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### Mathematics Interest, Phobia, Self-Efficacy and Performance: Investigate Reciprocal Relations

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#### Abstract

As per the National Education Policy 2020, a new curriculum framework has been proposed and implemented in India. According to the demand of time, the conventional 10+2 structure is transformed to 5+3+3+4 structure labelled as foundational stage, preparatory stage, middle stage and secondary stage of school education<sup>[19]</sup>. With the advent of time mathematics education has been largely emphasized at school level. STEM education has become a prerequisite to develop 21<sup>st</sup> century skills among students. However, research revealed a decline of interest in mathematics subjects among students (Warren. et.al., 2020).<sup>[29]</sup>

Thus, the present paper focuses on investigating the correlation between mathematics interest, mathematics phobia, the self-efficacy of students and mathematics performance of middle stage school students. The findings reveal a *significant relationship* between mathematics interest, mathematics phobia, self-efficacy and mathematics performance among grade 6 students; between mathematics interest and mathematics phobia and between mathematics performance and mathematics phobia among grade 7 students; and between mathematics phobia and mathematics interest among grade 8 students.

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## 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)<sup>[4]</sup>. There are numerous approaches to thinking and one form of thinking that is covered in mathematics is developing the ability to deal with abstraction. Mathematical problem-solving skills are just one aspect of what mathematics gives; more significantly, it teaches how to approach problems of all types logically and systematically and with the correct frame of mind (Uchechi et al, 2018)<sup>[27]</sup>. As per the position paper of National Focus Group on Teaching of Mathematics teaching, 2006 (NCERT, 2006)<sup>[20]</sup> it has been revealed that a sense of fear and failure regarding mathematics acts as a major concern among most children at school level. Mathematics is a fascinating discipline with numerous applications and infinite depths to discover. There is always something intriguing to be discovered, whether it be in the fields of algebra, geometry, calculus, number theory, or another discipline.

Unlike other disciplines, several factors such as *interest, fear, and self-efficacy*, as well as elements like curriculum design, individual learning styles, and quality of instruction, affect students' performance in mathematics (Boruah et al., 2014)<sup>[8]</sup>. It is frequently necessary to take a holistic approach to improving arithmetic skills considering both the cognitive and affective elements of learning (Zimmerman et al., 2000)<sup>[30]</sup>. For motivation and engagement in mathematics, it is essential to cultivate an *interest* in the subject. It can be more engaging and relevant to draw links between mathematical ideas and practical applications. Discovering the splendour of many mathematical subfields may stimulate interest and generate motivation. For many people, *mathematics fear or phobia* can be a major learning obstacle. It generally originates from unfavourable experiences in the past, a fear of failing, or false beliefs about one's own aptitude for mathematics. Strategies include resolving negative ideas, gaining confidence via small accomplishments and asking teachers or tutors to assist that can assist students conquer arithmetic fear (Kaur et al., (2017)<sup>[13]</sup>. The term *self-efficacy* describes a person's confidence in their own capacity to succeed in a certain endeavour or field. In the context of mathematics, having high self-efficacy can lead to greater perseverance, effort, and ultimately better performance. Building self-efficacy in mathematics involves setting achievable goals, practicing problem-solving skills and receiving constructive feedback (Shofiah et al, 2023)<sup>[24]</sup>. The exploration of mathematics interest and phobia on the mathematical performance in education has evolved over decades reflecting changes perfectly on teaching- learning and the psychological factor influencing academic achievement (Kumaraswamy et al, 2014; Waller et al, 2006).<sup>[16][28]</sup>

Psychologists such as Albert Bandura introduce the concept of self-efficacy in sensing the role of individual beliefs in their ability to perform tasks and achieve goals. Bandura's Social Cognitive Theory provided a framework for understanding how self-efficacy influence motivations, behaviour and learning outcome in various domains, including mathematics (Bandura, 1989).<sup>[6]</sup> Researcher explored the reciprocal relationship between mathematics interest, phobia and self-efficiency demonstrating that believe in one's ability will enhance mathematics performance on one hand and will significantly impact motivation and persistence on the other hand (Bandura, 1997).<sup>[7]</sup>

## **Literature review**

The social-cognitive career theory suggested that mathematics interest arises from student's mathematical self-efficacy and outcome expectancy beliefs (Lent, Brown & Hackett, 1994)<sup>[17]</sup>. Therefore, mathematical self-efficacy was the strongest variable in predicting mathematics interest and choice intentions (Waller, 2006)<sup>[28]</sup>. Students with higher mathematics interest spend more time doing maths 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)<sup>[4]</sup>. 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)<sup>[9]</sup>. Amoako et al., (2021)<sup>[3]</sup> 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)<sup>[5]</sup> 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)<sup>[1]</sup>.

Self-efficacy is closely linked to motivation and academic performance. Studies by Shofiah et al., (2023)<sup>[24]</sup> and Portento et al., (2022)<sup>[23]</sup> 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 & Heriningsih, 2016)<sup>[18]</sup>. Furthermore, self-efficacy is not only relevant in academic settings but also in professional contexts. Agustiani et al., (2016)<sup>[2]</sup> 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 & Ong, 2015)<sup>[26]</sup>. Additionally, students' interest in mathematics has been linked to their performance in the subject.

## **Present study**

The present study investigates the reciprocal relationship among mathematics interest, phobia, self-efficacy and performance. It also aims to reveal the direction and degree of these closely associated variables in the present scenario.

## Research Question

**Q1.** Is there any reciprocal relationship among mathematics interest, phobia, self-efficacy and performance of middle school students?

## Objective of study

1. To find out the reciprocal relationship among mathematics interest, mathematics phobia, self-efficacy and mathematics performance of middle school students

## Hypothesis

**H<sub>0</sub>1:** There is no significant reciprocal relationship of mathematics performance with mathematics interest, mathematics phobia and self-efficacy of middle school students.

## Research Methods

The present study revolves around the mathematics interest of the middle school students i.e. grades 6<sup>th</sup>, 7<sup>th</sup> and 8<sup>th</sup> (NEP, 2020)<sup>[19]</sup>. In the present study mathematics performance of students acts as dependent variable and mathematics interest, mathematics phobia and self-efficacy of students acts as independent variables. The research design used is a quantitative research method. The type of quantitative research used is a descriptive-survey research design specifically a correlational study with the objective to analyse the reciprocal relationship among the variables taken under the study. The population of the study comprised of middle school students of unaided schools of South district of Delhi. The sample size was 600 middle school students. 200 students from each grade were selected. In total 8 schools from the 3 sub-division of south district were selected on a simple random sampling basis.

A 5 point scale self-developed questionnaire with 36 Items on three basic dimensions of general interest of the students towards studies, specific liking of the students towards mathematics concepts, textbooks and classroom, curiosity to further exploration of mathematics concepts learned is used to assess mathematics interest among the students. The calculated cronbach alpha reliability index of the tool is for class 6<sup>th</sup> 0.60 , for class 7<sup>th</sup> 0.59 and class 8<sup>th</sup> 0.70 respectively. Mathematical Phobia Scale by Sandeep Kumar and Dr. Anjali Vajpayee, 2020 (Kumar, 2020)<sup>[15]</sup> is adopted to analyse the extent of mathematical phobia among the students. The General Self-Efficacy Scale (GSF), 1979 translated in 1995 by Matthias Jerusalem and Ralf Schwarzer<sup>[12]</sup> is adopted to analyse the self-efficacy of the students. The mathematics marks out of 100 achieved by students in their respective previous annual exams were taken as the mathematics performance scores. In the study the analytical method used in the present study is a multivariate analysis due to the involvement of more than two variables. Multiple correlation test is used to determine the relationship due to the involvement of more than two independent variables followed by multiple regression analysis to ascertain the dependent variable based on its covariance with all the concerned independent variables (Kothari, 2004)<sup>[14]</sup>. The analysis of the present study has been done through IBM SPSS Statistics version 23.

## Results and Interpretation

**Table 1** Correlations between Mathematics Interest, Mathematics Phobia, Self-Efficacy and Mathematics Performance among grade 6<sup>th</sup> students

(N=200)

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)

The above table shows a negative but insignificant correlation between mathematics phobia and mathematics interest and between self-efficacy and mathematics phobia among grade 6 students, where  $r$  -0.118 and -0.137 respectively. It also shows a positive and significant correlation between mathematics performance and mathematics interest and mathematics performance and self-efficacy at 0.05 level and 0.01 level respectively. Result shows a negative but significant (*at point 0.01 level*) relation exists between mathematics performance and mathematics phobia. Here the positive correlation means that with an increase in one variable the other variable will also increase with the calculated value of 'r'. The results of the present study support the earlier finding by Seudib et al., (2018)<sup>[25]</sup> and Humphrey & Hourcade (2010)<sup>[11]</sup>.

*Thus, null hypothesis is rejected for reciprocal relationship of mathematics performance with mathematics interest, phobia and self efficacy for grade 6 students.*

**Table 2** Correlations between Mathematics Interest, Mathematics Phobia, Self-Efficacy and Mathematics Performance among grade 7<sup>th</sup> students

(N=200)

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)**

The above table shows a negative but insignificant correlation between mathematics phobia and self-efficacy of 7 grade students, where  $r = -0.080$ . A negative but significant correlation was found between mathematics phobia and mathematics interest and between mathematics phobia and mathematics performance **at point 0.01 level and 0.05 level of significance respectively**. The results of the present study support the earlier finding by Uchechi et al., (2018)<sup>[27]</sup>.

**Thus, null hypothesis is rejected for reciprocal relationship of mathematics phobia with mathematics interest and mathematics performance for grade 7 students.**

**Table 3 Correlations between Mathematics Interest, Mathematics Phobia, Self-Efficacy and Mathematics Performance among grade 8<sup>th</sup> students**

(N=200)

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)**

The above table shows a negative but insignificant correlation between mathematics phobia and self-efficacy and between mathematics phobia and mathematics performance of grade 8 students. It also shows a negative and significant correlation between mathematics phobia and mathematics interest with a  $r$  value of  $-0.251$  at **0.01 level of significance**. The results of the present study support the earlier finding by Hembree et al. (1990)<sup>[10]</sup>.

**Thus, null hypothesis is rejected for reciprocal relationship between mathematics phobia and mathematics interest for grade 8 students.**

## Conclusion

The findings of the study can be concluded that almost in grades 6th the student's mathematics performance is being significantly affected by their interest in mathematics, self-efficacy, and level of phobia. Therefore, there is a need to improve the mathematics interest and self-efficacy among students by adopting more engaging and innovative classroom pedagogies. For grade 7 students the mathematics performance is insignificantly but negatively impacted by mathematics phobia. On the other hand, the present study also reveals that the mathematics performance of grade 8 students is not being significantly affected by any other variable taken in the study.

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