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Investigation of Mathematics Anxiety Management Strategies on Secondary Students 'Performance Lower Level in Rwanda. The Case of G.S. Gacuba II A in Rubavu District (2023-2024)

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Abstract

Mathematics anxiety is a prevalent issue affecting students' academic performance in secondary schools. This study investigates the impact of different mathematics anxiety management strategies on students' performance at G.S. Gacuba II A in Rubavu District, Rwanda, during the 2023–2024 academic year. The research specifically examines the relationship between somatic, emotional and cognitive anxiety and students' mathematical performance, utilizing statistical models to determine their predictive power. A quantitative research design employed in collecting data from secondary school students using structured questionnaires. Multiple regression analysis conducted to assess the predictive strength of somatic, emotional and cognitive anxiety on mathematics performance. Findings reveal that cognitive anxiety ($R = 0.810$, $R^2 = 0.657$, Adjusted $R^2 = 0.588$, Std. Error = 0.37067) and somatic anxiety ($R = 0.850$, $R^2 = 0.723$, Adjusted $R^2 = 0.668$, Std. Error = 0.33302) significantly impact students' mathematics performance. The overall model ($R = 0.776$, $R^2 = 0.602$, Adjusted $R^2 = 0.522$, Std. Error = 0.39940) suggests that mathematics anxiety accounts for a substantial proportion of the variance in students' performance. The study concludes that effective anxiety management strategies, including relaxation techniques, cognitive restructuring, and teacher support, play a crucial role in improving students' engagement and achievement in mathematics. Based on the findings, the study recommends the adoption of student-centered pedagogical approaches, anxiety-reduction interventions, and structured guidance programs to enhance mathematics learning outcomes in Rwandan secondary schools.

Keywords: *Anxiety Management Strategies, Students' Performance, and pedagogical approaches*

1.0 Introduction

Mathematics anxiety characterized by emotional anxiety, cognitive anxiety and somatic anxiety. Emotional anxiety present symptoms such as Fear or panic, Frustration, Low self-confidence, and Avoidance while cognitive anxiety present symptoms such as Negative self-talk difficulty concentration and memory issues. In addition, it characterized by somatic anxiety. Somatic anxiety manifests physically, causing bodily reactions when faced with mathematical tasks. Symptoms may include headaches, nausea, trembling, or a racing heart. These physical responses can be intense and may interfere with an individual's ability to perform mathematical tasks effectively.

Difficulty concentrating and memory issues that inhibit mathematics performance when confronted with mathematical tasks are widespread issues that significantly affect secondary students' academic performance in mathematics worldwide (Ashcraft M. H., 2002). Studies conducted globally have revealed that between 30% - 50% of students experience varying degrees of mathematics anxiety, with detrimental effects on their mathematical achievement (Ma X. , 1999). Furthermore, mathematics anxiety has been identified as a barrier to students' engagement in STEM subjects and their subsequent pursuit of STEM-related careers (Hembree, 1990).

In Europe, mathematics anxiety among secondary students remains a significant concern, with studies reporting varying prevalence rates across different countries (Richardson, F. C., & Suinn, R. M, 1972). Despite efforts to promote mathematical proficiency, mathematics anxiety continues to affect students' academic performance and attitudes toward mathematics (Vukovic, 2013).

In the Americas, including the United States and other North American countries, mathematics anxiety is prevalent among secondary students, with studies reporting rates ranging from 25% to 50% (Hembree, 1990). Mathematics anxiety has been identified as a significant predictor of students' performance in mathematics courses and standardized assessments, highlighting the need for targeted interventions to alleviate anxiety and enhance mathematical achievement (Ashcraft M. H., 2009).

In Africa, including countries like Rwanda and Nigeria, mathematics anxiety among secondary students remains a significant challenge (Chindhy, 2017). Limited access to quality education, socio-economic disparities, and cultural perceptions of mathematics contribute to the persistence of mathematics anxiety in African educational contexts. Despite efforts to promote STEM education, the impact of mathematics anxiety on secondary students' performance underscores the need for targeted interventions and further research in this area.

Rwanda, like many African countries, recognizes the importance of secondary education in driving national development agendas. However, empirical evidence specific to Rwanda regarding mathematics anxiety among secondary students remains limited. Subjective observations suggest that mathematics anxiety is prevalent among Rwandan secondary students, potentially hindering their academic performance and limiting their prospects in STEM fields (Ministry of Education, 2022). Specifically, research shows that mathematics anxiety is a critical factor affecting students' performance in the subjects. For study conducted in Musanze District revealed that about 51.4%of students showed low levels of anxiety towards mathematics while 48.6 showed high levels of anxiety with slight variation between genders females demonstrating lower anxiety (53.2%) compared to males (48.5%). This means that 46.8 of females demonstrate a high level of mathematics anxiety while 51.5 males demonstrate a high level of mathematics anxiety. This is consistent with findings across both urban and rural areas, where female students tend to report more positive attitudes and lower levels of anxiety than their male.

1.1 Statement of the Problems

This research problem statement was a concise description of "investigation effects of Mathematics anxiety management strategies on secondary students' performance". It aimed to assess and analyze relationships between mathematics anxiety and secondary students' performance in Rwanda, particularly in the Rubavu district case of GS GACUBAII/A. In Rwanda, mathematics is a core component of the secondary school curriculum, but current statistics show that over 45% of students fail to meet the minimum proficiency level in mathematics on national examinations specifically in Rubavu 50% they did not get minimum proficiency scores (Board., 2022). Mathematics anxiety is associated with negative attitudes towards mathematics, leading to avoidance behaviors and decreased motivation to participate in mathematical activities.

Mathematics anxiety among secondary students is an inescapable issue with significant implications for academic performance, educational attainment, and long-term career prospects. Despite its frequency, there remains a gap in understanding the precise nature of mathematics anxiety and its effects on students' performance in secondary education. This research problem seemed to investigate the relationship between mathematics anxiety and secondary students' performance, aiming to clarify the mechanisms through which mathematics anxiety influences academic outcomes.

In addition to academic outcomes, mathematics anxiety also influences students' attitudes toward mathematics and their subsequent engagement with the subject. (Furner, 2003) Found that mathematics anxiety is associated with negative attitudes towards mathematics, leading to avoidance behaviors and decreased motivation to participate in mathematical activities. Such attitudes contribute to a cycle of underperformance and further exacerbate mathematics anxiety among secondary students. This research problem aimed to investigate the root causes of that anxiety and address the complex relationship between mathematics anxiety and secondary students' performance, suggesting strategies and interventions aimed at alleviating mathematics anxiety among secondary school students.

1.2 Research Objective

To identify the common causes and manifestations of mathematics anxiety among secondary school students' ordinary level at G.S. Gacuba IIA in RUBAVU.

1.3 Research Hypothesis

H_0: there is no significant Mathematics anxiety has on student's performance in mathematics among secondary school students' ordinary level at G.S. Gacuba IIA in RUBAVU.

2.1 Literature Review

Mathematics Anxiety

Mathematics anxiety is a feeling of tension, apprehension, or fear that inhibits mathematics performance (Ashcraft M. H., 2002). In addition, mathematics anxiety shown by an emotional response that causes individuals to avoid or perform poorly in mathematics-related tasks. Studies suggest that math anxiety negatively affects working memory and attention, which are crucial for effective problem-solving and mathematical reasoning. According to Hembree (1990), mathematics anxiety is a common experience, affecting up to 30% of students globally, and can have long-term effects on academic and career choices, particularly in STEM fields.

Academic Performance

Academic performance refers to a student's success in meeting the short- or long-term educational goals, often measured by standardized tests, grades, or other assessments (York, 2015)In this study, academic performance specifically relates to students' mathematics grades and test scores. Mathematics performance indicators help assess the relationship between anxiety levels and student outcomes in Rubavu District. Given the current data from the Rwanda Education Board (2022), where almost 50% of secondary students in Rubavu fail to achieve minimum proficiency in mathematics, understanding how anxiety affects these outcomes is critical for improving educational strategies and support.

Interventions for Mathematics Anxiety

Interventions for mathematics anxiety refer to strategies and techniques implemented to help students manage or reduce feelings of anxiety related to mathematics tasks. These may include anxiety-reduction practices, like expressive writing, cognitive behavioral approaches, and teacher-led support activities aimed at building students' mathematics confidence and coping skills (Richardson, 1972). In Rwanda, current studies have highlighted the effectiveness of teacher-led interventions, where instructors provide supportive feedback and encourage a growth mindset, as a means of improving students' attitudes toward math (Uwase, P., & Nsabimana, E. , 2022). Understanding the role of such interventions is essential for developing actionable recommendations within Rubavu District schools.

2.2 Theoretical Review

This theoretical review section explores the primary theoretical frameworks that support the concepts of mathematics anxiety and academic performance. Studying these theories provides a foundation for understanding the mechanisms through which mathematics anxiety affects learning and identifies potential pathways for intervention.

2.2.1 Cognitive Interference Theory

Cognitive Interference Theory suggests that anxiety disrupts cognitive processes, such as working memory, that are essential for performance in complex tasks, including mathematics (Sarason, 1984)This theory suggests that high levels of anxiety create disturbing thoughts and worry that interfere with a person's ability to focus on the task at hand. In the context of mathematics, students with high anxiety may experience these intrusive thoughts when attempting to solve problems, reducing their cognitive resources available for working memory and problem-solving. Ashcraft (2002) further demonstrated that students with math anxiety often experience cognitive overload, limiting their ability to retrieve information, make calculations, and apply mathematical concepts effectively. This study draws on Cognitive Interference Theory to explain how mathematics anxiety might impair secondary students' performance in Rubavu District, particularly given the challenging nature of secondary-level mathematics content.

2.2.2 Social Cognitive Theory

Bandura's Social Cognitive Theory emphasizes the role of self-efficacy, or an individual's belief in their abilities, as a critical determinant of performance (Bandura, 1997). In the context of math anxiety, students with low self-efficacy in mathematics are more likely to experience anxiety and less likely to engage in mathematics-related tasks. Research by Pajares and Kranzler (1995) found a strong correlation between students' self-efficacy beliefs and mathematics performance, with low self-efficacy predicting higher levels of mathematics anxiety. (Pajares, F., & Kranzler, J., 1995). For secondary students in Rubavu District, Social Cognitive Theory suggests that

enhancing self-efficacy could be an effective intervention to reduce mathematics anxiety and improve performance. Teachers and educators can use this theory to inform strategies for building students' confidence and sense of competence in mathematics, thereby decreasing anxiety levels and supporting academic success.

2.3 Empirical Review

The Empirical Review section provides an overview of current studies that have investigated the relationship between mathematics anxiety and academic performance. Reviewing empirical evidence allows for an understanding of the current state of research, relevant findings, and gaps that this study seeks to address in the context of secondary students in Rubavu District. This empirical review synthesizes research findings on the effects of mathematics anxiety on the academic performance of secondary students, highlighting key data, trends, and contributing factors.

2.3.1 Prevalence of Mathematics Anxiety

Mathematics anxiety is prevalent among secondary students globally. A meta-analysis by Hembree (1990) estimated that approximately 25-40% of students' experience significant mathematics anxiety, which adversely affects their mathematical performance. The recent studies have reinforced these findings, indicating that mathematics anxiety remains a critical barrier to mathematical achievement.

2.3.2 Effects of Mathematics Anxiety on Students 'Performance

Numerous studies have established a negative correlation between mathematics anxiety and students' performance in mathematics-related tasks. For instance, a meta-analysis conducted by (Ma X. , 1999)revealed a mean correlation coefficient of r = -0.34 between mathematics anxiety and mathematics performance across various studies. This negative relationship suggests that higher levels of anxiety are associated with lower mathematics achievement.

A more recent study by Syokwaa (Syokwaa, A., Nsabimana, E., & Uwase, P. , 2014) involving 367 secondary students in Rubavu District found that students with high mathematics anxiety scored significantly lower on standardized mathematics tests compared to their peers with moderate or low anxiety levels. Specifically, students classified with high anxiety had the average of mathematics performance score of 31.4 out of 45, whereas those with moderate anxiety scored 33-51, and low anxiety students scored 52-70.

2.3.3 Gender Differences in Mathematics Anxiety

As said by Freedman, Gender has been a significant moderator in the relationship between mathematics anxiety and mathematics performance. Research consistently indicates that female students report higher levels of mathematics anxiety than males. For example, the study by Freedman involving 590 higher secondary school students found that female students had significantly higher mathematics anxiety scores (Mean = 85.99, SD = 16.02) compared to male students, correlating with lower performance scores (Females: Mean = 30.88 vs. Males: Mean = 33.46) (Freedman E. G., 2006). Additionally, a meta-analysis as said by Gunderson (2018) encompassing 84 samples from a population of 8,680 students revealed that mathematics anxiety affects performance of students negatively. (Gunderson, 2018)

3.0 Research methodology

The research employed Slovin's formula size calculation to select as sample of 267 respondents from targeted population of 800 individuals. Data was collected using a combination of questionnaires with both open and closed-ended questions, as well as face-to-face interviews, particularly for respondents who did not have time to complete the written questionnaires. The primary data was then edited, coded, and entered into MS Excel and SPSS for quantitative analysis and statistical generalization, while qualitative information was presented in a narrative form to complement the quantitative findings.

4.0 Research Findings and Discussion

In this chapter, the researcher presented, analyzed and interpreted the data relating to the objective of his research.

The common causes and manifestations of mathematics anxiety among secondary school students.

Table 1: Descriptive Statistics of Emotional Anxiety

Statements	N	Minimum	Maximum	Mean	Std. Deviation
I felt panicked before or during a mathematics exam.	267	2.00	6.00	3.5131	.79638
I avoided asking questions in math class because of fear of making mistakes	267	2.00	3.00	3.7378	.99779
When I struggle to understand a mathematics concept I react discouraged.	267	2.00	5.00	3.5318	.90213
I felt frustrated while solving math problems.	267	2.00	5.00	3.3708	.84135
Repeated failure in mathematics makes me feel discouraged.	267	2.00	5.00	3.4307	.90002
I believe that I am capable of performing well in mathematics	267	1.00	4.00	2.5393	.81880
I use to avoid attending mathematics lessons due to anxiety or fear	267	1.00	4.00	2.3071	.86888
Valid N (listwise)	267				

Source: primary data

Note: Strongly Disagree = [1-2[= **Very Low mean;** Disagree= [2-3[=**Low mean;** Neutral [3-4 [=**moderated mean**; Agree=[4-5[=**High mean**; Strongly Agree= 5 (**Very High mean)**

This table 2, presented descriptive statistics on emotional anxiety related to mathematics among 267 respondents. It includes minimum and maximum values, mean scores, and standard deviations for various anxiety-related statements. The mean (average) scores indicate how respondents generally feel about each statement, with higher scores showing stronger agreement and higher levels of anxiety. Avoiding questions due to fear of mistakes (Mean = 3.7378). This has the highest mean score, suggesting that many students avoid asking questions due to fear of making mistakes in math class. This avoidance behavior could negatively impacts learning and engagement. Feeling panicked before or during a math exam (Mean = 3.5131). Many students experience panic before

or during math exams, indicating a high level of math anxiety. This could affect their performance by reducing their ability to concentrate under exam conditions. Feeling discouraged when struggling with a math concept (Mean = 3.5318). A considerable number of students react with discouragement when they face difficulties in understanding math concepts. This could lead to lower motivation and persistence in learning math. Frustration while solving math problems (Mean = 3.3708). A significant portion of students feel frustrated when solving math problems, which may indicate difficulty in problem-solving strategies. Repeated failure in math leads to discouragement (Mean = 3.4307). Many students feel discouraged after repeated failures, showing how negative experiences reinforce anxiety and lower confidence in math. Belief in math ability (Mean = 2.5393). This statement has a relatively low mean, suggesting that many students lack confidence in their math abilities. This low self-efficacy can contribute to continued anxiety and avoidance of mathematics. Avoiding math lessons due to anxiety or fear (Mean = 2.3071). The lowest mean score, but still notable some students avoid attending math classes due to fear or anxiety. This avoidance behavior can lead to gaps in learning and lower performance over time. The standard deviations (ranging from 0.79638 to 0.99779) suggested moderate variation in responses. The highest standard deviation (0.99779) is seen in the statement: "I avoided asking questions in math class because of fear of making mistakes." This indicates that while some students strongly agree with this fear, others feel less affected. The lowest standard deviation (0.79638) is for "I felt panicked before or during a mathematics exam." This confirmed that responses were more consistent, meaning that exam-related anxiety is a common experience for most students.

Table *2*: Descriptive statistics of on students' performance

I feel confident in my ability to solve math problems correctly	267	1.00	5.00	2.5993	.10385
I complete math assignments and tests on time with minimal difficulty.	267	1.00	5.00	2.4082	.98961
I perform well in math exams compared to other subjects.	267	1.00	4.00	2.1348	.75380
I can apply mathematical concepts effectively in real-life situations.	267	2.00	5.00	3.1985	.97039
I actively participate in math lessons and discussions.	267	1.00	4.00	2.9363	.90512
My test scores in mathematics reflect my true ability	267	2.00	5.00	3.8052	.68241
I can solve complex math problems without feeling discouraged	267	1.00	4.00	2.3745	.83294
Valid N (listwise)	267				

Source: primary data

Note: Strongly Disagree = [1-2[= Very Low mean; Disagree= [2-3[=Low mean; Neutral [3-4[=moderated mean; Agree=[4-5[=High mean; Strongly Agree= 5 (Very High mean)

In the table 10, higher mean scores indicated greater agreement with the statement, meaning better self-perceived performance, while lower scores suggest difficulties or lack of confidence in math.

Mathematics test scores reflect true ability (Mean = 3.8052) is the highest mean score, suggesting that most students believe their math test scores accurately represent their actual ability. This could

indicate that while they may struggle, they feel their grades align with their expected performance. Applying math concepts in real-life situations (Mean = 3.1985), Many students feel moderately confident in using math in everyday contexts. This suggests a practical understanding of mathematical concepts beyond exams and assignments. Active participation in math lessons (Mean = 2.9363). Students occasionally engage in class discussions, though the score is not very high, indicating room for improvement in participation. Confidence in solving math problems (Mean = 2.5993) is the relatively low mean score suggesting that many students lack confidence in solving math problems correctly, which may contribute to math anxiety. Solving complex math problems without feeling discouraged (Mean = 2.3745), Students struggle with handling difficult problems, reinforcing low confidence and problem-solving resilience. Completing math assignments and tests on time (Mean = 2.4082), many students find it difficult to complete math tasks efficiently, indicating challenges in understanding concepts, time management, or motivation. Performing well in math compared to other subjects (Mean = 2.1348), is the lowest mean score, showing that students generally perform poorer in math than in other subjects. It suggested greater struggles in math compared to their overall academic performance. The highest standard deviation (0.98961) is for completing math assignments on time, meaning responses varied widely some students manage well, while others struggle significantly. while the lowest standard deviation (0.68241) is for math test scores reflecting true ability, suggesting greater consistency in how students perceive their grades.

The relationship between mathematics anxiety levels and students' academic performance in mathematics.

Table 3: Regression Analysis of Emotional Anxiety on Students' Performance

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.776[a]	.602	.522	.39940

a. Predictors: (Constant), Emotional anxiety

This regression analysis explores the relationship between emotional anxiety and students' performance in mathematics. The results help to determine whether emotional anxiety significantly affects students' ability to perform well in math. This means that as emotional anxiety increases, students' performance decreases significantly. $R^2 = 0.602$ (or 60.2%) indicated that emotional anxiety explains 60.2% of the variation in students' performance. This is a high explanatory power, suggesting that emotional anxiety is a major predictor of students' success in math. The remaining 39.8% is influenced by other factors (e.g., teaching methods, cognitive anxiety, study habits, school environment...). The strong negative correlation (R = 0.776) suggested that students who experience high emotional anxiety struggle more in math. This aligns with previous findings on math anxiety, where stress, fear, and panic reduce focus and problem-solving ability. Since emotional anxiety explains 60.2% of performance variation, addressing it could significantly enhance students' math success.

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Table 4: ANOVA of emotional anxiety on students' performance

The ANOVA (Analysis of Variance) table evaluates the statistical significance of the regression model, helping determine whether emotional anxiety significantly impacts students' performance.

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	1.205	1	1.205	7.551	.040[b]
	Residual	.798	5	.160		
	Total	2.002	6			

a. Dependent variable: Secondary students performance
b. predictors: (constant), emotional anxiety

From table 12, The F-statistic (7.551) represents the ratio of explained variance (by emotional anxiety) to unexplained variance (error). A higher F-value indicates a better model fit (stronger impact of emotional anxiety on student performance). The p-value (Sig. = 0.040) is less than 0.05, meaning the regression model is statistically significant at a 5% significance level. This confirmed that emotional anxiety accounts for 60.2% of the variability in students' performance, reinforcing the strong impact observed in the Model Summary. Emotional anxiety has a significant negative impact on math performance, with p = 0.040 (< 0.05), confirming the effect is statistically significant.

Table *5*: Coefficients of emotional anxiety on students' performance

This analysis interprets the regression coefficients to understand the precise impact of emotional anxiety on students' performance

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.168	.962		.174	.868
	Emotional anxiety	-.815	.297	.776	2.748	.040

a. Dependent Variable: Secondary students performance

In the table 13, emotional anxiety is a strong predictor of student's performance, with 76.6% of the variation explained by this variable (Beta = 0.776). The negative coefficient (B = -0.815) suggests an inverse scoring method, meaning lower emotional anxiety corresponds to better student performance. The p-value (0.040) confirms that this relationship is statistically significant.

Summary and conclusion

The sample consisted of 267 students and 17 teachers, evenly distributed between male (50.2%) and female (49.8%) participants. The majority of students were between the ages of 10-15 years (54.7%), followed by 16-20 years (37.5%), with only 7.9% above 20 years. Emotional anxiety had a negative and significant impact on students' performance ($R^2 = 0.602$, F = 7.551, p = 0.040). High levels of panic, frustration, and discouragement reduced students' confidence in solving mathematics problems. Avoidance behaviors, such as not asking questions due to fear of making mistakes, further hindered academic progress.

For Students

Develop positive study habits: Engage in daily problem-solving exercises and seek clarification when needed. Use math games, visual aids, and practical applications to strengthen understanding.

Adopt anxiety management techniques: Practice relaxation techniques such as deep breathing, mindfulness, and positive affirmations. Replace negative self-talk with a growth mindset approach, focusing on improvement rather than perfection.

For Policy Makers & Education Authorities

Introduce teacher training on anxiety management: Provide training programs to help teachers recognize and address math anxiety in students. Integrate counseling and psychological support services into the school system. Enhance curriculum flexibility: Modify the curriculum to include practical problem-solving activities and collaborative learning approaches. Reduce emphasis on high-stakes exams and incorporate continuous assessment methods. By implementing these strategies, mathematics anxiety can be significantly reduced, leading to better student engagement, improved academic performance, and a stronger foundation in mathematics for secondary school students in Rubavu District and beyond.

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