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Exploring the Relationship between Mathematics Anxiety, Interest, and Academic Achievement among Secondary School Students

Dr.Venu Balakonda[1*]

[1*]Assistant Professor, MNR PG Teacher Education College, Kukatpally, Hyderabad, Telangana, India. Email: balakondav@gmail.com

Abstract
This study explores the complex relationship between mathematics anxiety, interest, and academic achievement among secondary school students in Telangana, India. Recognizing the significance of affective factors in mathematics learning, the research investigates how students' interest in and anxiety toward mathematics influence their academic performance. A sample of 30 ninth-grade students from both rural and urban schools participated in the study. Two researcher-developed instruments—a Mathematics Interest Questionnaire and a Mathematics Anxiety Scale—were used alongside Summative Assessment-1 scores to assess academic achievement. Results indicated high levels of interest ($M = 86.30$) and moderate anxiety ($M = 57.23$) among students. A strong positive correlation was found between mathematics interest and academic achievement ($r = .734$, $p < .001$), while a moderate negative correlation was observed between anxiety and performance ($r = -.389$, $p = .000$). Regression analysis revealed that mathematics interest significantly predicted academic success ($\beta = .682$, $p < .001$), whereas anxiety, though negatively associated, did not contribute significantly when combined with interest ($\beta = -.149$, $p = .285$). These findings emphasize the dominant role of interest in shaping academic outcomes, suggesting that fostering student engagement and enjoyment can mitigate the adverse effects of anxiety. The study advocates for interest-driven teaching strategies and emotionally supportive learning environments. Limitations include a small sample size and limited generalizability. Future research should consider larger, more diverse populations and longitudinal designs to further examine the interplay of psychological factors influencing mathematics achievement.

Key words: Mathematics Anxiety, Mathematics Interest, Academic Achievement, Secondary School Students, Affective Factors in Learning

1. Introduction

Background and Significance of Mathematics Education in Secondary Schools

Mathematics learning at the secondary stage is pivotal in developing analytical thinking, problem-solving abilities, and orientation toward higher education or a competitive job market. According to Yeh et al. (2019), the 21st Century sees global competition where success in mathematics would go a long way in justifying the parameter of success.

Mathematics proficiency can be utilized toward nurturing the cognitive ability of the student as well as in catering to the individual's need in an ever-growing technology-driven world. Psychological variables like interest in mathematics and anxiety can significantly impact students' involvement and performance.

Problem Statement: The Impact of Mathematics Anxiety and Interest on Students' Academic Achievement

Mathematics anxiety is a feeling of tension and apprehension (Rani & Rani, 2024) along with no interest towards mathematics, most importantly acting as inhibitions to high academic achievement among the secondary school learners.

There was a significant negative relationship between mathematics anxiety and performance, according to Namkung et al. (2019), whilst Akorede et al. (2024) showed a positive effect of interest on mathematics achievement. All together, these factors pull in different directions over how well students perform in mathematics because anxiety could lead to withdrawal and poor performance while interest might increase motivation and improve success. Their interaction will thus be a key issue in dealing with underachievement and improving students' outcomes.

Objectives of the Study

The study aims to:

- Assess levels of mathematics interest and anxiety among secondary school students.
- Examine the relationship between mathematics interest and academic achievement.
- Examine the relationship between mathematics anxiety and academic achievement.
- Examine the relationship between mathematics interest, mathematics anxiety, and academic achievement.

Research Questions/Hypotheses

The study addresses the following research questions:

1. What are the levels of mathematics interest and anxiety among secondary school students?
2. How does mathematics interest correlate with academic achievement in mathematics?
3. How does mathematics anxiety correlate with academic achievement in mathematics?
4. What is the combined influence of mathematics interest and anxiety on academic achievement?

Hypotheses:

- H1: Higher mathematics interest is positively correlated with higher academic achievement.
- H2: Higher mathematics anxiety is negatively correlated with academic achievement.
- H3: Mathematics interest and anxiety together significantly predict academic achievement, with interest having a positive effect and anxiety a negative effect.

Review of related Literature

Theoretical Frameworks on Mathematics Anxiety and Interest

Mathematics anxiety is widely understood as a negative emotional reaction toward mathematics, which can hinder performance and motivation. Drawing from Bandura’s triadic reciprocal causation model, the interaction between environmental, cognitive, and behavioral factors is central in shaping students' mathematical experiences (Tosto et al., 2016). Within this framework, mathematics interest and self-efficacy are pivotal constructs that mediate the effects of the learning environment on achievement.

Previous Studies

Mathematics Anxiety and Its Effects on Performance

It has been seen and reported by a great number of scientific studies that there is a negative and consistent relationship between mathematics anxiety and academic performance. For instance, Namkung, Peng, and Lin (2019) performed a meta-analysis about mathematics anxiety correlating to performance. It found mathematics anxiety significantly negatively related to math performance ($r = -0.34$) along with stronger effects on the assessments attached to student grades. Rani and Rani (2024), on the other hand, were focused on how anxiety would affect the performance of students in doing their habits and shed their confidence, particularly from middle school onward.

Role of Interest in Academic Achievement

Mathematical interest is one of the fundamental motivating factors that have a direct positive effect on achievement in academics. According to Yeh et al. (2019), technology-enhanced learning such as "Math-Island" can create interest and achievement in mathematics. This corroborates that interest and motivation are significant predictors of mathematics achievement among junior secondary school students (Akorede et al., 2024).

Interplay Between Anxiety, Interest, and Performance

The latest research trend emphasises the dynamic interconnection among interest, anxiety, and performance. For example, Du et al. (2021), in their research, discovered that interest in mathematics has a direct relationship with achievement and that the same achievement can be measured using self-efficacy and anxiety as mediators. Zhang and Wang (2020) asserted this by saying that part of this positive effect of interest on achievement is mediated through self-efficacy and lower anxiety as well. Moreover, Gunderson et al. (2018) stated that motivational beliefs, anxiety, and achievement create a reciprocal relationship between them early on during elementary school and indicate that early intervention would be sufficient for remedying the negative cycles.

Gaps in the Literature That This Study Addresses

While the existing literature provides extensive insights into individual relationships between mathematics anxiety, interest, and achievement, fewer studies explore their "interplay using longitudinal and context-specific data", particularly in diverse educational settings such as Indian secondary schools. Additionally, "the moderating roles of self-efficacy, socio-economic context, and instructional strategies" remain underexplored. The aim of this research is to bridge those gaps with regard to the intertwined effects of the psychological constructs on mathematics achievement of secondary students in a local context.

Methodology

Sample and sampling technique

The sample in the study included 30 ninth-graders who were selected through simple random sampling from Khammam and Rangareddy districts, from urban and rural schools of Telangana. All these students attended English medium schools so as to ensure uniformity concerning the language of instruction. This strategy was meant to reflect some diversity due to the varying geographical and educational contexts within the state to generalize the findings.

Tools of the study

Two researcher-developed instruments were developed to measure affective factors regarding mathematics achievement. The Mathematics Interest Questionnaire targets interest from five dimensions: enjoyment, engagement, relevance, confidence, and preference. The Mathematics Anxiety Scale probes anxiety from five dimensions: emotional reactions, avoidance, confidence, test anxiety, and physiological symptoms. Both instruments had 20 items each, and these were first piloted on a group of 30 students for reliability and validation purposes. On the other hand, achievement level concerning the performance in mathematics is measured through scores gotten from Summative Assessment 1 (SA-1), which was obtained from school records and served to standardize the mathematics performance.

Reliability and Validity of the Questionnaires

The further procedure was to check the reliability and internal consistency of questionnaires with a sample of 30 students from a secondary school. For instance, MI has an alpha coefficient value of 0.848, average scores ranging from 3.80 to 4.73 across the five scales into which it is sub-divided, showing a high degree of reliability and indeed positive interest of the student. The MA

questionnaire, on the contrary, had an even higher reliability at a Cronbach's Alpha of .938, and the mean scores (i.e., 1.87 to 3.73) suggested levels of moderate anxiety. The construct validity was affirmed through the Exploratory Factor Analysis (EFA) and the variance explained for MI and MA questionnaires were 70.17 % and 81.75 %, respectively. Moreover, criterion-related validity, signified by significant correlations with academic performance, was evidenced as MI positively correlated to SA-1 ($r=0.734$, $p < 0.001$) and negatively correlated with MA ($r = -0.389$, $p = 0.034$).

Procedure of Data Collection and Analysis

Data collection took place during the schools' hours, after obtaining permission from the authorities, and informed consent was collected from students. Ethical standards, including confidentiality, voluntary participation, and the right to withdraw, were strictly maintained. Responses on both questionnaires were scored using a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree). Data analysis involved descriptive statistics (mean, standard deviation) to identify trends in interest, anxiety, and achievement. Correlation analysis explored relationships among these variables, while regression analysis assessed the predictive influence of mathematics interest and anxiety on academic achievement.

Results

Objective 1: Assess levels of mathematics interest and anxiety among secondary school students.

Table 1: Shows that Assessment of Mathematics Interest (MI) and Mathematics Anxiety

	N	Minimum	Maximum	Mean	Std.Deviation
MI	30	69.00	97.00	86.30	7.63
MA	30	20.00	91.00	57.23	18.12

Table 1 presents Mathematics Interest (MI) and Mathematics Anxiety (MA) statistics among thirty participating individuals. The MI score is as low as 69 and as high as 97, with an average value of 86.30 and a standard deviation of 7.63, indicating that most respondents are likely to have a high interest in mathematics, with not much variation. By contrast, the MA score is very wide-ranging, starting from 20 and up to 91. It has an average of 57.23 and even higher standard deviation of 18.12, indicating a very high variation of anxiety levels in students. Compared to that, one could say that there is high interest and even consistency in terms of interest toward mathematics at this point however; picture on experiences of anxiety could be varying greatly with a number of students experiencing thus much anxiety towards mathematics. It can implicitly be suggested from the data that there may be some sort of negative correlation between interest and anxiety, although this would need to be substantiated by an additional statistical analysis, such as a correlation test.

Objective 2: Examine the relationship between mathematics interest and academic achievement

H1: Higher mathematics interest is positively correlated with higher academic achievement.

Table 2: Shows that Correlation between Mathematics Interest and Academic Achievement

Variable	**Mean**	**Std. Deviation**	**N**	**MI**	**SA Marks**
1. Mathematics Interest (MI)	86.30	7.63	30	1.00	0.734 (P=0.000)
2. SA Marks	67.83	8.82	30	0.734 (P=0.000)	1.00

The above table 2 presents the correlation between Mathematics Interest (MI) and academic performance, measured through summative assessment marks, for a sample of 30 secondary school students. The average MI score was 86.30 (SD = 7.63), indicating a generally high level of interest in mathematics, while the mean Mathematics assessment score was 67.83 (SD = 8.82), reflecting moderate academic performance. A strong, statistically significant positive correlation was found between MI and summative assessment marks ($r = .734$, $p < .001$), suggesting that students with higher interest in mathematics tend to achieve better academic results. This result supports the

predictive validity of the MI questionnaire and underscores the important role of student interest in influencing academic success in mathematics. This shows that our hypothesis is true in this case.
Objective 3: Examine the relationship between mathematics anxiety and academic achievement.
H2: Higher mathematics anxiety is negatively correlated with academic achievement.

Table 3: Shows that Correlation between Mathematics Anxiety and Academic Achievement

Variable	Mean	Std. Deviation	N	MA	SA Marks
1. Mathematics Anxiety (MA)	57.23	18.12	30	1.00	-0.389 (P=0.000)
2. SA Marks	67.83	8.82	30	-0.389 (P=0.000)	1.00

Table 3 presents the correlation between Mathematics Anxiety (MA) and Academic Achievement, as measured by SA Marks, based on a sample of 30 participants. The mean score for MA is 57.23 with a standard deviation of 18.12, indicating generally high levels of anxiety with moderate variability. SA Marks have a mean of 67.83 and a standard deviation of 8.82, showing a slightly wider spread in academic performance. The Pearson correlation coefficient between MA and SA Marks is **-0.389**, which is statistically significant (**p = 0.000**). This negative correlation suggests that higher levels of mathematics anxiety are associated with lower academic achievement. The statistical significance indicates that this relationship is unlikely to be due to chance, highlighting the potential impact of anxiety on students' performance in mathematics. In this case our hypothesis 2 is accepted.
Objective 4: Examine the relationship between mathematics interest, mathematics anxiety, and academic achievement.
H3: Mathematics interest and anxiety together significantly predict academic achievement, with interest having a positive effect and anxiety a negative effect.

Table 4: shows correlation between Mathematics Interest (MI), Mathematics Anxiety (MA) and academic achievement (Regression Analysis)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.748a	.559	.526	6.069

a. Predictors: (Constant), MA, MI

ANOVA					
Model	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Regression	1259.570	2	629.785	17.097	000b
Residual	994.592	27	36.837		
Total	2254.167	29			
Coefficients					
Model	**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
	B	Std. Error	Beta		
(Constant)	4.014	15.404		.261	.796
MI	.788	.158	.682	4.994	.000
MA	-.072	.066	-.149	-1.091	.285

a. Dependent Variable: **SUMMATIVE ASSESSMENT MARKS**
b. Predictors: (Constant), MA, MI

The regression analysis presented in Table 4 explores the predictive relationship between Mathematics Interest (MI), Mathematics Anxiety (MA), and academic achievement, as measured by summative assessment marks. The model reveals a strong correlation (R = .748) and a substantial

proportion of explained variance (R^2 = .559; Adjusted R^2 = .526), indicating that approximately 55.9% of the variance in academic achievement is accounted for by the combined influence of MI and MA. The model's statistical significance is affirmed by the ANOVA results ($F(2, 27) = 17.097$, $p < .001$), confirming that the predictors collectively contribute meaningfully to the prediction of student performance. Further examination of the standardized coefficients shows that MI is a strong and statistically significant positive predictor ($\beta = .682$, $p < .001$), suggesting that increased interest in mathematics significantly enhances academic performance. In contrast, MA exhibits a negative association ($\beta = -0.149$), though it does not reach statistical significance ($p = .285$), indicating that in this model, anxiety has a weaker and non-significant impact. The regression equation derived from the un standardized coefficients is:

Summative Assessment Marks = 4.014 + 0.788(MI) − 0.072(MA).

Overall, the findings underscore the critical role of mathematics interest in academic achievement, with anxiety playing a comparatively minor role within this sample. In this case our hypothesis 3 is accepted.

Discussion

Interpretation of Findings

The findings of this study affirm the significant positive correlation between mathematics interest and academic achievement and a moderate negative correlation between mathematics anxiety and achievement, consistent with prior research. The strong positive correlation ($r = 0.734$, $p < 0.001$) between mathematics interest and student performance aligns with the work of Akorede et al. (2024) and Yeh et al. (2019), who demonstrated that enhanced engagement and motivation directly improve student outcomes. Meanwhile, the negative correlation between anxiety and performance ($r = -0.389$, $p = 0.034$) echoes the meta-analytic findings of Namkung et al. (2019) and the work of Rani and Rani (2024), both of which highlight how emotional distress interferes with students' ability to process and solve mathematical problems effectively.

The regression analysis indicated that interest in mathematics was a considerable predictor for academic grades, while mathematics anxiety, when assessed concurrently with interest, exhibited no unique contribution. This may signal that a high level of interest somehow diminishes or neutralizes some of the negative effects caused by anxiety, as proposed in the serial mediation model by Du et al. (2021) and Zhang and Wang (2020): with interest augmenting self-efficacy and thus reducing anxiety. The absence of significance of anxiety as a predictor could have been due to the fact that there was a lot of variation concerning anxiety levels in this sample as shown by the extremely large standard deviation; hence unmeasured variables may have played their own roles.

Educational Implications

Well-being at school was another aspect this research considered along with the enhancement of tuition in mathematics. It was cited that interest-based teaching practices that transform math into real-life applications include interactive learning environments and student-centered methodologies which may tremendously enhance math learning. In Tosto et al. (2016) and Gunderson et al. (2018), evidence has been presented showing that creating a positive classroom environment and instilling students with belief in themselves have worked to keep students engaged in mathematics for the long haul.

To ward off mathematics anxiety, teachers should adopt emotional support practices such as reducing accelerated test pressure, normalizing making mistakes along the learning process, and rendering feedback which encourages positive learning. In addition to this, Deb et al. (2014) and Halder & Hasan (2018) pointed out that if a teacher could identify anxious students and greet them with mindfulness or stress management skills, further performance stress could be eased. Self-

confidence training and meta-cognitive strategies are some other immediate activities that will help the student oppose the anxiety.

Suggestions for Teachers and Curriculum Designers

Teachers must use differentiated instruction most importantly based on the emotional or cognitive needs of learners differentiated into the respective categories. Fun and meaningful collaborative explorations in math, gamified tools, and a growth mindset in classrooms would create interest in the subject and a less fearful attitude toward failure. An example of digital platforms that would promote fun while allowing a student to learn at his/her pace is Yeh et al.'s (2019)" Math-Island" study, which increased motivation and achievement.

It is, therefore, incumbent on curriculum developers to enhance congruence and engagement; incorporate psychological literacy training for teachers; and facilitate intellectual inter-disciplinarily connections that lay meaning in math. There should then be integrated structured interventions involving measures for raising interest in and alleviating anxiety toward mathematics into regular instruction, especially in early schooling, to nurture healthy life-long attitudes toward mathematics.

Conclusion

The interaction among interest in mathematics, mathematics anxiety, and academic achievement was studied on 9th Grade students. Results indicated a strong positive correlation between interest in mathematics and performance in mathematics, thus advocating for interest in the subject to be nurtured and encouraged. On the contrary, anxiety related to mathematics was moderate and negatively correlated with achievement, suggesting that emotional distress may detract from performance. The regression analysis indicates that interest does predict academic achievement while anxiety does hinder it; however, it did not reach statistical significance with respect to anxiety when the two are analyzed together.

However, these interestingly highlighted study findings have some limitation. One limitation is the small sample size, only 30 students, which limits the generalization of findings to a larger population from Telangana. Since the study was cross-sectional, it could not establish causation among the variables. Socio-economic background, teacher influence, and previous achievement level might also affect interest and anxiety, but they were excluded from this analysis.

Future studies would do well to include a larger and more heterogeneous sample from different regions and educational boards to improve the reliability of the findings. At a minimum, longitudinal studies would be helpful in tracking interest and anxiety over time and how they dynamically relate to influencing academic achievement. It would equally be important to look at variables such as self-efficacy, teaching strategies, and parental involvement in moderating relationships to gain a comprehensive understanding of the psychological factors influencing performance in mathematics.

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