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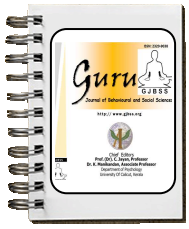

# Influence of Mathematics Anxiety on Mathematical Creativity among Secondary School Students

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**Abstract**

The relationship of creativity and anxiety was a focus area for many psychologists for decades. Studies in this area are not confirmatory about the nature and extent of relationship between these two variables. Participants of the study include 100 ninth standard students of Calicut district in Kerala. Hypotheses were tested using test of significance of difference between two large independent groups and Pearson's Product Moment Coefficient of correlation. Results of the study reveal significant but low negative linear relationship between the variables, for the components and the total Mathematical Creativity. High and low anxiety groups are found to be significantly differing in their Mathematical Creativity. Mathematics Anxiety is found to be influencing Mathematical Creativity, so for fostering Creativity among students, teachers must take care to give a tension free, encouraging environment which will flourish the original thinking among students. The phobia in learning Mathematics should be reduced through arranging interesting, motivating classroom activity, proper counseling and sympathetic approach of teachers.



At primary and secondary levels of school education, mathematics plays a prominent role because of its use in understanding the world around the learner and its unique ability to develop logical thinking that help the learner take decisions on social issues. The National Policy on Education (1986) views Mathematics as the vehicle to train a child to think, reason, analyze and to articulate logically. Mathematics should be dealt as a way of thinking, an art or form of beauty, and as a human achievement. A sufficient knowledge of mathematics helps the learners to be successful in the academic performance, and also in the vocation as well as in house hold activities. The quality of mathematics education determines the scientific and technological development of the country. Therefore it is necessary to prepare the child with a strong base of mathematical knowledge to face the challenges of the modern society.

Nature of mathematics helps a person develop the ability to imagine various situations, to develop divergent thinking and problem solving ability, which all leads to creativity. Thus one of the important but difficult tasks of mathematics education is to develop creativity among students. According to International Commission on Mathematical Institution (2004) Mathematical Creativity is the capacity of a person to produce logical and imaginative numerical literacy which are essentially novel and previously unknown to the producer.

Mathematical Creativity makes a sound footing to the world of development and progress. It ensures the growth of mathematics as a whole. According to Ervynck (1991), Mathematical Creativity does not occur in vacuum but it need a context in which the individual moves forward through previous experiences. This can be provided through effective mathematics education. Mathematics teaching helps the children to develop problem solving ability and try out new methods and approaches in different situations. Through education students have to develop the abilities to face the challenging world creatively. School is the best platform for identifying and fostering mathematically creative students. According to Lalit (2004) enriching the creative talent in mathematics can be done through different methods of teaching and practices like brain storming, group discussion, buzz session, symposium etc.

Gulati (1988) also recommended such methods to develop creativity among school children. Mehta and Thakur (2008) have suggested co-operative learning for better learning and achievement in mathematics, which give a strong base for creative thought. Similar studies reveal that if teachers have a mind set, they can be a catalyst to foster creative thinking among students.

Even though mathematics education aims to develop Mathematical Creativity among children, the extent of attainment of this aim is not much satisfactory due to many reasons. A good number of students feel scared and panic in doing mathematical problems and incapable of understanding the concepts. Other symptoms include tension, nervousness, worrying, impatience, confusion, fear and developing a mental block**.** (Tyteca, Castro, Segovia, Castro, Fernandez & Cano, 2009). Such feelings are at all levels of education from primary to higher education. Once it was established, it can persist for entire life and even transferred to the next generation. These emotions aroused through negative experiences in working with surroundings can be named as anxiety. Mathematics Anxiety is an inconceivable dread of mathematics that can interfere with manipulating numbers and solving mathematical problems with in a variety of everyday life and academic situations (Richardson & Suinn, 1972; Buckley & Ribordy, 1982).

According to Trujillo and Hadfield (1999), Mathematics Anxiety is aroused through environmental, intellectual, and personality factors. Negative experiences in the class room, parental pressure, insensitive teachers etc are included in environmental factors where as mismatched learning style, students attitude, self- doubt, lack of perceived usefulness of mathematics are included in intellectual factors. The personality factors include shyness to ask doubts, low self-esteem etc.

Many studies in the area of anxiety show consistent results in its relationship with achievement (Quilter & Harper, 1988; Clute, 1984; Hembree, 1990), motivation (Tapia, 2004), self confidence (Garry, 2005), and Academic performance (Ashcraft & Kirk, 2001). Srivastava, Imam, Sing and Sing (2016) studied about Mathematics Anxiety among secondary school students in relation to personal and school related factors and found that there exists significant difference in math anxiety between male and female students and among students of different types of schools. The area of Mathematics Anxiety is explored by researchers to some extent, but still there are some specific areas which are to be more analyzed.

The relationship of Creativity and Anxiety was a focus area for many psychologists for decades. Adams (2014) have reported anecdotes of many creative professionals in various fields showing creative's had an unusually high number of mood disorders, and anxiety syndromes. Many studies are conducted that resulted in positive, negative and no relationship between the variables. Saxena and Kumar (1985) reported a negative relationship between creativity and anxiety; no sex differences in mean scores of creativity and anxiety; and differences between low, average, and high creative Students in levels of anxiety. ZDEP (1966) in a study on college students concluded that creative non-conformists experience less anxiety than individuals of lower creativity who have a tendency to conform rather than deviate. Smith and Carlsson (1983) also in an experimental study on a group of 31 psychiatric patients with anxiety as one of their main symptoms found that low tolerance of anxiety necessarily associated with creative work.

But Paul and Nathan (2010) in a study found that anxiety, depression, and social anxiety predicted little variance in creativity. The words of Kierkegaard, a famous Danish philosopher "Because it is possible to create — creating one's self, willing to be one's self… — one has anxiety. One would have no anxiety if there were no possibility whatever" highlights the role of anxiety and it is not a killer but is a qualification of dreaming spirit, and as such it has its place in psychology.

Kristini, Shalini and Deborah (2010) in a Meta analysis of 76 studies on the effect of stressors on creativity found a curvilinear relationship between evaluative stress and a linearly negative relationship between uncontrollability and creativity. They also reported that stressors' effect on creativity is more complex than previously assumed and demands more studies on their relationship with creativity.

Mathematical Creativity is a higher level learning outcome of mathematics learning; but it needs a free and clean thinking. Anxiety, a negative emotion may hinder this process, but at the same time, a slight amount of anxiety may improve the effort made by the individual to attain higher levels. Review of related literature shows that studies regarding the relationship between Mathematics Anxiety and Mathematical Creativity are rare in India and abroad. Hence it will be relevant to study the influence of Mathematics Anxiety on Mathematical Creativity, the findings of which may contribute to attempts on fostering creativity among students.

**Objectives**

1. To find out the extent of Mathematical Creativity among secondary School Students.
2. To find out the extent of Mathematics Anxiety among Secondary School Students.
3. To find out whether Mathematical Creativity differ in the low- and high- Mathematics Anxiety group
4. To find out whether there is any significant relationship between Mathematical Creativity and Mathematics Anxiety of Secondary School Students.

**Hypotheses**

1. Low- and high- Mathematics Anxiety groups differ in their mean score on Mathematical Creativity
2. There exists relationship between Mathematical Creativity and Mathematics Anxiety of Secondary School Students.

**Method**

**Participants**

The study was conducted on a sample of 100 ninth standard students of three schools of Kozhikode District in Kerala.

**Instruments**

1. Mathematical Creativity: Mathematics creativity was measured using Test of Mathematical Creativity developed by Sumangala (1998) and revalidated by Kavithamole (2015). The test contains seven questions based on the use of mathematical knowledge and sample response is given for each item. Each question must be completed within the specified time and the total time limit is 35 minutes. Each item was measured for originality, fluency and flexibility. The total of these scores was taken as Mathematical Creativity score. The test retest reliability co-efficient is reported to be 0.77 and the criterion related validity coefficient is 0.62. Hence the test is reliable and is valid to measure Mathematical Creativity.
2. Mathematics Anxiety: Mathematics Anxiety was measured using Scale of Mathematics Anxiety developed by Sumangala and Malini (1993). This scale is in the form of a five point Likert type attitude scale and is intended to measure the extent of fear or the feeling of apprehension in working with mathematics. This scale consists of 29 statements measuring both debilitating and facilitating anxiety. The test retest reliability coefficient is 0.86 and reliability estimated by Cronbach's Alpha coefficient is 0.79. The statement of the scale was phrased in the least ambiguous way and hence wording of the statement will suggest that the scale is a good measure of Mathematics Anxiety. This indicates that the scale is reliable and valid to measure Mathematics Anxiety.

**Results and Discussion**

To know the extent of the variables Mathematical Creativity, its components Fluency, Flexibility and Originality and Mathematics Anxiety among secondary school students, Mean, Median, Mode, Standard Deviation, Skewness and Kurtosis were computed and is presented in table 1.

Table 1

*Descriptive statistics of the variables Mathematical Creativity and Mathematics Anxiety.*

| Statistics / Variable | Mean | Median | Mode | SD | Skewness | Kurtosis |
|---|---|---|---|---|---|---|
| Mathematical Creativity | 70.78 | 70.50 | 55.00 | 21.97 | 0.175 | -0.813 |
| Mathematics Anxiety | 85.34 | 86.00 | 86.00 | 13.52 | 0.003 | -0.294 |
| Fluency | 40.85 | 41.00 | 35.00 | 12.28 | 0.061 | -0.783 |
| Flexibility | 18.12 | 17.00 | 17.00 | 6.07 | 1.232 | 3.676 |
| Originality | 11.81 | 10.00 | 7.00 | 7.67 | 0.931 | 0.341 |

Table 1 reveals that mean, median and mode of Mathematical Creativity are 70.78, 70.50 and 55 respectively. Though mean and median values are the same, value of mode is far less than that of mean and median. This may be due to the presence of multiple modes. The standard deviation of Mathematical Creativity is found to be 21.97, which shows that the scores are highly deviated from the mean score. The skewness of Mathematical Creativity is found to be 0.175 which shows that the curve is positively skewed and the value of kurtosis is -0.813, Values less than two, indicate a possibility of non-skewed, mesokurtic distribution.

From table 1, it can be seen that Mean, Median and Mode of Mathematics Anxiety are 85.34, 86.00 and 86.00 respectively. These three values are almost equal. The Standard Deviation of the scores of Mathematics Anxiety is 13.52 which show that the scores are slightly deviating from the Mean score. Skewness and Kurtosis of the distribution of anxiety are found to be 0.003 and -0.294. Very small values of Skewness and Kurtosis shows that the distribution is almost symmetric and Mesokurtic. Hence the distribution of Mathematics Anxiety can be considered as normal.

Mean, Median and Mode of the variable Fluency are found to be 40.85, 41.00 and 35.00 respectively. The Standard Deviation is found to be 12.28. The Skewness and kurtosis are found to be 0.061and -0.783 respectively, which shows that the variable fluency is almost normally distributed.

The Mean, Median and Mode of the variable Flexibility are 18.12, 17.00 and 17.00 and for the variable Originality it is 11.81, 10.00 and 7.00 respectively. The Standard Deviation of the variable Flexibility is 6.07 and that of Originality is 7.67, which show that the scores are deviated from their Mean scores. The Skewness and Kurtosis of the variable Flexibility are found to be 1.232 and 3.676 respectively. A less value on Skewness shows that the distribution of the variable Flexibility is non skewed, but a relatively high value of Kurtosis shows that the distribution is not Mesokurtic. In the case of the variable Originality the Skewness and Kurtosis are found to be 0.931and 0.314, and hence can be considered as non skewed and Mesokurtic.

In order to find whether Mathematical Creativity is influenced by Mathematics Anxiety, test of significance of Mean difference for independent groups was used. For this the total group was divided into two based on the score on Mathematics Anxiety. The Median value of

Mathematics Anxiety (86) was taken as the cut off value for High and Low Mathematics Anxiety group. A score less than 86 was taken as low anxiety and greater than 86 was taken as high anxiety. In the total sample, it was found that 54 students are in low Mathematics Anxiety group and 46 are in the High Mathematics Anxiety group. The significance of difference in Mathematical Creativity between the Low Mathematics Anxiety group and High Mathematics Anxiety group was tested and is presented as table 2.

Table 2

*Mean, Sd and 't' value of Mathematical Creativity between Low and High Mathematics Anxiety groups*

| Variable | Mathematics Anxiety | N | Mean | SD | 't' value |
|---|---|---|---|---|---|
| Mathematical creativity | Low-group | 54 | 76.59 | 23.25 | 2.82** |
| | High-group | 46 | 63.9 | 21.73 | |

**p< .01

Table 2 shows that the obtained 't' value for Mathematical Creativity for Low anxiety group and High anxiety group is 2.82. Since the calculated t value is greater than 2.58, there is a significant difference in the mean Mathematical Creativity scores of Low anxiety group and High anxiety group (p≤0.01).

Graphical representation of Mean scores on Mathematical Creativity of Low Anxiety group and High Anxiety group is given as figure 1.

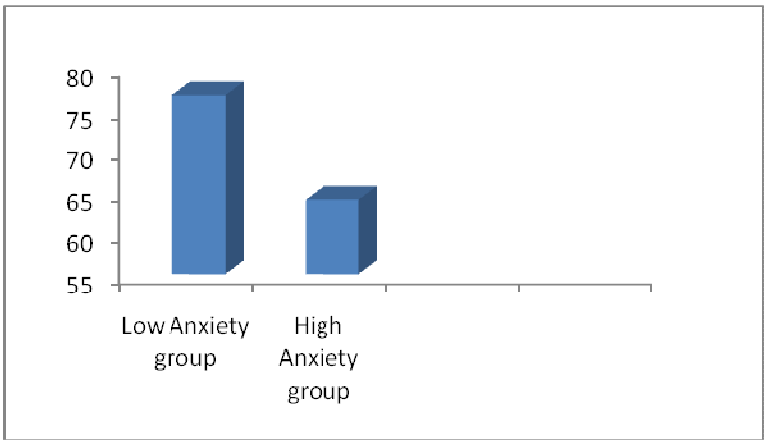


*Figure 1:* Bar diagram showing Mean Mathematical Creativity score of High and Low Mathematics Anxiety groups.

An observation of the mean scores of the two groups and the diagram show that the low Mathematics Anxiety group has comparatively higher score on Mathematics Creativity than that of high group.

To know whether Mathematics anxiety is related to Mathematical creativity and its components and its nature, Pearson's product moment coefficient of correlation was calculated. To know the linearity of the relationship scatter diagrams were drawn for each case and is presented as figure 2.

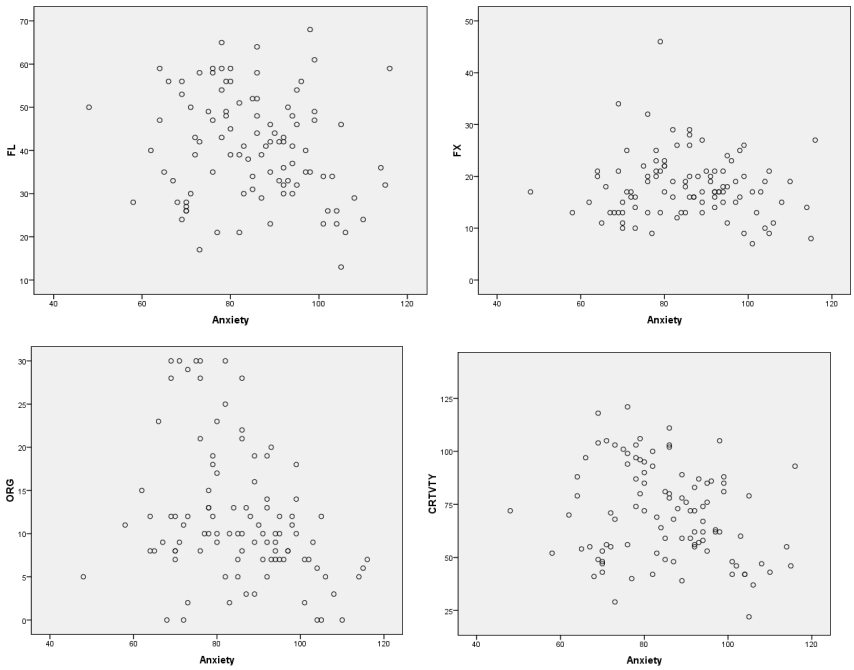


*Figure2*: Scatter diagrams for Mathematical Anxiety with Mathematical Creativity and its components.

The scatter plots show that the relationship between the variables is linear as the points tend to cluster around a straight line, but the extent of relationship is low.

The correlation coefficients between the variables are shown in table 3.

Table 3

*Pearson's correlation coefficient for Mathematical Creativity and Mathematics Anxiety*

| Variable | Anxiety | Mathematical creativity | | Fluency | Flexibility | Originality | |
|---|---|---|---|---|---|---|---|
| Anxiety | 1 | R | $r^2\times100$ | -0.158 | -0.065 | r | $r^2\times100$ |
| | | -0.215** | 4.62 | | | -0.311** | 9.67 |

** p≤ 0.01

Table 3 reveals that the obtained correlation coefficients for Mathematics Anxiety and Mathematical Creativity and Originality are greater than the value needed for significance at 0.01 level for N=100. Hence there is significant relationship between the variables. A low negative relationship is found for the variable Mathematics Anxiety with Mathematical Creativity and Originality. That is Mathematics Anxiety is significantly negatively related with Mathematical Creativity and its component Originality, but the extent of relationship is low. That is for an increase in Mathematics Anxiety there will be a small decrease in Mathematical Creativity and Originality. It was also found that Mathematics Anxiety is not significantly related with Fluency and Flexibility even at 0.05 level. That is, Fluency and Flexibility are not related with Mathematics Anxiety or as Mathematics Anxiety increases or decreases; Fluency and Flexibility are not changing.

When shared variance is calculated ($r^2\times100$) it can be seen that 4.62percentof variation in Mathematical Creativity can be explained by variance in Mathematics Anxiety and 9.67percent of variation in originality is explained by Mathematics Anxiety. These results are partially agreeing with the studies on general creativity and anxiety which show a negative relationship

between the variables, at the same time two components of Mathematical Creativity are found to be not related to Mathematics Anxiety.

Comparatively small values of shared variance show that Mathematical Creativity is influenced by variables other than Mathematics Anxiety.

**Conclusion**

Creativity is an unavoidable factor in the progress of every nation. So fostering Creativity in children is one of the major aims of education, for which true Mathematics Education is an excellent vehicle. Thus learning Mathematics and become adept users play an important role in one's life. But some factors hinder this development. The present study is a contribution which indicates that Mathematics Anxiety is one of the factors that hinder Mathematics Creativity. Though, the extent of relationship is low, Mathematics Anxiety is found to be influencing Mathematical Creativity. So in the path of fostering Creativity among students, teachers must take care to give a tension free, encouraging environment which will flourish the original thinking among students. The phobia in learning Mathematics should be reduced through arranging interesting, motivating classroom activity, proper counseling and sympathetic approach of teachers. In order to find out other contributing factor of Mathematics Creativity, more studies in the area are also recommended.

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