Analysis of Mathematics Anxiety and its Effects on Mathematics Achievements in Male and Female Students Studying at 10th Grade

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ABSTRACT

The focus of this study was on the analysis of mathematics anxiety in male and female students studying mathematics at secondary level in Pakistan and its effects on their achievements. It was correlational study and the researcher applied quantitative method to collect the data. Students studying at grade 10 were the population of the study. Random sampling technique was applied to select the participants. Mathematics anxiety scale developed by Bai, Wang, Pan, & Frey (2009) was applied to analyse mathematical anxiety after its translation, modification and validation. The effects of mathematics anxiety on the performance of students were determined applying correlation. The major conclusions of the study are that the level of mathematics anxiety is higher in female as compared to male students. It is also concluded that the achievement level of female students in mathematics is lower than male students because of psychological, educational and societal factors that raise the level of mathematical anxiety. It is recommended that learning in classroom in the subject of mathematics needs to be relevant with the problems of life so that students in general and female students in particular gain interest in the study of this subject. Special attention needs to be given to high anxiety victims to raise their confidence. Parents are recommended that they may work to root out stereotyped, illogical perceptions about math as male dominated subject that is out of the reach of female students.

Keywords: *Mathematics anxiety, Effect, Mathematics achievement.*

INTRODUCTION

Mathematics anxiety is defined as feelings of tension that interfere with the manipulation of numbers in solving mathematical problems in academic situations. It may cause to forget and lose one's self-confidence (Ashcraft & Kirk, 2001). Hopko, McNeil, Lejuez, Eifert and Riel, (2003) observed that persons with Mathematics anxiety make more mistakes in dealing with mathematics problems. According to Norwood (1994), origin of mathematics anxiety lies in the personality factors, intellectual factors and environmental factors. Personality factors about mathematical anxiety include low self-esteem, timidity in asking questions, and nurturing ideas that mathematics is a male-dominated field. Intellectual factors of mathematics anxiety involve poor attitude, low self-confidence, and weak belief in the purposefulness of mathematics. Environmental factors of mathematics anxiety include damaging classroom events, indifferent teachers, and demanding parents. Mathematics anxiety has four symptoms: panic, paranoia, passive behavior, and lack of confidence. In panic, the subject has a feeling of helplessness that does not subside. Paranoia makes the students think that they are the only persons not capable of completing Math task. In passive behavior, the student or adult decides that they will never understand or be comfortable with Math. Lack of confidence means feeling of helplessness in students and adults who undergo severe nervous tension in solving math problem (Harris & Coy, 2003).

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Higher level of mathematics anxiety negatively affects the performance of students studying Mathematics at secondary level in public and private schools of Pakistan. The annual results of the Boards of Intermediate and Secondary Education (BISE) in Pakistan present a dismal picture. The performance of the students including both the genders is not up to the required standard (Hussain, 2013). Keeping in view this scenario, the study was focused on finding out mathematics anxiety in male and female students studying at grade 10 and its effects on their performance. The conclusions of the study may enable the students to control anxiety and perform up to the optimum level. The teachers may give considerations to negative effects of anxiety while conducting teaching learning process in the classroom and may positively improve the relationship between teacher and students.

Objectives of the study

The objectives of the study were:

1. to analyse mathematics anxiety in female students studying mathematics at secondary level

2. to analyse mathematics anxiety in male students studying mathematics at secondary level.

3. to compare mathematics anxiety in male and female students studying mathematics at secondary level

4. to determine the effects of mathematics anxiety on the performance of students studying mathematics at secondary level by determining relationship between mathematics anxiety and mathematics achievement.

Hypotheses

Following were the descriptive and alternative hypotheses of the study:

1. There is significant difference between the level of mathematics anxiety in male and female students studying at lower secondary level.

2. Those students who will score higher on MAS-R may be more likely to score lower on Math's Class Test.

LITERATURE REVIEW

Mathematics communicates in universal language that enables human beings to consider, record, and communicate ideas regarding the components and the relationships of quantity. It (Mathematics) is taught as a compulsory subject from grade 1 to grade 10 in Pakistan. The lower secondary curriculum is structured around the contents such as numbers, operations, measurement, geometry, data handling and algebra. The focus of Mathematics study at school level is to develop capability in students to understand and use their knowledge of Mathematics in everyday life and in the study of other fields as well. According to Bekdemir (2010), Mathematics has played a vital role in the development of science, technology, industry, business, and agriculture. Its learning may improve logical thinking, intellectual independence, effective reasoning and creative expression. It is considered the most difficult subject in education community of Pakistan and continues to be a concern for students, teachers, parents and researchers. Low achievement in mathematics is the result of mathematics anxiety, traditional methods of teaching, incompetent teachers and teaching it as a note-taking subject with no emphasis on understanding, reasoning, critical thinking and creativity (Hussain, 2013).

According to Ertekin, Dilmac, and Yazici (2009), anxiety is a state of provocation that surfaces through bodily, emotional, and mental changes in an individual when faced to a challenging stimulus. Symptoms of anxiety are pressure, nervousness, worrying, intolerance, misunderstanding, fear, and development of mental blocks. Anxiety is one of the key predictors of academic performance. Students with higher anxiety display a passive attitude in their studies such as lack of interest in learning, poor performance in examination and on assignments. It (anxiety) effects performance of a student on a test by producing tough, boring, tiresome feelings (Rachel & Chidsey, 2005). According to Grosse (2002), Mathematics anxiety creates a cognitively passive mood, panicky and losing state of mind, unhappy, helpless, nervous and fearful feelings. When body senses anxiety, it discharges adrenaline that affects higher order thinking skills. He concludes that when the higher-order thinking processes stop, then the mind goes blank and a person will not be able to handle mathematical situations .At the same time, it is accompanied by some physiological reactions such as sweat of the palms, holding tight the fists, being sick, vomiting, dry lips, and pale face.

There are certain Mathematical myths that also convince or support mathematics anxiety e.g. the myth that boys are better than girls in Mathematics and only particular people have Math mind. It may challenge positive self-efficacy beliefs in the study of Mathematics. A research involving over 1000 undergraduate students in the United States confirms the view that failure in Mathematics is socially acceptable, and the participants were less ashamed in relation to lack of Mathematical skills compared with language skills (Latterell, 2005).

According to Watson (2000), informal assessment practices in classroom found that the students who do not perform well in written or timed assessments or activities within competitive environments, frequently feel humiliated and come to believe that they cannot do well in Mathematics. Students with high level of anxiety have a reduced memory span, loss of attentiveness, lack of confidence, and poor thinking power. It is common for students to perform poorly when they experience stress or high level of anxiety during their tasks or studies. Rachman and Bichard (1988) found that individuals with anxiety often overestimate their fear, tension at the mathematics test. Such over predictions are maladaptive because they serve to sustain anxious and fearful responding in future circumstances (Ruffins, 2007).

METHODOLOGY OF THE STUDY

Methodology of the study is explained under the following headings:

Research approach and design

It is correlational study and the researcher applied quantitative method to collect data. It is considered suitable because the variables of the study: mathematical anxiety and mathematical achievement of the students studying at grade 10 in schools located in the ambit of Municipal Corporation Rawalpindi were studied as they exist without any manipulation or control. Mathematics anxiety scale was applied to measure mathematical anxiety in male and female students. The students falling above the cut-off scores were considered as they have higher level of anxiety symptoms and the students below the cut-off scores were considered to be carrying low level of anxiety symptoms. The effects of mathematics anxiety on the performance of students were determined through correlation between anxiety scores and achievement test. Chi Square was applied to find out the significant difference among boys and girls on MAS-R.

Population

The focus of the study was to find out mathematical anxiety in male and female students studying Mathematics at 10th grade and its effects on their performance. The target population of the study was the students studying Mathematics at 10th grade in Municipal Corporation (MC) schools located in Rawalpindi city. Sixteen Secondary Schools for Boys & Girls supervised and financed by Rawalpindi Municipal administration were the population of the study. These institutions follow the curriculum of the Punjab Education Department and appear in the examinations annually conducted by the Board of Intermediate and Secondary Education Rawalpindi. By and large population of the study belonged to middle class and lower middle class families having almost similar socio- economic status. Well-to-do people send their children to elite primary schools. The students follow the unified curriculum, teaching hours and the evaluation system. In this respect, the population is homogenous.

Sample

Multi stage random sampling technique was applied to select the schools and the participants of the study. Eight Municipal Corporation Secondary Schools (MCS), four for each gender, were selected. At the second stage of sample selection 30 male and 30 female students were selected. This technique ensured equal participation of all the participants of the study. It also helped in generalizing the results of the study on the overall population. The rising enrolment in private schools is decreasing the enrolment in the public sector institutions, likewise the case of MCS. More than 50 percent of given population were selected as a sample of the study. The tabular presentation of student sample is as under:

Table-1 Students sample

Arbitrary School Names	Number of student	Boys/Girls
01	08	Girls
02	08	Girls
03	07	Girls
04	07	Girls
05	08	Boys
06	08	Boys
07	07	Boys
08	07	Boys
Total	60	30+30

The teachers who were teaching Mathematics in these schools had almost equal qualification and teaching experience. They all had more than five years of mathematics teaching experience. The minimum experience was five years and maximum experience was 8 years of both male and female teachers. The range of their qualification was B.Sc to M.Sc along with B.ED. Four of the teachers were M.Sc whereas the other four were B.Sc along with B.Ed. The teachers were also willing to complete the first two units of mathematics and cooperate with the researcher to conduct the study.

Table-2 Teachers' profile

S.No	Teachers' name	Gender	Experience	Academic qualification	Professional qualification
01	A	Male	5	M.SC	B.ED
02	B	Male	6	B.SC	B.ED
03	C	Male	7	B.SC	B.ED
04	D	Male	8	M.SC	B.ED
05	E	Female	7	B.SC	B.ED
06	F	Female	5	M.SC	B.ED
07	G	Female	6	B.SC	B.ED
08	H	Female	8	M.SC	B.ED

Instruments of the study

Math anxiety scale and math achievement test were used as instruments of the study. Math Anxiety Scale-Revised (MAS-R) developed by Bai, Wang, Pan, & Frey (2009) was applied to measure mathematical anxiety of male and female students. The scale contains 14 statements on five categories: strongly agree, agree, neutral, disagree and strongly disagree. The major variables of the scale for measuring mathematical anxiety were interest in Mathematics, feeling of up-tightness on doing mathematics, ability to solve mathematical problems, relationship of mathematics with life. The researcher translated the scale into Urdu language and it was validated by the Urdu language experts. The language experts pointed out language errors to establish clarity in meanings for the respondents. They pointed out certain words of Urdu language for the accurate translation and understanding of the instrument. The instrument was pilot tested before administering to students who were not included in the sample of study. The items No. 3, 5.8 were modified because they were left out by the majority of respondents while pilot testing. In order to ensure the internal consistency of the tool, data of the pilot study was analyzed in SPSS (Statistical Package for Social Sciences) software. The results of the analysis showed .893 Alpha Coefficient Reliability for the questionnaire. This meant that tool was highly significant and reliable to collect data. The scores of the statements were given as 5 Scores to strongly agree, 4 agree, 3 neutral, 2 disagree and strongly disagree1.

The researcher constructed achievement test with the consultation of the subject teachers and mathematics experts from two units of mathematics text-book: Quadratic Equations and Theory of Quadratic Equations. There are four sub-chapters about Quadratic Equations and 8 chapters about Theory of Quadratic Equations. There are10 objective type questions and 7 subjective type questions from the two selected units. The subjective and objective items linked to the Bloom's taxonomy of learning (knowledge, understanding, application, analysis). The test was validated by getting the opinions of mathematics experts and ensuring content validity by formulating table of specification. Total number of scores was 30.

Table-3 Table of specification for content validity

Major concept	Branching concept	Nature of items		Level of knowledge				Marks
		Sub.	Obj	Know	Comp	Apply	Analyze	
Quadratic Equations	Quadratic Equations in Standard Form	1	2	Q3 (3) Q2 (1)	Q1 (1)	-	-	4
	Factorization	1	-	-	-	Q3 (1)	-	3
	Types of Equation	1	2	-	Q3 (2) Q2 (2)	-	Q1 (2)	5
Theory of Quadratic Equation	Nature of Roots of Quadratic Equation	1	1	-	Q3 (4)	Q2 (3)	-	4
	Discriminant of Roots of Quadratic Equation	-	1	-	-	-	Q1 (5)	1
	Cube Roots of Unity	-	2	Q2 (4) Q1 (4)	-	-	-	2
	Properties of Cube Roots of Unity	1	1	-	Q2 (5)	Q3 (5)	-	4
	Symmetric Functions	-	1			Q1 (3)	-	1
	Synthetic Division	1	-	-	-	Q3 (6)	-	3
	Problems leading to Quadratic Equations	1	-	-	Q3 (7)	-	-	3
Total		7	10					30

Formal approval for data collection

Participants of the study were students studying in Municipal Corporation schools located in Rawalpindi city at grade 10. The researcher obtained necessary permission from the concerned Education Officer and visited schools to administer the instrument. For administering the anxiety scale, the researcher briefed the students that there is no incorrect or correct item in the scale and they have to tick according to their own preference whatever seems appropriate to them. During the second phase of data collection, the researcher administered achievement test to the respondents of the study. The teachers teaching mathematics in respective schools helped the researcher in administering the tests. The researcher ensured the respondents that their information will not be disclosed to anybody except used to draw generalizations of the study.

DATA ANALYSIS

The major objectives of the study were to measure mathematical anxiety and its effects on mathematical achievement of the students studying mathematics at lower secondary level. SPSS version 13 was applied to analyze the data. Cross tabulation analyses was calculated to measure mathematical anxiety. The students who scored above cut-off scores were considered to possess higher level of mathematical anxiety. Chi square was applied to measure the significant difference between boys and girls students on the variable of mathematical anxiety. Pearson correlation was calculated to measure the relationship of mathematical anxiety and academic achievement of the students.

RESULTS

Data under the following tables was analysed by calculating percentage, cut-off scores, cross tabulation analysis, mean, standard deviation and chi-square to draw out the findings and conclusions of the study.

Table 4 Mathematics anxiety on the variables of getting uptight, worried about math capability and unable to think with clarity on a test

Scale items	Gender	SA	Agree	Neutral	DA	SDA
Mathematics anxiety on getting uptight on	Male	6%	11%	5%	23%	5%
math test	Female	16%	11%	6%	14%	3%
Mathematics anxiety on the variable of	Male	15%	5%	13%	15%	2%
getting worried about math capability	Female	18%	11%	8%	13%	0%
Mathematics anxiety on the variable of	Male	9%	10%	8%	18%	5%
unable to think with clarity on math test	Female	15%	12%	8%	14%	1%

SA= strongly agree DA= disagree SDA= strongly disagree

This table reflects analysis of Mathematics anxiety on the variable of getting uptight, worried about mathematical capability and unable to think with clarity on a Math test. The percentage of male respondents who viewed that they strongly agreed to the statement on the variable of uptightness was 6 percent, worried about Math capability was 15 percent and unable to think with clarity was 9 percent. The percentage of female respondents who viewed that they strongly agreed to the statement on the variable of uptightness was 16 percent, worried about Math capability was 18 percent and unable to think with clarity was 15 percent. The percentage of male respondents who viewed that they disagreed to the statement on the variable of uptightness was 23 percent, worried about math capability was 15 percent and unable to think with clarity was 18 percent. The percentage of female respondents who viewed that they disagreed to the statement on the variable of uptightness was 14 percent, worried about math capability was 13 percent and unable to think with clarity was 14 percent. The analysis of table reveals that majority of the female students are feeling uptightness, worried about math capability and unable to think with clarity on a math test. This high rate of test anxiety may negatively effects their performance on a math test, and consequently they will not be able to get high grades on a test. It is also inferred that communication of the settled notion that mathematics suits to the capacities of male students, and female are not good at the study of this subject may influence the performance of the students and raise the rate of anxiety. It is also reflected that female mathematics teachers are not able to develop and promote interests in students about the study of mathematics that may raise the rate of mathematical anxiety.

Table 5 Taking Mathematics in future study as an interesting subject to solve life problems

Scale items	Gender	SA	Agree	Neutral	DA	SDA
Mathematics anxiety on the variable of	Male	10%	16%	5%	8%	9%
importance of math in solving problems	Female	0%	15%	11%	13%	12%
Mathematics anxiety on the variable of	Male	10%	26%	3%	5%	6%
interest	Female	5%	14%	5%	11%	13%
Mathematics anxiety on the variable of	Male	11%	16%	8%	6%	9%
studying math in future	Female	0%	13%	13%	10%	14%

This table reflects analysis of Mathematics anxiety on the variable of importance of Math in solving life problems, interest in the study of mathematics, and taking mathematics in future course of study. The percentage of male respondents who viewed that they strongly agreed to the statement on the variable of importance of Math as an important subject to solve problems of life was 10 percent, Mathematics as an interesting subject was 10 percent, and taking math in future course of study was 11 percent. The percentage of female respondents who viewed that they strongly agreed to the statement on the variable of importance of Math as an important subject to solve problems of life was zero percent, Mathematics as an interesting subject was 5 percent, and taking Math in future course of study was zero percent. The percentage of male respondents who viewed that they agree to the statement on the variable of importance of math as an important subject to solve problems of life was 16 percent, mathematics as an interesting subject was 26 percent, and taking math in future course of study was 16 percent. The percentage of female respondents who viewed that they agree to the statement on the variable of importance of math as an important subject to solve problems of life was 15 percent, mathematics as an interesting subject was 14 percent, and taking math in future course of study was 13 percent. The percentage of male respondents who viewed that they strongly disagreed to the statement on the variable of importance of math to solve problems of life was 9 percent, mathematics as an interesting subject was 6 percent, and taking math in future course of study was 9 percent. The percentage of female respondents who viewed that they strongly disagreed to the statement on the variable of importance of math to solve problems of life was 12 percent, mathematics as an interesting subject was 13 percent, and taking math in future course of study was 14 percent.

This shows that most of the male students feel positively about the importance of mathematics to solve the problems of life as compared to the female students. It is also revealed that the contents of mathematics taught at grade 10 lack relevance with the problems of life. The learners consequently lose interest in this subject. It is also reflected that the teachers teaching this subject do not provide opportunities to students to apply mathematics to solve problems of life. In this respect, analysis of female students is found worse than the male students. It is inferred that the lower level of interest on the part of female is due to sociological, psychological factors about mathematics that is considered to be male dominated subject. It is observed that teaching of mathematics in classroom does not create interest in female students about the study of this subject in future, and the educationists have to revisit the curriculum, content of mathematics textbooks and teaching learning process in the classroom to develop interest in the study of mathematics and relate it to solve the problems of life.

Table 6 Measurement of mathematics anxiety on the basis of cut-off score in male and female students

Labels	Gender	Frequency (30)	%	Labels	Gender	Frequency (30)	%
Above cut off	Male	2	7	Above cut off	Female	5	17
Below cut off	Male	28	93	Below cut off	Female	25	83

This table reflects the frequency distribution, above cut-off scores and below cut-off scores of male and female students. The frequency distribution of the above cut-off of male students was 2 that were 7 percent of the overall frequency. The frequency distribution of the below cut-off scores of male students was 28 that was 93 percent of the overall frequency. It is revealed that 7 percent among the male students possess symptoms of high rate of Mathematics anxiety that may effects their performance on math test. The frequency distribution of the above cut-off scores of female students was 5 that were 17 percent of the overall frequency. The frequency distribution of the below cut-off scores of female students was 25 that was 83 percent of the overall frequency. It is revealed that 17 percent among the female students possess symptoms of high rate of mathematics anxiety that may effects their performance on math test.

Table 7 Significant difference of mathematical anxiety of male and female students

Chi-value P Variable	Male (N=30)	Female (N=30)	Total (N=60)		
Above cut off	2(7%)	5(17%)	7	1.45	.22
Below cut off	28(93%)	25(83%)	53		

$P \leq .01$, df=1

It was hypothesized that females may be more likely to exhibit symptoms of mathematics anxiety as compared to males. Gender differences were calculated on MAS-R. The table above indicates that females are more preoccupied with the anxiety about Math as 7 percent of the total participants scored above the cut-off scores on MAS-R among which 5 percent were females who exhibited mathematics anxiety symptoms while only 2 percent were males. But p value indicates that these differences of scores between males and females are not statistically significant. It is essential that we need to revisit teaching learning process in classroom, contents of mathematics to develop and promote interests of the students in the study of this subject.

Table 8 Pearson Correlation Coefficient of mathematical anxiety and mathematics achievements

Variables			MAS-R	
		Total		Math's Test
MAS-R	Total (.0003)	-		-.952**
Math's Test	Total	-.952** (.0003)		-

$p<0.01$

Students who will score higher on mathematics anxiety scale may be more likely to score lower on the math class test. Correlation between the two variables (scores on MAS-R and Math's class test) was determined. As higher scores on MAS-R indicate higher anxiety level, and significant strong negative correlation was found between the two variables. Those who scored higher on the mathematics anxiety scale scored significantly lower on the math class test. Correlation of 0.952** showed that mathematics anxiety of students negatively effects their math performance. They scored significantly lower on the class test of math due to their over-whelming symptoms of math anxiety. It reveals that mathematics anxiety significantly affects the performance of the students on math test because human brain does not function properly to perform cognitive operation in observing, analyzing, criticizing, inferring results.

DISCUSSIONS, CONCLUSIONS RECOMMENDATIONS

The study was designed to investigate Mathematics anxiety in male and female students and its effects on Math's performance. The findings of the study revealed that the symptoms of Mathematics anxiety are greater in female students as compared to male students. Females scored higher on every item of MAS-R. These findings are consistent with the study conducted by Khatoon & Mahmood (2010); Szucs & Dowker (2012). Khatoon and Mahmood (2010) concluded that American female students have a higher rate of Mathematics anxiety than male students in the process of cognitive operation; similarly, Taiwan's female students have a higher anxiety level than male students, but is not consistent with mathematics anxiety level of China's mainland' students, where there does not exist gender difference on the variable of mathematic anxiety. It is inferred that attitude of female towards Mathematics as a tough and male dominated subject may raise the level of Mathematical anxiety and effects their performance on Math test. Most of the female students consider that boys are blessed with the advantage of mastering Mathematics. The study also concluded that none of the female respondents viewed that she strongly agreed to the statement about studying Mathematics in future. It indicates the attitude of female about studying mathematics in future is not positive oriented. It is also revealed from the analyses that none of the female respondent viewed that mathematics is an important subject to solve problems of life. It reflects the attitude of female about the practicability of Mathematics subject in life.

It is also concluded that the students get uptight and worried about Mathematical capability because of the pressure they take about the study of this subject. It also negatively affects their performance on the test and they get low grades. It is also inferred that communication of the settled notion that Mathematics suits to the capacities of male students, and female are not good at the study of this subject may influence the performance of the students and raise the rate of anxiety. It is also inferred that female Mathematics teachers are not able to develop and promote interests in students about the study of Mathematics that may raise the rate of Mathematical anxiety.

But studies conducted by Hamza (2011); Olmez (2012) reveal that better performance of male students in Mathematics is because of willingness on their part to take up challenging task as compared to girls. It is also concluded that females are more up tight, tense and over stressed on Mathematical test as compared to boys. This extra pressure also negatively affects the performance of girl students on mathematical test. This extra pressure may be the result of over carefulness and taking Mathematics as a difficult subject on the part of girls students. This condition also produces negative effects on the performance of the students in mathematics test. The male respondents viewed that it is an important subject for solving the problems of life. It is required that the study of Mathematics related to the real problems of life so that the leaner may gain interest and need of learning this subject.

It was hypothesized that those students who will score higher on MAS-R may be more likely to score lower on Math achievement test. The findings are consistent with the hypothesis as correlation between MAS-R and Math's Achievement Test was found to be 0.952**. Literature also supports the findings of the study, and the results are consistent with the findings of Luo, Wang, Luo (2009); Maloney, Ansari, & Fugelsang (2011), Sherman and Wither (2003) . Cognitive operation is influenced negatively when the rate of anxiety is high and the students are not able to perform at the best of their abilities.

The study recommends that the teachers need to relate mathematics learning to the real problems of life for the development of positive attitudes in the study of this subjects for students in general and female students in particular so that they may gain interest and develop confidence. They may learn how to solve life-problems with mathematical learning gained from classroom that may enhance their active participation and lower the rate of mathematical anxiety. Parents are recommended that they may play a vital role in shaping their children's attitudes about the study of Mathematics and to lower the level of test anxiety. They may help them to root out stereotyped, illogical perceptions about math as male dominated subject that is out of the reach of female students. They may start to support their children to gain basic mathematical expertise from the initial years of childhood by using math games, numerical activities, and appealing their children in everyday mathematical situations. Special considerations needs to be given anxiety struck victims and female students on the part of the teachers and parents.

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