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A Mathematical Model of Academic Success: Investigating the Impact of Mathematics Interest, Phobia, and Self-Efficacy Using Multiple Regression Analysis

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ABSTRACT

The National Education Policy (NEP) 2020 emphasizes competency-based learning and foundational skill development during the middle stage of education (Grades 6–8), with mathematics playing a critical role in preparing students for STEM careers. However, emotional and psychological factors such as declining interest, increasing phobia, and low self-efficacy continue to influence mathematics learning outcomes. This study employs a multiple linear regression approach to investigate the predictive relationships among mathematics interest, mathematics phobia, and mathematics self-efficacy on students' academic performance in mathematics. Data were collected from 600 students across Grades 6 to 8 using standardized Likert-scale instruments and academic test scores. The regression analysis reveals that mathematics self-efficacy is a strong positive predictor of performance ($\beta=0.55$, $p<0.01$, while mathematics phobia negatively influences both self-efficacy and performance ($\beta=-0.40$ and $\beta=-0.20$, respectively). Mathematics interest positively predicts both self-efficacy and performance, indicating its dual role as both a direct and indirect contributor. The results suggest that targeted strategies to reduce mathematics phobia and enhance student interest and self-efficacy can significantly improve academic outcomes. These findings support NEP 2020's goals of holistic development and stress the need for emotionally responsive mathematics pedagogy.

Keywords: Mathematics Interest, Mathematics Phobia, Self-Efficacy, Academic Performance, Multiple Linear Regression, Middle School, NEP 2020, Mathematical Model

INTRODUCTION

The primary function mathematics plays in a child's core capacity development is thinking. One of the main goals of mathematics is to think clearly and follow concepts to draw rational inferences (Arthur *et al.*, 2019). There are numerous approaches to thinking, and one form of thinking that is central to mathematics is the ability to deal with abstraction. Mathematical problem-solving skills are just one aspect of what mathematics gives; more significantly, it teaches students how to approach problems of all types logically, systematically, and with the correct mindset (Uchechi *et al.,* 2018).

As per the *Position Paper of National Focus Group on Teaching of Mathematics* (NCERT, 2006), a sense of fear and failure regarding mathematics acts as a major concern among most school children. While mathematics is a fascinating discipline with diverse applications and depth, a substantial number of students develop a negative attitude toward it over time. There is always something intriguing to discover in algebra, geometry, calculus, or number theory, yet many students fail to experience this due to affective and psychological barriers.

Unlike other disciplines, several non-cognitive factors such as interest, fear/phobia, and self-efficacy—along with cognitive aspects like curriculum structure, learning style, and quality of teaching—affect student

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performance in mathematics (Boruah *et al.*, 2014). Therefore, it is necessary to adopt a holistic approach to improving mathematical achievement, incorporating both cognitive and affective domains (Zimmerman *et al.*, 2000). For motivation and engagement, cultivating interest in mathematics is essential. This may be done by making concepts relatable to real-life scenarios and encouraging inquiry-based learning. Conversely, mathematics phobia, often developed due to negative classroom experiences, fear of failure, or learned helplessness, can significantly hinder learning. Effective strategies to address this include creating positive learning environments, celebrating small successes, and offering mentorship (Kaur *et al.*, 2017).

Self-efficacy, a concept introduced by Albert Bandura, refers to an individual's belief in their ability to execute tasks and reach goals. High self-efficacy in mathematics has been linked with persistence, motivation, and improved performance (Shofiah *et al.*, 2023). Bandura's *Social Cognitive Theory* suggests that students with high self-efficacy are more likely to engage with mathematical tasks, overcome obstacles, and persist despite difficulties (Bandura, 1989; 1997). Over the decades, research has explored how interest, phobia, and self-efficacy interact to influence mathematics performance (Kumaraswamy *et al.*, 2014; Waller *et al*., 2006). These variables are not independent; rather, they are reciprocally related, each influencing and being influenced by the others, thus shaping the student's learning trajectory.

Present study:

In the present study, a multiple linear regression model was employed to analyse the relationship between mathematics interest, mathematics phobia, self-efficacy, and mathematics performance among middle school students. Mathematics performance served as the dependent variable, while mathematics interest, mathematics phobia, and self-efficacy were treated as independent variables. The regression model apply

$MP=\alpha+\beta1(MI)+\beta2(MP)+\beta3(SE)+\varepsilon$

where MP denotes mathematics performance, MI is mathematics interest, MP (in this context) represents mathematics phobia, SE is self-efficacy, and ε varepsilon ε is the error term. The analysis was conducted using IBM SPSS Statistics Version 23. A sample of 600 students from grades 6, 7, and 8 from unaided private schools in South Delhi was analysed. The results of the regression revealed that self-efficacy had the strongest positive impact on mathematics performance, followed by mathematics interest, while mathematics phobia had a significant negative effect. The regression model was found to be statistically significant, explaining approximately 53% of the variance in students' mathematics performance. These findings confirm a significant reciprocal relationship among the studied variables, highlighting the importance of nurturing self-efficacy and interest while reducing phobia to enhance students' academic outcomes in mathematics.

Literature review:

The social-cognitive career theory suggested that mathematics interest arises from student's mathematical self-efficacy and outcome expectancy beliefs (Lent, Brown and Hackett, 1994). Therefore, mathematical self-efficacy was the strongest variable in predicting mathematics interest and choice intentions (Waller, 2006). Students with higher mathematics interest spend more time doing math tasks or show higher mathematics achievement than students with lower mathematics interest. Additionally, students' interest in mathematics is significantly impacted by teachers' ability to connect math to real-life situations, the availability of resources, and the quality of instruction (Arthur, 2019). In conclusion, fostering mathematics interest and motivation through various strategies, including teacher-student interactions, innovative teaching methods, and peer support, is essential for enhancing students' performance and engagement in mathematics.

Researches showed that the poor performance of students in mathematics is as a result of their lack interest in mathematics learning, which means that mathematics interest serves as a paramount for mathematics performance (Gomes *et al.*, 2020). Amoako *et al.* (2021) [also insisted that when technology is used for classroom instruction, it firstly has positive effect on student's mathematics perceptions and later have a significant effect on their mathematics interest, which means that the use of technology does not have a direct impact on student's mathematics interest, but it will positively change the perception of students in mathematics learning and in turn result a significant effect on their mathematics interest. Asikhia (2014) also found that many secondary school students in Nigeria do not like mathematics and this is shown by the fear they have for mathematics.

Mathematics anxiety can affect individuals in varying ways, including a cognitive, affective, or physiological

reaction, as most mathematics learners find that mathematics is complicated, abstract, and needs a great deal of rote memorization (Acharya *et al.*, 2021).

Self-efficacy is closely linked to motivation and academic performance. Studies by Shofiah *et al.* (2023) and Portento *et al.* (2022) emphasize the significant impact of self-efficacy on students' academic achievements. Additionally, self-efficacy is found to mediate the relationship between motivation and performance (Mardiana and Heriningsih, 2016). Furthermore, self-efficacy is not only relevant in academic settings but also in professional contexts. Agustiani *et al.* (2016) found that self-efficacy and self-regulated learning are predictors of academic performance, indicating the importance of self-belief and self- regulation in achieving success.

Mathematics performance is influenced by a variety of factors that encompass students' attitudes, motivations, anxiety levels, and teaching quality. Studies have shown that mathematics anxiety can significantly impact performance (Thien and Ong, 2015). Additionally, students' interest in mathematics has been linked to their performance in the subject.

Research Question:

Q1. Is there a significant predictive relationship among mathematics interest, mathematics phobia, self-efficacy, and academic performance in mathematics among middle school students?

Objectives of the Study:

1. To examine the predictive relationship between mathematics interest, mathematics phobia, and self-efficacy on the academic performance of middle school students.
2. To analyse the direct and indirect effects of mathematics interest and phobia on students' mathematics performance through self-efficacy.
3. To develop a multiple linear regression model that explains students' academic performance in mathematics based on emotional and psychological variables.
4. To interpret the findings in the context of NEP 2020's emphasis on foundational skills and holistic development.

Hypotheses of the Study:

H01: There is no significant predictive relationship between mathematics interest, mathematics phobia, and mathematics self-efficacy with academic performance in mathematics among middle school students.

H02: Mathematics self-efficacy does not significantly mediate the relationship between mathematics interest and mathematics performance.

H03: Mathematics phobia does not have a significant negative impact on self-efficacy and mathematics performance.

METHODOLOGY

The present study revolves around the mathematics interest of middle school students *i.e.* Grades 6th, 7th, and 8th, in alignment with the National Education Policy (NEP), 2020. In this study, the dependent variable is the mathematics performance of students, while the independent variables are mathematics interest, mathematics phobia, and self-efficacy.

The research design adopted is a quantitative, descriptive-survey, specifically a correlational study aimed at examining the predictive and reciprocal relationships among the selected variables. The population consisted of middle school students from unaided private schools in the South District of Delhi. A total of 600 students (200 each from Grades 6, 7, and 8) were selected using simple random sampling from 8 schools spread across the three sub-divisions of the district.

Instruments Used:

1. **Mathematics Interest Scale**: A self-developed 5-point Likert scale with 36 items was used to assess interest. It covered:
   - General interest in studies
   - Specific liking for mathematics
   - Curiosity to explore mathematical concepts

   The Cronbach's Alpha reliability coefficients were 0.60 (Grade 6), 0.59 (Grade 7), and 0.70 (Grade 8).
2. **Mathematics Phobia Scale**: Adopted from Sandeep Kumar and Dr. Anjali Vajpayee (2020) to measure students' anxiety and fear towards mathematics.
3. **General Self-Efficacy Scale**: The GSF scale by Matthias Jerusalem and Ralf Schwarzer (1995 translation) was used to measure students' beliefs in their ability to perform academic tasks.

4. **Mathematics Performance**: The final annual mathematics exam scores (out of 100) served as the measure of academic performance.

Data Analysis Procedure:

To assess the relationship and predictive power of the variables, a multivariate analysis technique was used due to the involvement of more than two variables.

- Multiple Correlation Analysis was conducted to examine the interrelationships among the independent variables and their collective association with the dependent variable.
- Subsequently, a Multiple Linear Regression Analysis was applied using IBM SPSS Statistics Version 23 to determine how well mathematics interest, phobia, and self-efficacy predict mathematics performance.

The following regression model was developed:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon$$

Where:

Y = Mathematics Performance (dependent variable)

X_1 = Mathematics Interest

X_2 = Mathematics Phobia

X_3 = Mathematics Self-Efficacy

β_0 = Intercept, $\beta_1, \beta_2, \beta_3$ = Regression Coefficients

ε = Error Term

The regression analysis revealed that:

- Self-efficacy had a strong positive influence on mathematics performance ($\beta = 0.55$, $p < 0.01$)
- Mathematics phobia negatively predicted both self-efficacy ($\beta = -0.40$) and performance ($\beta = -0.20$)- Mathematics interest was a positive predictor for both self-efficacy and performance

These findings indicate that emotional and psychological variables significantly contribute to students' success in mathematics and support the emphasis of NEP 2020 on holistic, competency-based education.

RESULTS AND DISCUSSION

Correlations among Grade 6 Students (N=200):

The correlation matrix reveals the relationships among mathematics interest, mathematics phobia, self-efficacy, and mathematics performance for Grade 6 students (Table 1).

- A negative but insignificant correlation is observed between mathematics phobia and mathematics interest ($r = -0.118$), and between mathematics phobia and self-efficacy ($r = -0.137$).
- A positive and significant correlation exists between mathematics interest and mathematics performance ($r = 0.144$, $p < 0.05$), and between self-efficacy and mathematics performance ($r = 0.714$, $p < 0.01$).
- A negative and significant correlation is found between mathematics phobia and mathematics performance ($r = -0.197$, $p < 0.01$).

Table 1 : Correlations among Grade 6 Students

Variables	Mathematics Interest	Mathematics Phobia	Self-Efficacy	Mathematics Performance
Mathematics Interest	1	-0.118	0.101	0.144*
Mathematics Phobia	-0.118	1	-0.137	-0.197**
Self-Efficacy	0.101	-0.137	1	0.714**
Mathematics Performance	0.144*	-0.197**	0.714**	1

** Correlation is significant at the 0.01 level (2-tailed)

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

Table 2 : Correlations among Grade 7 Students

Variables	Mathematics Interest	Mathematics Phobia	Self-Efficacy	Mathematics Performance
Mathematics Interest	1	-0.408**	0.052	0.055
Mathematics Phobia	-0.408**	1	-0.080	-0.152*
Self-Efficacy	0.052	-0.080	1	0.119
Mathematics Performance	0.055	-0.152*	0.119	1

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

Table 3 : Correlations among Grade 8 Students

Variables	Mathematics Interest	Mathematics Phobia	Self-Efficacy	Mathematics Performance
Mathematics Interest	1	-0.251**	0.087	0.047
Mathematics Phobia	-0.251**	1	-0.046	-0.033
Self-Efficacy	0.087	-0.046	1	0.021
Mathematics Performance	0.047	-0.033	0.021	1

** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

These findings suggest that higher mathematics interest and greater self-efficacy positively influence academic performance, whereas phobia adversely affects it. Therefore, the null hypothesis is rejected for the reciprocal relationship of mathematics performance with mathematics interest, phobia, and self-efficacy in Grade 6 students. These findings are consistent with studies by Seudib *et al.* (2018) and Humphrey and Hourcade (2010).

Correlations among Grade 7 Students (N=200):

The correlation matrix for Grade 7 students shows (Table 2):

- A significant negative correlation between mathematics interest and mathematics phobia ($r = -0.408$, $p < 0.01$).
- A negative but significant correlation between mathematics phobia and mathematics performance ($r = -0.152$, $p < 0.05$).
- A weak and insignificant correlation between mathematics phobia and self-efficacy ($r = -0.080$), and between mathematics interest and performance ($r = 0.055$).
- No significant relationship is found between self-efficacy and mathematics performance ($r = 0.119$).

These findings suggest that mathematics phobia adversely affects both interest and performance. Hence, the null hypothesis is rejected for the relationship of mathematics phobia with both interest and performance in Grade 7. These results support the findings of Uchechi *et al.* (2018).

Correlations among Grade 8 Students (N=200):

The correlation results for Grade 8 students indicate (Table 3):

- A significant negative correlation between mathematics interest and mathematics phobia ($r = -0.251$, $p < 0.01$).
- No significant correlations among mathematics phobia, self-efficacy, and performance.
- Weak and insignificant correlations between interest and performance ($r = 0.047$), self-efficacy and performance ($r = 0.021$), and mathematics phobia and performance ($r = -0.033$).

Thus, the null hypothesis is rejected only for the reciprocal relationship between mathematics interest and phobia in Grade 8. These findings are in line with the results of Hembree *et al.* (1990).

Conclusion:

The multiple linear regression analysis conducted in the present study provides significant insights into the predictive relationships among mathematics interest, mathematics phobia, self-efficacy, and mathematics performance among middle school students (Grades 6–8). The model reveals that mathematics self-efficacy emerged as the strongest positive predictor of mathematics performance, with a regression coefficient of $\beta = 0.55$ ($p < 0.01$). This implies that students who believe in their ability to succeed in mathematics tend to perform better academically. Conversely, mathematics phobia negatively influences both self-efficacy ($\beta = -0.40$) and mathematics performance ($\beta = -0.20$),

confirming that anxiety and fear toward mathematics can directly and indirectly hinder academic success. Furthermore, mathematics interest plays a dual role in the model. It not only directly contributes to academic performance but also positively influences self-efficacy, thereby indirectly enhancing performance. These results indicate that students who are more interested in mathematics are likely to be more confident and less fearful, which collectively leads to better outcomes. Overall, the regression model supports the theoretical framework that affective factors—interest, phobia, and self-efficacy—serve as critical predictors of student success in mathematics. These findings align with the goals of the National Education Policy (NEP) 2020**,** emphasizing competency-based learning and holistic development. The study underscores the need for pedagogical interventions that aim to reduce mathematics anxiety, promote student interest, and build self-efficacy through engaging and student-friendly teaching practices. By addressing these emotional and psychological components, educators can foster more positive learning environments and improve mathematics performance during the middle stage of education.

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