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Mathematics Anxiety among Secondary School Students in relation to their Self-Concept

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Abstract

The purpose of the present study was to study the levels of Mathematics anxiety among secondary school students and its relationship with their self-concept. Further, it also explored the respective influence of demographic variables on anxiety and the relationship between anxiety and self-concept. The study was both descriptive and correlational in nature. The sample was taken from two secondary schools in Aligarh, Uttar Pradesh (India) and consisted of 160 students. Data was collected online using standardized Abbreviated Mathematics Anxiety Rating Scale (AMARS) and Self-Concept Clarity Scale (SCCS) respectively. The collected data were analyzed using descriptive statistics and inferential statistics. The statistical results clearly indicated that the students had Mathematics anxiety of varying levels; demographic variables had no significant influence on their anxiety and the relationship between anxiety and self-concept was negative and moderately strong.

Keywords: secondary school students, Mathematics, Mathematics anxiety, self-concept

Introduction

Mathematics is a compulsory subject at school level in different countries across the world. According to Nolting (2012), Learning Mathematics is different from learning other subjects as:

- it involves learning and mastering the following tasks: (i) Understand the material, (ii) Process the material, (iii) Apply what you have learned to solve a problem correctly, and (iv) Remember what you have learned in order to learn new material. Of these four tasks, applying what we have learned to solve a problem correctly is the hardest.
- it follows a sequential learning pattern, which simply means that the material learned on one day is used the next day and the next day, and so forth. Sequential learning is influenced by how much previous Mathematics knowledge and skills the students have at the beginning of a particular class. Sequential learning is interrupted if Mathematics is studied irregularly and results in forgetting of important concepts and skills.
- it is a skill subject, which means that the students have to practice actively the skills involved to master it.
- it is a speed subject, which means that it is taught faster than other subjects and students not only must understand how to do the math problems but also must learn the math well enough to complete the problems with enough speed.

These reasons somehow reveal the complex and demanding nature of Mathematics as a subject. As a consequence, a number of students are not able to learn and master Mathematics and thus develop Mathematics anxiety.Mathematicsanxiety is an unpleasant feeling associated with numerical manipulations and math problem-solving (Richardson & Suinn, 1972).Mathematicsanxiety is a negative emotional response to current or prospective situation involving Mathematics. Those who suffer from Mathematics anxiety have decreased Mathematics self-confidence, enjoy Mathematics less and may even avoid Mathematics altogether (Ashcraft, Kirk, & Hopko, 1998; Hembree, 1990; Maloney & Beilock, 2012).Mathematics anxiety depends a lot on one's self-appraisal of abilities such as self-concept. Self-concept is defined as student's self-perception of their abilities and their expectancy to perform well in Mathematics (Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002; Wigfield & Eccles, 2000).

Background and Rationale of the Study

A majority of studies have investigated Mathematics anxiety in secondary school students. Although some research studies have revealed no gender differences in Mathematics anxiety (Birgin, Baloğlu, Çatlıoğlu, & Gürbüz, 2010; Dede, 2008; Kyttälä & Björn, 2014), most of the studies have reported higher Mathematics anxiety in girls than boys (Devine, Fawcett, Szűcs, & Dowker, 2012; Frenzel, Pekrun, & Goetz, 2007; Jain & Dowson, 2009; Kvedere, 2012;

Luo, Wang, & Luo, 2009; Primi, Busdraghi, Tommasetto, Morsanyi, & Chiesi, 2014). Several explanations have been proposed as to why females exhibit higher MA levels. Although research indicates that genetic factors contribute to individual differences in MA (Wang et al., 2014), environment and socialisation may also play a part. Since Mathematics is traditionally viewed as a male domain, females may be forced to believe that they are less mathematically able which may engender higher anxiety (Bander & Betz, 1981).

A number of researchers have focused on studying the potential origins of Mathematics anxiety. According to Shields (2005), Mathematics anxiety can be perpetuated at home, in society and the classroom. Parents giving Mathematics low or high status may contribute to the development of Mathematics anxiety in their children (Fraser & Honeyford, 2000). Parents who themselves suffer Mathematics anxiety can unintentionally transfer such anxiety to their children(Else-Quest, Hyde, & Hejmadi, 2008).Stolpa (2004) has pointed out that, the parents' irresponsible and careless statements such as "Don't worry, I've never understood Mathematics" or "Never mind, Mathematics was always tricky for me at school too", may unintentionally raise Mathematics anxiety in their children at times when they are frustrated or upset due to difficulties with mathematical tasks. Over-bearing parental pressure on children for getting high marks in Mathematicsmay contribute to Mathematics anxiety(Bernstein, Coté-Bonanno, Reilly, Carver, & Doremus, 1995).Social factors such as mathematical myths may also reinforce Mathematics anxiety for some students. For example, the myth that boys are better than girls in Mathematics and that only some people have a 'Mathematics mind' can undermine positive self-efficacy beliefs (Whyte & Anthony, 2012). Researchers have suggested that, in combination with the parental and societal factors(Vinson, 2001), Mathematics anxiety may have its roots in traditional ways of teaching that are characterised by an over-reliance on traditional instructional activities such as: drills, flash cards, and work sheets; assigning the same work for everyone; teaching from the same textbook; insisting on only one correct way to solve a problem; concentrating more on basic skills rather than concepts and their applications; and whole class instruction (Gurganus, 2007).

Studies have shown that self-appraisal of abilities such as self-concept and self-efficacysubstantially predict Mathematics anxiety (Hembree, 1990; Meece, Wigfield, & Eccles, 1990; Pajares & Miller, 1994).A considerable number of studies have provided insight into the negative relationship between Mathematics anxiety and self-concept (Ahmed, Minnaert, Kuyper,& Werf, 2012; Frenzel, Pekrun, & Goetz, 2007; Goetz, Cronjaeger, Frenzel, Lüdtke,& Hall, 2010; Hembree, 1990; Pajares & Miller, 1994).

Review of studies as mentioned above have revealed some research gaps. For instance, gender-wise findings regarding anxiety have reported inconclusive findings and a number of personal and educational factors (type of study help and type of study materials) have not been taken into consideration by previous researchers. Moreover, the relationship between Mathematics anxiety and self-concept with respect to gender and personal and educational factors (type of study help and type of study materials) has not been explored for secondary school students at both national and international levels.

Purpose of the Study

In order to fill in the identified research gaps, the present study is aimed at answering the following research questions:

1. What are the levels of Mathematicsanxiety among secondary school students?
2. What are the levels of Mathematicsanxiety among secondary school students with respect to their gender?
3. What are the levels of Mathematicsanxiety among secondary school students with respect to their type of study help?
4. What are the levels of Mathematicsanxiety among secondary school students with respect to the type of study materials used by them?
5. Is there any significant influence of gender on Mathematicsanxiety of secondary school students?
6. Is there any significant influence of type of study help on Mathematicsanxiety of secondary school students?
7. Is there any significant influence of using different types of study materials on Mathematicsanxiety of secondary school students?
8. Is there any significant relationship between Mathematicsanxiety and self-concept among secondary school students?
9. Is there any significant relationship between Mathematicsanxiety and self-concept among secondary school students with respect to their gender?
10. Is there any significant relationship between Mathematicsanxiety and self-concept among secondary school students with respect to their type of study help?

11. Is there any significant relationship between Mathematicsanxiety and self-concept among secondary school students with respect to the type of study materials used by them?

Research Methodology

Descriptive method of research was employed to answer research questions raised about the current status of the participants of this study. The main variable was secondary school students' Mathematicsanxiety. Other variables were their self-concept and demographic variables. The study focused on studying the respective influence of demographic variables on their Mathematicsanxiety.

Sample

In the present study, a non-probability sampling technique, the purposive convenient sampling, was employed with a purpose of selecting a sample of secondary school students from two schools in Aligarh, Uttar Pradesh, India. The sample consisted of 160 students.

Tools used for Data Collection

Two tools, namely, Abbreviated Mathematics Anxiety Rating Scale (AMARS) and Self-Concept Clarity Scale (SCCS)wereused for collecting data online.

AMARS was developed by Alexander and Martray (1989) to measure the students' level of Mathematics anxiety or anxiety. It consists of 25 items and 3 factors or dimensions, namely, Mathematics test anxiety (15 items), numerical task anxiety (05 items) and Mathematics course anxiety (05 items). It is a Likert-type scale and has five-option choices ranging from '*not at all*'to '*very much*' ('*Not at all*', '*A little*', '*A fair amount*', '*Much*' and '*Very Much*'). For every item, a score of '*1*', '*2*', '*3*', '*4*' and '*5*' for '*Not at all*', '*A little*', '*A fair amount*', '*Much*' and '*Very Much*' respectively was given. The sum of the item scores on 25 items gave the total AMARS score for a particular student. This total AMARS score was then divided by 25 to get mean AMARS score for a particular student. The internal consistency reliability, as assessed by Cronbach's Alpha, for Mathematics test anxiety, numerical task anxiety and Mathematics course anxiety were found to be 0.96, 0.86 and 0.84 respectively. Its content validity was established by a team of subject experts.

SCCS was developed by Campbell, Trapnell, Heine, Katz, Lavallee and Lehman (1996) to assess the consistency of students' self-descriptions. It is a Likert-type, 5-point scale, consisting of 12items. Items were given a score of '*1*', '*2*', '*3*', '*4*' and '*5*' for '*Strongly Agree*', '*Agree*', '*Undecided*', '*Disagree*' and '*Strongly Disagree*' respectively. The sum of the item scores on 12 items gave the total SCCS score for a particular student. Higher total scores on the scale reflect greater self-concept clarity. The internal consistency reliability, as assessed by

Cronbach's Alpha, for this scale was found to be 0.87. Its content validity was established by a panel ofexperts.

Statistical Techniques used for Data Analysis

Descriptive statistics (namely, frequency, percentage, mean and standard deviation) and inferential statistics (namely, independent-samples *t* test and Pearson product-moment correlation) were employed for analysing the quantitative data in accordance with the nature of variables involved and research questions of the study.

Data Analysis and Interpretation

Research Question 1: What are the levels of Mathematicsanxiety among secondary school students?

In order to answer this question, descriptive statistics (namely, frequency and percentage) were used. Frequency and percentage for the groups having high, medium and low levels of Mathematicsanxiety respectively are presented in Table 1.Out of 160 students, 40 (25.00 %), 55 (34.40 %) and 65 (40.60 %) students were found to have high, medium and low levels of Mathematicsanxiety respectively.

Table 1

Frequency and Percentage of secondary school students having high, medium and low levels of Mathematicsanxiety respectively

Levels of MathematicsAnxiety	Frequency (N)	Percentage (%)
High (3.34 to 5.00)	40	25.00
Medium (1.67 to 3.33)	55	34.40
Low (1.00 to 1.66)	65	40.60

Research Question 2: Whatare the levels of Mathematicsanxiety among secondary school students with respect to their gender?

Descriptive statistics (namely, frequency and percentage) were calculated for both genders separately to answer this question. Results are presented in Table 2.Out of 80 male students in the sample, 20 (25.00 %), 30 (37.50 %) and 30 (37.50 %) students were found to have high, medium and low levels of Mathematicsanxiety respectively.Further, out of 80 female students, 20 (25.00 %), 25 (31.20 %) and 35 (43.80 %) students were found to have high, medium and low levels of Mathematicsanxiety respectively.

Table 2

Frequency and Percentage of secondary school students having high, medium and low levels of Mathematicsanxiety respectively with respect to their gender

Gender	Levels of MathematicsAnxiety	Frequency (N)	Percentage (%)
Male	High (3.34 to 5.00)	20	25.00
	Medium (1.67 to 3.33)	30	37.50
	Low (1.00 to 1.66)	30	37.50
Female	High (3.34 to 5.00)	20	25.00
	Medium (1.67 to 3.33)	25	31.20
	Low (1.00 to 1.66)	35	43.80

Research Question 3: Whatare the levels of Mathematicsanxiety among secondary school students with respect to their type of study help?

For answering this question, descriptive statistics (namely, frequency and percentage) were computed.Results are presented in Table 3.Out of 84 students who did self-study, 18 (21.40 %), 22 (26.20 %) and 44 (52.40 %) students were found to have high, medium and low levels of Mathematicsanxiety respectively. Further, out of 76 students who went for tuition/coaching class, 22 (28.90 %), 33 (43.40 %) and 21 (27.60 %) students were found to have high, medium and low levels of Mathematicsanxiety respectively.

Table 3

Frequency and Percentage of secondary school students having high, medium and low levels of Mathematicsanxiety respectivelywith respect to their type of study help

Type of Study Help	Levels of MathematicsAnxiety	Frequency (N)	Percentage (%)
Self-Study	High (3.34 to 5.00)	18	21.40
	Medium (1.67 to 3.33)	22	26.20
	Low (1.00 to 1.66)	44	52.40
Tuition/Coaching Class	High (3.34 to 5.00)	22	28.90
	Medium (1.67 to 3.33)	33	43.40
	Low (1.00 to 1.66)	21	27.60

Research Question 4: Whatare the levels of Mathematicsanxiety among secondary school students with respect to the type of study materials used by them?

Descriptive statistics (namely, frequency and percentage) were used to find out the answer of this question.Results are presented in Table 4.Out of 75 students who used self-made notes, class notes and textbook for studying, 10 (13.30 %), 25 (33.30 %) and 40 (53.30 %)

students were found to have high, medium and low levels of Mathematicsanxiety respectively. Further, out of 85 studentswhousedself-made notes, class notes, textbook and study guides for studying, 30 (35.30 %), 30 (35.30 %) and 25 (29.40 %) students were found to have high, medium and low levels of Mathematicsanxiety respectively.

Table 4

Frequency and Percentage of secondary school students having high, medium and low levels of Mathematicsanxiety respectively with respect to the type of study materials used by them

Type of Study Materials	Levels of MathematicsAnxiety	Frequency (N)	Percentage (%)
Self-made Notes, Class Notes and Textbook	High (3.34 to 5.00)	10	13.30
	Medium (1.67 to 3.33)	25	33.30
	Low (1.00 to 1.66)	40	53.30
Self-made Notes, Class Notes, Textbook and Study Guides	High (3.34 to 5.00)	30	35.30
	Medium (1.67 to 3.33)	30	35.30
	Low (1.00 to 1.66)	25	29.40

Research Question 5: Is there any significant influence of gender on Mathematicsanxiety of secondary school students?

In order to determine the influence of gender on Mathematicsanxiety of secondary school students, an independent-samples *t* test was applied, the results of which are presented in Table 5.The results show that there was no significant influence of gender on Mathematicsanxiety of secondary school students, t (158) = 1.28, p> .05. The mean Mathematicsanxietyof male students (M = 2.61, SD = 1.24) was not significantly higher than that of female students (M = 2.36, SD = 1.20).

Table 5

Comparison of mean Mathematicsanxietyscores of male and female secondary school students

Gender	N	Mean	*SD*	*df*	*t*	Sig. (*p*)
Male	80	2.61	1.24	158	1.28	.199
Female	80	2.36	1.20			

Not Significant at .05 level

Research Question 6: Is there any significant influence oftype of study help on Mathematicsanxiety of secondary school students?

In order to determine the influence of type of study help on Mathematicsanxiety of secondary school students, an independent-samples *t* test was applied, the results of which are presented in Table 6.The results show that there was no significant influence of type of study help on Mathematicsanxiety of secondary school students, *t* (158) = - 1.90, *p*> .05. The mean Mathematicsanxietyof students who went for tuition/coaching class (M = 2.68, SD = 1.16) was not significantly higher than that of students who did self-study (M = 2.31, SD = 1.26).

Table 6
Comparison of mean Mathematicsanxietyscores of secondary school studentswith respect to their type of study help

Type of Study Help	N	Mean	*SD*	*df*	*t*	Sig. (*p*)
Self-Study	84	2.31	1.26	158	- 1.90	.059
Tuition/Coaching Class	76	2.68	1.16			

Not Significant at .05 level

Research Question 7: Is there any significant influence ofusing different types of study materials on Mathematicsanxiety of secondary school students?

In order to determine the influence of using different types of study materials on Mathematicsanxiety of secondary school students, an independent-samples *t* test was applied, the results of which are presented in Table 7.The results show that there was significant influence of using different types of study materials on Mathematicsanxiety of secondary school students, *t* (158) = 3.05, *p*< .05. The mean Mathematicsanxietyof students who used self-made notes, class notes, textbook and study guides for studying (M = 2.75, SD = 1.22) was significantly higher than that of students who usedself-made notes, class notes and textbook for studying (M = 2.18, SD = 1.15).

Table 7
Comparison of mean Mathematicsanxietyscores of secondary school studentswith respect to the type of study materials used by them

Type of Study Materials	N	Mean	*SD*	*df*	*t*	Sig. (*p*)
Self-made Notes, Class Notes and Textbook	75	2.18	1.15	158	3.05*	.003
Self-made Notes, Class Notes, Textbook and Study Guides	85	2.75	1.22			

**** Significant at .05 level***

Research Question 8: Is there any significantrelationship between Mathematicsanxiety and self-concept among secondary school students?

Pearson Product-Moment correlation was used to explore the relationship between Mathematicsanxiety and self-concept among secondary school students. Table 8 clearly shows that the correlation betweenMathematicsanxiety and self-conceptwas statistically significant, r (158) = - .420, p< .01 (two-tailed). Since the value of Pearson correlation coefficient was negative, this indicated a negative relationship betweenMathematicsanxiety and self-conceptamong secondary school students. Moreover, as per Cohen's guidelines (1988), since the value of Pearson correlation coefficient (r = - .420) fell in medium range, therefore it revealeda significant and moderately strong relationship betweenMathematicsanxiety and self-concept.

Table 8

Correlation matrix of Mathematicsanxiety and self-concept for secondary school students using Pearson Product-Moment Correlation

	MathematicsAnxiety	**Self-Concept**
MathematicsAnxiety	1.000	- .420**

***Significant at .01 level*

Research Question 9: Is there any significantrelationship between Mathematicsanxiety and self-concept among secondary school studentswith respect to their gender?

The gender-wise results of Pearson product-moment correlationarepresented in Table 9. For male students, the correlation between Mathematicsanxiety and self-concept was found statistically significant, r (78) = - .477, p< .01 (two-tailed). Similarly, for female students, the correlation between Mathematicsanxiety and self-concept was statistically significant, r (78) = - .394, p< .01 (two-tailed). Since the values of Pearson correlation coefficient for both genders was negative, this indicated clearly a negative relationship between Mathematicsanxiety and self-concept. Moreover, as per Cohen's guidelines (1988), since the values of Pearson correlation coefficient for both males (r = - .477) and females (r = - .394) fell in medium range, therefore they revealed a significant and moderately strong relationship between Mathematicsanxiety and self-concept.

Table 9

Correlation matrix of Mathematicsanxiety and self-concept for secondary school students with respect to their gender using Pearson Product-Moment Correlation

	MathematicsAnxiety	Self-Concept
MathematicsAnxiety		
Male	1.000	- .477**
Female	1.000	- .394**

***Significant at .01 level*

Research Question 10: Is there any significantrelationship between Mathematicsanxiety and self-concept among secondary school studentswith respect totheir type of study help?

The relationship between Mathematicsanxiety and self-concept among secondary school students with respect to their type of study help was investigated using Pearson product-moment correlation coefficient. The results of correlation are presented in Table10.For students who did self-study, the correlation between Mathematicsanxiety and self-conceptwas statistically significant, r (82) = - .431, p< .01 (two-tailed). Similarly, for students who went for tuition/coaching class, the correlation between Mathematicsanxiety and self-concept was statistically significant, r (74) = - .363, p< .01 (two-tailed).Since the values of Pearson correlation coefficient for both these groups was negative, this indicated a negative relationship between Mathematicsanxiety and self-concept. Moreover, as per Cohen's guidelines (1988), since the values of Pearson correlation coefficient for those who did self-study (r = - .431) and who went for tuition/coaching class (r = - .363)came undermedium range, therefore it disclosed a significant and moderately strong relationship between Mathematicsanxiety and self-concept.

Table 10

Correlation matrix of Mathematicsanxiety and self-concept for secondary school students with respect to their type of study help using Pearson Product-Moment Correlation

	MathematicsAnxiety	Self-Concept
MathematicsAnxiety		
Self-Study	1.000	- .431**
Tuition/Coaching Class	1.000	- .363**

***Significant at .01 level*

Research Question 11: Is there any significantrelationship between Mathematicsanxiety and self-concept among secondary school studentswith respectto the type of study materials used by them?

The relationship between Mathematicsanxiety and self-concept among secondary school students with respect to the type of study materials used by themwas examined using Pearson product-moment correlation coefficient. The results of correlation are presented in Table 11.For students who used self-made notes, class notes and textbook for studying, the correlation between Mathematicsanxiety and self-conceptwas statistically significant, r (73) = -.404, p< .01 (two-tailed). Similarly, for students who used self-made notes, class notes, textbook and study guides for studying, the correlation between Mathematicsanxiety and self-concept was statistically significant, r (83) = -.389, p< .01 (two-tailed).Since the values of Pearson correlation coefficient for both these groups was negative, this indicated a negative relationship between Mathematicsanxiety and self-concept. Moreover, as per Cohen's guidelines (1988), since the values of Pearson correlation coefficient for those who used self-made notes, class notes and textbook for studying(r = - .404) and who used self-made notes, class notes, textbook and study guides for studying(r = - .389) came to fall undermedium range, therefore it disclosed a significant and moderately strong relationship between Mathematicsanxiety and self-concept.

Table11

Correlation matrix of mathematics phobia and self-concept for secondary school students with respect to the type of study materials used by them using Pearson Product-Moment Correlation

	Mathematics Phobia	**Self-Concept**
Mathematics Phobia		
Self-made Notes, Class Notes and Textbook	1.000	- .404**
Self-made Notes, Class Notes, Textbook and Study Guides	1.000	- .389**

***Significant at .01 level*

Conclusions and Educational Implications

The results clearly indicate that the students had Mathematics anxiety of varying levels. Further, the results reveal the negative relationship between Mathematics anxiety and self-concept among secondary school students, irrespective of their gender, type of study help and

type of study materials used by them. This clearly indicates that the students may not possess the coping strategies or cognitive maturity to deal effectively with their Mathematics-related worries. The findings of this study highlight the need to provide more emotional support to students suffering from Mathematics anxiety and develop preventive and protective measures aimed at halting its emergence at primary school level itself in order to reduce effects on performance at secondary and higher levels of education. Moreover, suitable study habits should be developed in students and appropriate teaching-learning strategies should be implemented to decrease their level of anxiety. Mathematics usually refuse to persist when Mathematics tasks become difficult, responded inappropriately to failure, or simply gave up (Yates, 2009). To increase students' self-confidence and encourage them to persevere, teachers should create an atmosphere in which students can perceive failure as less threatening. In addition, the focus of classroom assessments should be structured to emphasize diagnostic and formative perspectives over summative perspectives (Dann, 2014). Teachers should be able to identify students' weaknesses and strengths and provide detailed diagnostic information to them. By providing less-challenging problems that Maths-anxious students could solve with minimal help and gradually increasing the level of difficulty, students could take step-by-step approaches to solve problems and perceive their own success (Yi & Na, 2020).

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