

Factors Influencing Students' Academic Performance in Mathematics

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ABSTRACT

This paper attempts to compare students' academic performance in mathematics on the basis of their level of mathematics anxiety. Moreover, students' IQ and SES are known to influence their academic performance in mathematics. Hence students' IQ and SES are included as control variables whose effect from academic performance in mathematics was removed statistically and then it was compared on the basis of the level of students' mathematics anxiety was studied. The participants of the study included 703 students of standard 8th from S.S.C board schools. Mathematics anxiety was measured using Mathematics Anxiety Scale (MARS-I) by Karimi (2008). Students' final examination marks in mathematics subject were considered as academic performance scores of mathematics. Results indicated that there is a significant difference in academic performance of students by mathematics anxiety. There is no significant difference in academic performance of students by mathematics anxiety when an effect of IQ has been removed statistically. This implies that the difference in students' academic performance in mathematics on the basis of their mathematics anxiety arose on account of their IQ rather than their mathematics anxiety. There is significant difference in academic performance of students by mathematics anxiety when effect of SES has been removed statistically. It may be concluded that the academic performance of students with low mathematics anxiety is significantly greater than that of students with moderate mathematics anxiety after controlling for their SES. The findings of the study would enable teachers to develop programmes to facilitate academic performance of students from different SES backgrounds and with different levels of IQ.

Keywords: mathematics anxiety, mathematics performance, IQ, SES

Mathematics is a broad and deep discipline. It is the science that deals with the logic of shape, quantity and arrangement. It is the building block for everything in one's daily life including mobile devices, architecture,

art, money, engineering and even sports. This makes learning of mathematics very important. Many students have a fear of mathematics while others enjoy the subject.

However, it is such a subject which no one can ignore or avoid. Parents also place immense emphasis on performance in mathematics. Thus, the present study is aimed at ascertaining the factors influencing academic performance of students in mathematics. One such factor identified by the researcher through a literature review is mathematics anxiety.

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Mathematics anxiety has been defined as "an inconceivable dread of mathematics that can interfere with manipulating numbers and solving mathematical problems within a variety of everyday life and academic situations"(Buckley 1982).

The impact of mathematics anxiety varies based on each individual student. Students who suffer from higher levels of mathematics anxiety typically develop negative attitudes and emotions toward mathematics. Cates and Rhymer (2003) found that students with higher levels of mathematics anxiety had significantly lower computational fluency in all areas of mathematical computations. These students, in turn, had lower levels of achievement in mathematics. Clute (1984) explored how two instructional methods, discovery and expository, interacted with students' mathematics anxiety in an undergraduate core curriculum mathematics course. Clute found that students with higher levels of mathematics anxiety scored higher on the achievement test if they were in the expository format course as opposed to the discovery format course. On the other hand, students with lower levels of mathematics anxiety performed better in the discovery course. Clute concluded that there is an interaction between mathematics anxiety and confidence. Students with higher levels of anxiety would have lower levels of confidence in mathematics and therefore would be less likely to perform well in courses where they would need the confidence to discover mathematics for themselves. Therefore, the amount of confidence required on the student's part to learn the mathematical concepts was partially determined by the instructional method. The present study also provides theoretical support for teachers, parents to reduce the consequences of students' mathematics anxiety.

Rationale of the Study

Mathematics anxiety is fear of numbers, calculations and feeling of tension about one's mathematics performance in class or in mathematics test. Tobias and Weissbrod (1980) described mathematics anxiety as "the panic, helplessness, paralysis and mental disorganization that arises among some people when they required solving a mathematical problem". Spicer (2004) summed it up

best by stating that mathematics anxiety is "an emotion that blocks a person's reasoning ability when confronted with a mathematical situation".

Thus, it is expected that students' mathematics anxiety will influence their performance in mathematics. Hence the present study has included this variable as a possible factor influencing academic performance of students in mathematics. Moreover, students' IQ and SES are known to influence their academic performance in mathematics. Hence students' IQ and SES were included as control variables whose effect on academic performance in mathematics was removed statistically and then its relationship with his/her mathematics anxiety was studied.

Review of Related Literature on Mathematics Anxiety

Ashcraft and Kirk (2001) investigated how students' working memory affected their levels of anxiety during mathematical tasks. Working memory, or short term memory, is the active part of the memory where information is temporarily stored and manipulated. Ashcraft and Kirk found that mathematics anxiety causes interference with the working memory's ability to focus on the mathematical task. For example, students who feel nervous while performing a mathematical task will have thoughts about their anxiety while working on the task. These thoughts take up part of the working memory's capacity, thereby decreasing the amount of working memory available for the mathematical task. Ashcraft and Kirk also found that this working memory interference not only causes students to take longer with mathematical tasks but also degrades students' accuracy. Walen and Williams (2002) conducted a qualitative study on how two college students' mathematical performance suffered when time constraints were placed on mathematics tests. Although both students demonstrated their understanding of the material in class and on homework assignments, both failed exams in class when they only had a limited amount of time to work. After discussing their concerns about timed tests with their instructors, both were allowed to take the tests without time constraints. Without having to worry about how much time was left, the students both received excellent grades on their exams and managed to finish

within the original time limit. Walen hypothesized that student' concerns about time interfere with their ability to focus on the mathematical tasks at hand. Worrying about the amount of time left can reduce the amount of working memory available to work on the mathematical problems. Pourmoslemi *et al.* (2013) conducted a study to investigate the level of mathematics anxiety and the relationship between mathematics anxiety and mathematics performance among undergraduate students of payame Noor University, Iran. The sample of the study consisted of 275 (162 women and 113 men) undergraduate students of various field of study. To measure the mathematics anxiety level, the participants responded to the 24 items of the Revised Mathematics Anxiety Rating Scale. The data were analyzed by One-way ANOVA and independent –samples t-tests using the statistical procedures for Social Sciences (SPSS 11.5). The result showed significant difference between men and women's evaluation anxiety and no significant difference was observed concerning field of study. There is a significant correlation between high level anxiety and low academic performance.

Need of the Study

A review of the related literature indicated that correlational studies have been conducted on meta-cognitive strategies related to performance of "average" students, giftedness, mathematics performance and gender difference. Similarly, experimental studies have been conducted for improving examination grades, grades in classes, retention and student satisfaction through meta-cognitive training.

While teaching mathematics the researcher found that the students are curious if the subject is taught in an interesting manner. It was also observed that students have difficulties with basic concepts in mathematics because they not understand that and as result their performance affected. Thus, the need of the study arose.

Besides, he researcher herself being a mathematics teacher was interested in improving students' academic performance in mathematics.

Since very few research work was conducted among school students the researcher was motivated and

decided on conducting the present study which investigates factors affecting academic performance in mathematic.

Operational Definition of the Terms

1. **Mathematics Anxiety:** Mathematics anxiety is a feeling of tension, or fear that interferes with mathematics performance.
2. **Academic Performance:** Students' final examination marks in mathematics subject are considered as academic performance scores of mathematics.
3. **Socio-Economic Status:** It refers to an individual's position within hierarchical social structure, including wealth, power and prestige enjoyed by a student and his/ her family.
4. **Intelligence Quotient (IQ):** IQ is a number meant to measure a person's cognitive abilities (intelligence) as measured by Nafde's NVTI.

Objectives of the Study

1. To compare students' academic performance in mathematics on the basis of their level of mathematics anxiety.
2. To compare students' academic performance in mathematics on the basis of their level of mathematics anxiety after controlling for their intelligent quotient.
3. To compare students' academic performance in mathematics on the basis of their level of mathematics anxiety after controlling for their socio-economic status.

Null Hypotheses of the Study

1. There is no significant difference in students' academic performance in mathematics on the basis of their level of mathematics anxiety.
2. There is no significant difference in students' academic performance in mathematics on the basis of their level of mathematics anxiety after controlling for their intelligent quotient.
3. There is no significant difference in students' academic performance in mathematics on the

basis of their level of mathematics anxiety after controlling for their socio-economic status.

Methodology of the Present Study

The descriptive research method of the causal-comparative type was included under the quantitative approach in the present research. In the causal-comparative method, the investigator examined the possible effect of mathematics anxiety, which is difficult to manipulate experimentally and ethically – on students' academic performance in the present study.

Sample of the Study

The sample size of the study was 703 students of eighth standard students from schools affiliated to the S.S.C Board including both 404 boys and 299 girls from English medium schools situated in Greater Mumbai in Maharashtra.

Techniques of Sampling

The researcher used a three-stage sampling technique. At the first stage, the schools were selected on the basis of their geographical location using stratified random sampling wherein the strata were North Mumbai, South Mumbai and Central Mumbai. At the second stage, schools were selected using stratified random sampling and the stratifying factor was the type of management of the school which was aided and unaided. At the third stage, students were selected from these schools using incidental sampling technique. Mathematics Anxiety Scale was administered to the participants by the researchers.

Instrument used in the Study

The following tools were used for data collection:

- ❑ Mathematics Anxiety Scale (MARS-I) by Karimi (2008) and contains 31 items of situations which causes mathematics anxiety. It has two subscales- Mathematics Test Anxiety with 15 items and Numerical Task with 16 items. Each item of this scale was rated on a five point scale rating from very much anxious (5) to not at all anxious (1). Psychometric properties of this scale were computed by the tool developers.

The correlation between scores on MARS-I and MARS (Richardson and suinn 1972) was 0.87. Two week test-retest reliability of the scale was 0.85 and internal consistency alpha coefficient was 0.88.

- ❑ *Academic Performance of Students:* Students' final examination marks in mathematics in standard eighth were considered as academic performance scores.
- ❑ *SES Inventory:* This inventory was prepared by Patel (1997) covering the areas of The size and nature of family, The type of accommodation, facilities and services available in the home, Article and assets possessed, Total family income, Literacy level of parents, Occupation of parents, Exposure to mass media, Library/ Club membership and Interaction among family member. The inventory provides a comprehensive index of an individual's level of socio-economic status. This inventory was modified slightly. There are 35 items in this inventory. The internal consistency reliability of this tool after modification as calculated by the split-half method was found to be 0.96 and the test-retest reliability was found to be 0.77. The highest possible score of an individual on this tool is 178 and the lowest possible score is 28.
- ❑ *Nafde's NVTI:* This inventory was prepared by Nafde (n.d) covering the areas of Analogies, Water-reflection, Series and Classification. The maximum score on this test is 100 excluding six practice items for each sub-test and minimum score is 24. These 24 items is practice items for each sub-test. Reliability is alpha 0.94 and 0.83.

Techniques of Data Analysis

The present research used ANOVA and ANCOVA as statistical techniques for data analysis.

Data Analysis

Null Hypothesis 1: There is no significant difference in students' academic performance in mathematics by their level of mathematics anxiety. To test this hypothesis, ANOVA was used.

Table 1 shows the three sub-groups of students on the basis of their mathematics anxiety, namely, low, moderate and high; number of students in each anxiety group and the mean scores of their academic performance in mathematics.

Table 1: Comparisons of students' AP mathematics by their level of mathematics anxiety

Variable	Level of MAn	N	Mean
AP	Low MAn	243	70.7078
	ModerateMAn	226	66.6637
	High MAn	234	69.5983

Table 2 shows the result of ANOVA for students' academic performance by levels of mathematics anxiety

Table 2: shows the ANOVA for students' AP by levels of mathematics anxiety

Source	SS	df	MS	F	P
Among Groups	2025.0261	2	1012.513	3.84	0.021948
Error	184658.9369	700	263.7985		
Total	186683.963	702			

The obtained P value is $P=0.021948$. It is significant. Thus, there is a significant difference in students' academic performance in mathematics on the basis of levels of mathematics anxiety. Hence, the null hypothesis is rejected.

Since table 2 shows that there is a significant difference in academic performance of students by mathematics anxiety. Tukey's HSD test shows that the academic performance of students with low mathematics anxiety is significantly greater than that of students with moderate mathematics anxiety.

Null Hypothesis 2: There is no significant difference in students' academic performance in mathematics by their level of mathematics anxiety after controlling for their intelligent quotient.

This hypothesis was tested using ANCOVA.

Table 3 shows the three sub-groups of students on the basis of their mathematics anxiety, namely, low, moderate and high; number of students in each anxiety group and the mean scores of their academic performance in mathematics after controlling for their IQ.

Table 3: Comparisons of students' AP mathematics by their levels of mathematics anxiety after controlling for their IQ

Variable	Level of MAn	N	Mean
AP (IQ)	Low MAn	243	70.0731
	Moderate MAn	226	67.2778
	High MAn	234	69.6643

Table 4 shows result of ANCOVA for students' academic performance by levels of mathematics after controlling for their IQ,

Table 4 shows the ANCOVA for students' AP by levels of mathematics anxiety after controlling for their IQ

Source	SS	df	MS	F	P
Adjusted Mean	1041.33	2	520.67		
Adjusted Error	170691.56	699	244.19	2.13	0.119608
Adjusted Total	171732.89	701			

The obtained P value is $P=0.119608$. It is not significant. Thus, there is a no significant difference in students' academic performance in mathematics on the basis of levels of mathematics anxiety after controlling for their intelligent quotient. Hence, the null hypothesis is accepted.

Null Hypothesis 3: There is no significant relationship in students' academic performance in mathematics by their level of mathematics anxiety after controlling for their SES.

This hypothesis was tested using ANCOVA.

Table 5 shows the three sub-groups of students on the basis of their mathematics anxiety, namely, low, moderate and high; number of students in each anxiety group

and the mean scores of their academic performance in mathematics after controlling for their SES.

Table 5: comparisons of students' AP in mathematics by their level of mathematics anxiety after controlling for their SES

Variable	level	N	Mean
AP (SES)	Low MAn	243	1.7183
	Moderate MAn	226	-1.0354
	High MAn	234	0.8490

Table 6 shows result of ANCOVA for students' academic performance by levels of mathematics after controlling for their SES.

Table 6 shows the ANCOVA for students' AP by levels of mathematics anxiety after controlling for their SES

Source	SS	df	MS	F	P
Adjusted Mean	1819.3	2	909.65		
Adjusted Error	176462.63	697	252.45	3.6	0.027832
Adjusted Total	178281.93	701			

The obtained $P = 0.027832$. It is significant. Thus, there is a significant difference in students' academic performance in mathematics on the basis of levels of mathematics anxiety after controlling for their SES. Hence, the null hypothesis is rejected.

Since the F-ratio for students' AP by levels of mathematics anxiety after controlling for their SES is significant, the t -test is applied for further analysis as shown in table 7.

Table 7 shows mean difference of students' AP by levels of mathematics anxiety after controlling for their SES.

The preceding table shows that the t -ratio for students' AP is significant with low and moderate mathematics anxiety after controlling for their SES ($P = 0.0078$). It is significant. Thus, there is a significant difference in the students' AP with low and moderate mathematics anxiety after controlling for their SES.

Table 7: shows mean difference of students' AP by levels of mathematics anxiety after controlling for their SES

NO.	Groups	Mean	N	t	P	I.o.s
1	Low MAn	70.7078	243	2.67	0.0078	S
	Moderate MAn	66.6637	226			
2	Low MAn	70.7078	243	0.75	0.4536	N.S
	High MAn	69.5983	234			
3	Moderate MAn	66.6637	226	-1.94	0.052	N.S
	High MAn	69.5983	234			

It may be concluded that the academic performance of students with low mathematics anxiety is significantly greater than that of students with moderate mathematics anxiety after controlling for their SES. There is no significant difference in the students' AP with low and high mathematics anxiety; and moderate and high mathematics anxiety after controlling for their SES.

Discussion

The result indicated that the academic performance of students with low mathematics anxiety is significantly greater than that of students with moderate mathematics anxiety. The result indicated that there is a significant difference in academic performance of students on the basis of their mathematics anxiety. When the effect of IQ was removed, it was found that no significant difference existed in the academic performance of students by mathematics anxiety. This implies that students having high IQ could have a low anxiety and therefore they showed high academic performance in mathematics. This finding is consistent with the studies of Betz (1978), Ma (1999) and Woodard (2004). Low mathematics anxiety leads to positive attitude towards mathematics. Students with low mathematics anxiety enjoy mathematics class, which enables them to develop confidence. These students are likely to have better cognitive, meta-cognitive, and social skills which enable them to perform better in mathematics class. Masten (1998), Wang *et al.* (1994), Hattie *et al.* (1996) pointed out that success in school demands three clusters of skills; cognitive and meta cognitive skills, social skills and self-management skills. The cognitive and meta cognitive skills include skills related to goal setting,

progress monitoring, and memory skills, whereas social skills refer to interpersonal skills, social problem solving, listening, and teamwork skills. In addition, the self-management skills such as managing attention, motivation, and anger are also essential in ensuring success.

When the effect of SES has been removed, it was found that significant difference existed in the academic performance of students by mathematics anxiety. This implies that students having low SES have high mathematics anxiety and because of their high mathematics anxiety their academic performance is low. Low SES prevents access to resources and leads to additional stress and conflicts at home that affect all aspects of child's life including academic achievement (Eamon, 2005). This finding is also consistent with study of Seyfried (1998) in which he found that low SES students have been found to score about ten percent lower on the National Assessment of Educational Programs than higher SES students. Research shows that supportive and attentive parenting practices positively affect academic achievement (Eamon, 2005).

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