	Frequency	Percentage (%)
Gender	Male	34	51.5
	Female	32	48.5
Age range	15 years and below	13	19.7
	16–20 years	52	78.8
	21 years and above	1	1.5

Table 2 Factors that contribute to test anxiety among students

Statement	Mean	SD
My preparedness before taking any exams	4.10	1.06
How well the teacher teaches mathematics	4.00	1.23
I feel a feeling of pressure when other people complete the task before me	3.91	1.20
Fear of letting others down	3.88	1.33
My learning disabilities	3.73	1.21
Past trauma related to test-taking	3.70	1.28
My poor study skills	3.64	1.31
Fear of failure and shame	3.56	1.45
My misconceptions about concepts in mathematics	3.29	1.37
No confidence in my ability to do mathematics	3.23	1.41

independent variable of test anxiety, commonly referred to as TA, and the dependent variable of academic performance denoted as AP. The statistical significance of the regression analysis was evaluated by employing a significance level of 0.05 ($\alpha = 0.05$). In the context of statistical analysis, an outcome is considered to possess statistical significance if the *p*-value is equal to or less than 0.05. Conversely, in cases where the *p*-value surpasses the threshold of 0.05, the observed outcome is deemed to lack statistical significance. Finally, the study employed an independent samples t-test to examine the existence of a statistical difference in the level of test anxiety of male and female students. The analysis is grounded on the underlying assumption that the research inquiry aimed to ascertain the disparities in the average scores of distinct cohorts, specifically male and female students, with regard to their levels of test anxiety.

3.7 Demographic data of respondents

According to the data presented in Table 1, it can be observed that the male participants comprised the larger proportion, representing 51.5% of the total sample. Conversely, the female participants constituted 48.5% of the overall sample. In relation to the distribution of ages, a considerable percentage (78.8%) of the participants belonged to the age range of 16–20 years. Individuals aged 15 years and below constituted the largest proportion (19.7%) of the sample, whereas those aged 21 years and above (1.5%) were the least prevalent.

4 Results

The main aim of this study was to examine the influence of test anxiety on the academic performance of senior high school students in mathematics in the Cape Coast Metropolis. Moreover, the present study aimed to examine potential disparities in the levels of test anxiety and academic achievement between male and female senior high school students in the domain of mathematics. The quantitative data analysis encompassed the utilisation of descriptive statistics, including frequencies, percentages, means, and standard deviations, in addition to inferential statistics, specifically simple linear regression and independent samples t-test.

RQ1: What are the sources of mathematics test anxiety that affect students' performance?

The results on the factors that contribute to test anxiety among students, as presented in Table 2, revealed that all factors have received positive responses, with students' preparedness before taking tasks ($M = 4.10$, $SD = 1.06$) having

the highest response. The substantial interest in students' preparedness indicates that feeling well-prepared for mathematics tests plays a crucial role in test anxiety. Students who are not fully ready might feel more anxious because they are unsure about how well they will do on the test, which can affect their performance in school. This was followed by students' agreeing that how well their teachers teach mathematics (M = 4.0, SD = 1.23) also contributes to their test anxiety in mathematics. Highlighting the impact of teachers' mathematics instruction on test anxiety emphasises the significance of implementing effective teaching methods to alleviate students' anxiety. Inadequate teaching techniques or unclear instructions can cause students to feel confused and anxious, impacting their performance on evaluations.

Additionally, the students agreed that feeling of pressure when other people complete the task before them (M = 3.91, SD = 1.20), fear of letting others down (M = 3.88, SD = 1.33), their learning disabilities (M = 3.73, SD = 1.21), and past trauma related to test taking (M = 3.70, SD = 1.28) are all contributing factors to test anxiety. Feeling pressured when others finish tasks first and fearing disappointing others emphasise the social aspect of test anxiety. Students may experience heightened anxiety when they compare themselves to their peers or sense pressure from others, resulting in elevated stress levels during assessments. Again, recognising previous trauma associated with test-taking and the existence of learning disabilities as factors contributing to test anxiety highlights the significance of taking into account individual differences and past experiences when assessing students' anxiety levels. Students who have faced past difficulties or have learning obstacles may be more susceptible to feeling anxious during tests, leading to a negative impact on their performance.

Other factors that contribute to test anxiety among the students include poor study skills (M = 3.64, SD = 1.31), fear of failure and shame (M = 3.56, SD = 1.45), misconceptions about concepts in mathematics (M = 3.29, SD = 1.37), and no confidence in their ability to do mathematics (M = 3.23, SD = 1.41). Identified factors contributing to test anxiety include poor study skills, misconceptions about mathematical concepts, and lack of confidence in mathematical abilities. The results underscore the significance of focusing on self-belief and offering assistance to students in cultivating successful study routines and belief in their mathematical skills to lower anxiety levels and enhance performance.

RQ2: What is the level of mathematics test anxiety among SHS students in the Cape Coast Metropolis?

It can be seen from Fig. 1 that 56 (84.8%) of the students have reported severe test anxiety, with the remaining 10 (15.2%) reporting moderate test anxiety. Hence, there is severe test anxiety among the students sampled for the study. The results suggest that a large number of students in Ghana suffer from intense test anxiety, causing worries about the welfare and educational achievements of students in the country. Various factors could be responsible for the high levels of test anxiety experienced by students. In Ghana, like in several other nations, students encounter crucial exams, such as the West African Senior School Certificate Examination (WASSCE), that significantly impact their future educational and professional opportunities. The demand to excel in these exams can worsen test anxiety in students, resulting in increased stress levels and adverse effects on mental well-being.

The organisation and requirements of the educational system in Ghana could also be a factor in causing test anxiety. Students frequently encounter fierce competition for restricted educational opportunities, resulting in a strong emphasis on exam results. Moreover, the focus on memorisation and standardised assessments may not match students' unique learning styles and preferences, leading to heightened levels of stress. Several educational institutions in Ghana may not have sufficient resources and support services to cater to students' mental health and overall well-being. Insufficient

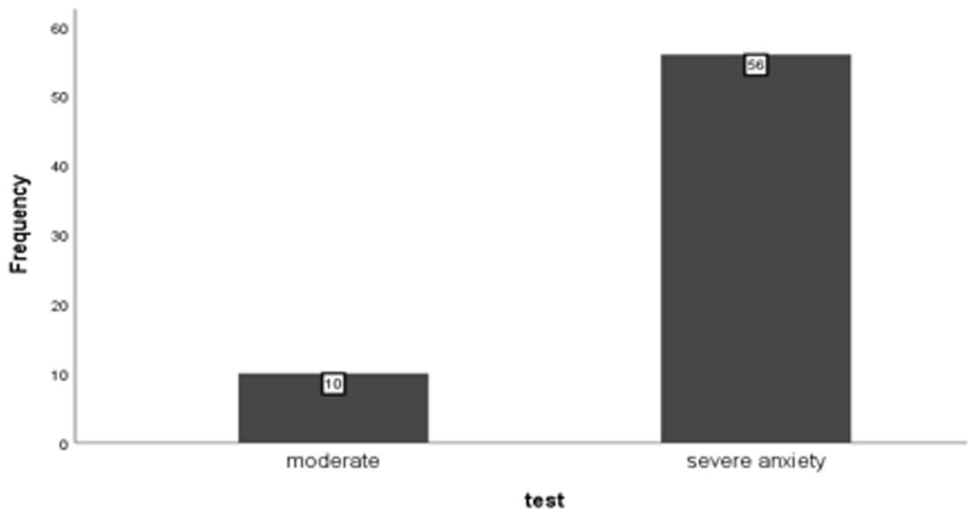


Fig. 1 Level of test anxiety among students

access to counselling services, guidance from teachers, and parental support may cause students to feel overwhelmed and unsupported in dealing with their anxiety. At times, educational methods that emphasise memorisation rather than critical thinking and problem-solving abilities can lead to students feeling anxious. Insufficient teaching methods can cause students to feel unprepared and anxious about their exam performance.

RQ3: What is the effect of test anxiety on students' academic performance in mathematics?

The ANOVA test was employed to assess the suitability of the model for evaluating the impact of test anxiety on students' academic performance in mathematics, as indicated in Table 3. The model is considered to be appropriate for the sample if the *p*-value of the F-statistic is found to be less than the predetermined significance level of 0.05. Similarly, the model is considered unfit for the sample if the F-statistic *p*-value exceeds the significance level of 0.05. According to the findings presented in Table 3, the F-statistic ($F = 7.200$, $df = 1$, $p < 0.05$) suggests that the linear regression model employed in this study is sufficient in elucidating the impact of test anxiety on students' academic achievement in the field of mathematics.

Moreover, the distinction in the independent variables, specifically test anxiety, and its impact on the dependent variable, namely academic performance, can be elucidated by the coefficient of determination. This coefficient also referred to as the proportion of the total effect of all independent variables on the dependent variable, serves to quantify the relationship between these variables.

According to the data presented in Table 4, the R-square value of 0.101 indicates that test anxiety is responsible for 10.1% of the variability observed in academic performance. This implies that there may be additional factors that contribute to the remaining 89.1% of variance in students' academic performance, which were not examined in the present study. The utilisation of the linear regression model was ultimately employed in order to ascertain the notable impact of test anxiety on the academic performance of students. The findings are presented in Table 5.

Table 5 shows that test anxiety has a significantly negative ($\beta = -0.042$, $p < 0.05$) effect on students' academic performance. The findings suggest that there is a negative relationship between test anxiety levels and academic performance among students at SHS in Mathematics in Cape Coast Metropolis. Specifically, a higher level of test anxiety is associated with a decrease in academic performance by a coefficient of 0.042. Conversely, when test anxiety among the students decreases by a unit, their academic performance is expected to increase by 0.042.

The inverse correlation between test anxiety and performance in academics emphasises the negative effects of anxiety on students' mathematics assessment results. When students face increased levels of test anxiety, they might find it difficult to focus, remember information, and use problem-solving techniques effectively during exams. This may result in decreased performance and lower grades in math classes. On the other hand, a decrease in test anxiety is projected

Table 3 ANOVA[a] test for students' academic performance and test anxiety

Model	Sum of Squares	Df	Mean square	F	Sig
Regression	71.283	1	71.283	7.200	0.009[b]
Residual	633.581	64	9.900		
Total	704.864	65			

[a]Dependent variable: academic performance in mathematics

[b]Predictors: (constant), test anxiety

Table 4 Model summary for students' academic performance and test anxiety

Model	R	R square	Adjusted R square	Std. error of the estimate
1	0.318[a]	0.101	0.087	3.15

Predictors: (Constant), Test anxiety

Table 5 Coefficient of students' academic performance and test anxiety

Model		Unstandardised coefficients		Standardised coefficients	T	Sig
		B	Std. error	Beta		
1	(Constant)	19.512	2.107		9.260	0.000
	Test anxiety	−0.042	0.016	−0.318	−2.683	0.009

[a]Dependent variable: academic performance

Table 6 Results of homogeneity of variance test

Levene's Statistic	Df	Cal. t-value	Sig	Remarks
0.122	64	−2.242	0.728	Equal variances assumed

Table 7 Independent sample t-test results for gender differences in test anxiety

	Gender	N	Mean	Std. deviation mean	Std. error mean	T	df	*p*-value
Anxiety	Male	34	126.6176	23.60022	4.04741	−2.242	64	0.028
	Female	32	140.0625	25.11000	4.43886			

to result in an increase in academic performance by 0.042 units. This quantifies the extent of the correlation between test anxiety and performance in academics, suggesting that minor fluctuations in anxiety levels can significantly affect students' mathematics performance.

H_0: There is no statistically significant difference between male and female SHS students' mathematics test anxiety levels

Table 6 demonstrates that the outcomes of Levene's test were statistically significant (t = −2.242, sig. = 0.728), indicating the assumption of equal variances. The findings suggest that the assumption of equal variances (homoscedasticity) holds, and therefore, there is no violation of the Homogeneity of Variances Test. Table 7 displays the outcomes of an independent sample t-test that examines the variance in test anxiety between male and female SHS students in the Cape Coast Metropolis.

As shown in Table 7, the average anxiety among females (N = 32, M = 140.06, SD = 25.11) is significantly higher than males (N = 34, M = 126.62, SD = 23.60). The analysis of descriptive statistics reveals notable disparities in the average scores of test anxiety among female and male students. After analysing the results, it was observed that female students demonstrated higher levels of test anxiety when compared to their male counterparts. In light of the descriptive findings, it is evident that the observed differences were not attributable to random variation, as indicated by the statistical analysis employing an independent sample t-test and p-values. The statistical analysis yielded a t-value of −2.242 with 64 degrees of freedom and a significance level of 0.028 (two-tailed). The obtained descriptive results exhibit statistical significance, indicating the presence of genuine disparities between male and female students with regard to their test anxiety.

5 Discussions

In this study, the authors seek to make a case for the importance of addressing test anxiety among senior high school students in Mathematics. The issue is highlighted as deserving of attention from educators, policymakers, and researchers. By examining different elements that influence test anxiety, exploring variations in anxiety levels between genders, and understanding how anxiety affects performance in school, the paper seeks to reveal the intricate relationship among psychological, social, and educational factors in shaping students' assessment experiences. The main point of the paper is that test anxiety negatively impacts students' performance in Mathematics at the senior high school level, particularly impacting female students. The results of the factors that contribute to test anxiety show that students' misconceptions about concepts in mathematics, fear of failure and shame, students' preparedness before taking any exams, how well the teacher teaches mathematics, students' poor study skills, the feeling of pressure when other people complete the task before them, fear of letting others down, past trauma related to test taking, no confidence in students' ability to do mathematics and students' learning disabilities are factors that affect students' performance. These findings confirm the findings of Mazana et al. [33]. It can be seen from the result that the preparedness of students before taking examinations is a major factor that affects students' performance as well as the way the teachers teach mathematics. Ayebale et al. [51] recommended that educators employ a diverse range of strategies and methodologies in order to promote equitable learning opportunities for all students. If the teaching method does not prioritise the development of understanding, students will attain lower levels of achievement in comparison to those exposed to alternative methods.

The study's findings on the extent of mathematics test anxiety among senior high school students in the Cape Coast Metropolis reveal that the students experience a high level of anxiety. Students experience anxiety when asked to demonstrate a high degree of mathematical proficiency [8, 12, 19]. Students' lack of confidence in mathematics may lead to anxiety [8]. On the other hand, anxiety exacerbates students' lack of confidence in their ability to acquire mathematical

knowledge. Innovative teaching strategies can help dispel students' uncertainty by connecting mathematical ideas to their everyday experiences. Research has also shown that teachers who exhibit anxiety related to mathematics are more likely to instill such tendencies in their students [39]. This means that in addition to attempting to address students' math anxiety, we also need to ascertain whether the instructor has ever experienced mathematics anxiety. On the other hand, Ding [14] claimed that parental raising practices can reduce pupils' anxiety about learning.

The study's findings indicate that individuals who experience anxiety in mathematics may be inadequately prepared for tests. This is evidenced by behaviours such as last-minute cramming, ineffective time management, disorganised information retention, suboptimal study habits, and preoccupation with past exam performance relative to peers and the potential negative outcomes of failure [1, 49]. As previously mentioned, the observation suggests a notable occurrence of test anxiety in mathematics.

Furthermore, the research findings concerning the correlation between test anxiety and academic performance suggest that test anxiety negatively affects students' academic achievements. Moreover, the results suggest that female students demonstrated higher levels of test anxiety when compared to male students. In light of the descriptive findings, it is evident that the observed variances were not attributed to random variation, as indicated by the statistical analysis employing an independent sample t-test and *p*-values. The findings derived from the present investigation are consistent with those of Leder [27] research that found a significant impact of gender on students' mathematics anxiety, with male students exhibiting a more pronounced decrease in mathematics anxiety compared to their female counterparts. The aforementioned statement is supported by Dortuo's [15] research, which indicated a notable distinction in anxiety reactions between genders. Specifically, females tend to report experiencing more severe symptoms of test anxiety compared to males. When examining the results obtained from self-reported test anxiety measures, it is crucial to consider the impact of gender. Furthermore, it is worth noting that there are discernible gender disparities in the experience of anxiety and its influence on academic performance, with females displaying a higher vulnerability to this phenomenon. In the Milovanovi [34] study, female students exhibit noticeably higher levels of test anxiety as compared to their male counterparts. This observation could potentially be explained by the distinct social roles that are assigned to women compared to men, as well as the increased emotional reactivity noted in females who were raised to express their emotions while males were encouraged to repress them. The results of the study show that, in comparison to their male peers, female students scored much higher on exam anxiety measures. According to Bruce's study, male senior high school students experience higher levels of exam anxiety than their female counterparts [50]. However, Abe and Gbenro [1] found that gender and class had no statistically significant discernible impact on test anxiety levels among JHS 2 and SHS 2 students in their study on the impact of test anxiety on students' performance in mathematics conducted in the state of Ekiti.

6 Conclusions and implications

The research on the factors that lead to test anxiety among senior high school students greatly enhances our comprehension of how psychological, social, and educational elements interact to influence students' test-taking experiences. The research illuminates the complex nature of test anxiety by examining factors like preparedness, quality of instruction, peer pressure, and past trauma. This thorough comprehension can guide the creation of specific interventions and support systems to meet the varied needs of students and enhance positive mental health outcomes in educational environments. Discovering the extent of test anxiety among students, with a significant number reporting high levels of anxiety, provides important insights into how common and severe test anxiety is in educational environments. This observation highlights the substantial influence that test anxiety can exert on students' educational experiences and results, especially in the realm of mathematics education at the senior high school level. The high occurrence of intense test anxiety among students emphasises the critical requirement for interventions and support services to effectively tackle this issue. Those involved in education should focus on mental health and well-being programs to reduce test anxiety and build resilience in students. Recognising and dealing with the significant levels of test anxiety experienced by students can help educational institutions establish more encouraging learning environments that promote mental well-being and success in studies.

Furthermore, acknowledging the prevalence of intense test anxiety among students highlights the significance of implementing comprehensive approaches to assessment and evaluation in educational practices. Teachers should explore different assessment methods like project-based assessments, portfolio evaluations, and performance-based assessments to decrease dependence on high-stakes testing and ease student stress. By incorporating a variety of

assessment methods and focusing on continuous assessment and enhancing skills, teachers can establish more inclusive and fair learning settings that promote students' holistic growth and success. Also, the discovery of a notable adverse impact of test anxiety on students' performance in school emphasises the crucial importance of mental well-being in influencing educational results. The results highlight the importance of implementing thorough approaches to tackle test anxiety and enhance students' mental health. Teachers can apply this knowledge to introduce evidence-based strategies to decrease test anxiety, create a nurturing learning atmosphere, and enhance students' resilience and coping abilities. By tackling test anxiety, educators can assist in unleashing students' complete potential and bolster their overall success in school.

Discovering a significant variation in test anxiety levels among male and female students enhances our comprehension of gender inequalities in educational experiences and results. This observation emphasises the significance of taking gender into account as a crucial element of students' encounters with stress related to assessments. By acknowledging the disparity in test anxiety levels between female and male students, educators and policymakers can develop targeted interventions and support services to cater to the unique needs of female students. Moreover, this discovery encourages additional investigation into the root causes of gender disparities in test anxiety. Exploring societal and cultural factors like gender socialisation, stereotype threat, and societal expectations can provide valuable insights into the reasons behind increased anxiety levels among female students during assessments. Through analysing these elements, educators and policymakers can create more specific and efficient strategies to help female students deal with test anxiety and enhance their mental health. In addition, acknowledging gender variations in test anxiety highlights the significance of establishing inclusive and fair learning settings that cater to the varied requirements of every student. Teachers can incorporate gender-sensitive teaching methods, create spaces for open discussions about stress and anxiety, and encourage a strong peer support system to alleviate test anxiety in female students. By focusing on gender disparities in test anxiety, educators can strive to create a fair educational experience for all students, irrespective of gender identity.

Author contributions Author 1 conceptualised the study, conducted the literature review, drafted the introduction and methodology sections, interpreted the results, wrote the discussion section, proofread the manuscript, and drew conclusions for the study. Author 2 interpreted the findings, wrote the discussion section, contributed to revisions throughout the manuscript, interpreted the results, proofread the manuscript, drew part of the conclusions for the study, and worked on the references for the study. Author 3 developed the data collection instruments, analysed the data, drafted the results section, interpreted the results, proofread the manuscript, drew conclusions for the study, contributed to data collection, drafted parts of the literature review, wrote the discussion section, and provided feedback on all drafts.

Data availability The datasets generated and /or analyzed during the current study are not publicly available due to privacy or ethical restrictions but are available from the corresponding author on request..

Declarations

Competing interests The authors declare no competing interests.

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