

A Comparative study of Math Anxiety between parents and their children and its impact on the children's achievement in Mathematics

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Abstract: Mathematics is used as an essential tool in several fields including natural science, engineering, medicine and social sciences throughout the world. Many people experience a great deal of anxiety when dealing with numbers. The main purpose of the present study was to investigate whether children's math anxiety serves as an underlying pathway between parental math anxiety and their children's math achievement. A total of 480 students (234 females and 246 males) of the age ranging from 10 to 15 years (5th to 10th grade) and one of their parents (mother/ father) participated in the study. Parents and their wards math anxiety was measured using MARS-S, MARS-E and MARS-A respectively. Mathematics achievement test was constructed for each grade level based on their current curriculum. The Mediation analysis was carried out. It was found that father's math anxiety contributes positively to their son's and daughter's math anxiety and negatively to their math achievement. However, mother's math anxiety maintained a direct effect on their daughter's math achievement. The findings are explained in terms of the immense role of the parents in the development of mathematics skills in children.

Key words: Parental Math Anxiety, Children's Math Anxiety, Children's Math Achievement and Mediation model

1 Introduction

Mathematics as a subject is imperative for excellence in any field of study and it acts as a bridge that connects various disciplines together. All over the globe, mathematics has been viewed as a challenging subject by a significant portion of learners. The academicians are majorly concerned due to the issue of student's poor performance in mathematics and its downfall at a higher level of education. According to (Pisa, 2009) report two Indian states bagged 72nd and 73rd position out of 74 in both reading and math. The poor performance of Indian students in PISA was acknowledged with disappointment by the Indian media (Anubhuti, 2012). For 2015 PISA cycle, India backed out, as the government officials felt that Indian students were not yet well prepared for such a test (Chappia, 2013).

Children's poor performance and maths avoidance has remained a significant challenge for the education community since several decades. There are numerous personal and environmental factors that can influence students achievement in mathematics. Student's math anxiety poses to be a crucial variable, affecting their performance and mathematics achievement. Math anxious individuals respond to the maths curriculum with boredom and discouragement by developing the perception that success in math depends on innate ability, which they simply do not possess. This divorces their entire lives and career away from the discipline of mathematics, bringing their future potential at crossroads. It has been observed that both parental and children math anxiety play an important role in children math achievement.

Parental Role and Children Math Achievement

Ichado (1998) states that home environment has a notable influence on students performance in school. The home environment comprises of various motivational variables, but the most relevant one involves the parents (Bandura, 1997; Eccles & Harold, 1993; Walberg, 1984). Parental involvement serves as a significant predictor of their children's mathematical achievement which also promotes their positive behaviors and emotional development (Cai, 2003). Chan and Koo (2011) found a strong connection between parenting style and their children academic achievement. Research shows that parents provide both psychological support and cognitive stimulation (Brutsaert, 1999; Eccles & Harrold, 1993) and they also influence the quality and level of educational resources (Campbell & Wu, 1994) which are the key factors influencing the student' learning. Studies have shown that the parents who are knowledgeable, aware and more involved with their wards, bring up their children having a more positive school attitude and a better academic performance (Epstein, 1992, as cited in Anthony & Walshaw, 2007).

Parental Math Anxiety

Parents have been identified as a vital force in their children's mathematics education. The influence of parents on children's education is very high in a collectivistic culture like India, as compared to the western culture, where individualism is more prevalent. Student's prior negative experiences of learning mathematics in the classroom or at home can be the major reason for math anxiety (Rossnan, 2006). There exists a relationship between parenting practices and children anxiety related behavior (McLeod, Wood & Weisz, 2007). Parents own personal feelings about math and are likely to influence the messages they convey about math to their children

(Gunderson, 2012). A study by Vukovic, Roberts and Wright (2013) on home-school mediation analysis depicted that the student's math anxiety is reduced by parental home support and expectation that also influence his mathematics performance.

Parental Stereotypes related to their Children Math Performance

Several studies have been initiated pertaining to parents gender stereotypes, beliefs, and expectations regarding their children's math aptitude, that subsequently influence their math anxiety and achievement in a way that maintain gender stereotypical roles. Eccles and colleagues (1990) state, that "if parents hold gender-differentiated perceptions of, and expectations for, their children's competencies in various areas, then, through self-fulfilling prophecies, parents could play a critical role in socializing gender differences in children's self-perceptions, interests, and skill acquisition" (p. 189). According to Eccles (1987) parents believe that "daughters are better at English than sons, sons are better at Maths than daughters, and daughters have to work harder to master Maths than sons and vice versa for English" (p. 156). Parents not only rate the importance of math as greater for boys than for girls but also anticipate that boys have more natural talent in math and will have greater future success in careers requiring maths skills. They also rate math as more difficult for girls than for boys (Eccles et al., 1990). Jacobs and Eccles (1992) showed that regardless of the children's actual grades in math, parents supporting gender stereotype for math have lower expectation of math success for their daughters than for their sons and also hold lower perception of competence for their daughters. There are mixed findings concerning the role of student gender in perceptions of parental math anxiety. On one hand Kazmi, Sajjid & Pervez (2011) reported that fathers are more involved in their children's academic achievement and on the other hand Alkan (2013) study demonstrated that mothers who are less involved in pupils learning increase their wards maths anxiety.

The Present Study

Previous studies have shown in general a positive relationship between parental involvement and academic achievement in young children (Fan & Chen, 2001; Jeynes, 2005). The researchers have not come across any study that attempts to examine how or the underlying pathway through which parental math anxiety impacts their children's math achievement. The focus of this study is to understand whether children math anxiety serves as an underlying pathway in the relationship between parental math anxiety and their children's math achievement. In addition to this, the goal of our study is to formulate a mediational model in order to explain a differential impact of father's and mother's math anxiety on their children's math achievement and math anxiety.

An attempt was made to test the models shown in the following figures, which made four predictions. First, we hypothesized that son's math anxiety serves as an underlying pathway between father's math anxiety and son's math achievement. Second, we hypothesized that daughter's math

anxiety serves as an underlying pathway between father's math anxiety and daughter's math achievement. Third, we predicted that son's math anxiety serves as an underlying pathway between mother's math anxiety and son's math achievement. Lastly, we hypothesized that daughter's math anxiety serves as an underlying pathway between mother's math anxiety and daughter's math achievement.

2 METHODOLOGY

2.1 SAMPLE- The sample comprised of four hundred and eighty students (234 females and 246 male) studying in 5th-10th grade in a school and also included one of the parents (father/mother) of each student. The sample was drawn from Patiala Sahodhya School Complex, which is a cluster of CBSE affiliated schools in and around Patiala district (Punjab). It mainly covers the following districts of South-West Punjab i.e Patiala, Rajpura, Nabha, Samana and Govindgarh.

Participants were selected through a two stage selection process. Initially, from the CBSE schools of Punjab, thirty eight Sahodhya schools were randomly selected (these thirty eight schools belong to various districts of Punjab). Then from each district 10% schools were selected through random sampling. Firstly, permission was sought from the principal of respective schools for conducting the study. The school authorities were asked to provide the enrolment list of their 5th to 10th grade students, out of which 100 school students were selected by means of stratified sampling from each of the school.

Then, informed consent was sent to parents for seeking permission from them to conduct study on their wards. Only those children whose parents gave consent were permitted to participate in the study. From the selected students, 96 percent students participated by completing the questionnaire. Mostly, students belonged to middle income background as it was ascertained from the Annual income of the parents.

2.2 TESTS-

(a) Mathematics Anxiety Rating Scale for Elementary School Students MARS-E (Suinn, Taylor & Edward, 1988)

This scale was developed by Suinn, Taylor & Edward (1988) in order to measure the degree to which students experience math anxiety in specific life situation. The reliability coefficient of this measure for my sample is 0.80.

The total score was calculated by taking the sum of the ratings for the 26 items of the inventory. The lowest possible total score was 26, signifying low anxiety, however a score of 130 was indicative of extreme anxiety (Taylor & Edward, 1988).

(b) Mathematics Anxiety Rating Scale for Adolescents MARS-A (Suinn & Edward, 1982)

The MARS-A was revised by Suinn and Edwards (1982) from the original Math Anxiety Rating Scale (MARS) created by Richardson and Suinn (1972) which is the most frequently used measure of math anxiety. The Cronbachs' alpha of this measure for my sample is .83.

This instrument consisted of 98 items related to everyday life and school situations that involve math or dealing with

numbers. A score of 98 on MARS- A indicated lower math anxiety, while a score of 490 signified extreme math anxiety (Suinn and Edwards, 1982).

(c) Mathematics Anxiety Scale- Short Version MARS-S
(Suinn & Wiston, 2003)

Mathematics Anxiety Scale- Short Version MARS-S was developed by (Suinn & Wiston, 2003). The instrument comprised of 30 items that were used to determine parental math anxiety. Each item on the scale represented a situation which aroused anxiety within a subject. The reliability coefficient of this measure for my sample is 0.77.

A score of 30 was the lowest possible score indicated lower parental math anxiety and highest score of 150 signified high parental math anxiety (Suinn & Wiston, 2003).

(d) Math Achievement Test

Math Achievement is defined as the level of attainment in any or all mathematics skills, usually estimated by performance on a test. Math achievement test comprised of two parts: In part one, children's math score in school final examination was taken and in second part, math achievement test was constructed for each grade.

According to CBSE norms, for each subject there is a CCE criteria (Continuous Comprehensive Evaluation) on the basis of which the students marks are assessed. There are 2 main parts of an assessment Formative Assessment (FA) Which is a school based internal assessment and the Summative Assessment (SA) namely the question papers and marking scheme supplied by the board and written assessments carried out by the school. There are 4 FA's and 2 SA's in a academic session. Till September FA (1), FA (2) of 10 marks each are conducted and SA (1) of 90 marks is conducted. This is considered as the First Terminal. In addition to this, for the Second Terminal FA (3) and FA (4) of 10 marks each are conducted and SA (2) of 90 marks up till March is conducted. Now for each student assessment is done on the basis of the below mentioned criteria.

The total marks of FA's (FA (1) + FA (2) + FA (3) + FA (4) which amounts to 40 is added to the sum of 1/3 of the total marks of SA (1) + SA (2) which amounts to 60. Therefore, the total marks for the FA and SA would be $40 + 60 = 100$. Eventually the total marks for every student for their mathematics exam are taken to be 100 (Inclusive of all the FAs and SAs). For my study I have taken 80% of 100.

The basic components for studying the math achievement of students of 5th to 7th grade were Algebraic expression, Data handling, Geometry and Bar graph. This involves basic mathematical skill which deals with the fundamentals of mathematics. For students of 8th to 10th grade basic components involves Statistics and Probability, Comparing quantities, Mensuration, Number system (Real numbers), Exponents and powers. It consists of some components that are involved in higher mathematics. However, for students from 11th to 12th grade all the components deals with the higher mathematics level, that comprises of Relation and functions, Algebra, Calculus, Vectors and Three-Dimensional Geometry, Linear programming and Probability.

In part two, math achievement test was constructed for each grade level to evaluate children's math achievement. It comprised of 20 questions based on the current math curriculum and all the questions were approved by the 10 experts of mathematics. Inter rater reliability of the math achievement test came out to be .80. Finally a composite score of Math Achievement was taken into consideration by adding these two math scores (Marks Obtained in Final Examination + Marks obtained in Math Achievement Tests). There exist a strong positive relationship between math score in final examination and math achievement test ($r = 0.87, p < 0.001$).

2.3 PROCEDURE-

The researcher approached various schools of Patiala Sahodhya School Complex and explained the purpose of the study to the authorities, who then assisted in the process of data collection. Firstly, the consent letter was sent to the parents for seeking permission to allow their wards to be part of the study. After the informed consent was signed by parents their children were provided with the questionnaire and were tested for math anxiety and mathematics achievement. Similarly, information was gathered from parents by sending them math anxiety inventory. The subjects were tested on these dimensions with the measures mentioned earlier. The scoring was carried out according to the standardized manuals of the respective tests. The data was analysed using SPSS (20.0 version) and AMOS (20.0 version) and results were interpreted in the light of mediation model.

DATA ANALYSIS AND DISCUSSION

Product moment correlation was computed to study the relationship among all variables. Correlation statistics, as presented in Table 1 (a and b) shows that there exists a positive relationship between parental math anxiety and their children's math anxiety. However, parental math anxiety was negatively related with their children's math achievement.

Insert Table 1 (a and b) about here

We conducted mediation analyses to examine a differential impact of father's and mother's math anxiety on their son's and daughter's math achievement and math anxiety. We used the AMOS 20.0 to run our analyses. The following tables and figures summarize the results.

As shown in **Table 2** and **Figure 1**, the effect of Father's math anxiety and son's math anxiety "path a" was statistically significant, which was necessary for mediation analyses to proceed. When we held Father's math anxiety constant, the effect of son's math anxiety on their math achievement "path b" was also significant. However, when son's math anxiety was held constant, the direct effect of Father's math anxiety "path c'" was not statistically significant for son's math achievement, indicating that son's math anxiety fully mediated the relationship.

Insert Table 2 about here

Insert Figure 1 about here

The effect of Father's math anxiety and daughter's math anxiety "path a" was statistically significant as presented in **Table 3** and **Figure 2**. A significant effect was evident between daughter's math anxiety on their math achievement "path b". However, the direct effect of Father's math anxiety "path c" was insignificant for daughter's math achievement, signifying that daughter's math anxiety fully mediated the relationship.

Insert Table 3 about here

Insert Figure 2 about here

As depicted in **Table 4** and **Figure 3**, the effect of Mother's math anxiety and son's math anxiety "path a" was significant. Similarly, "path b" depicts a statistically significant effect of son's math anxiety on their math achievement. However, son's math anxiety fully mediated the relationship between Mother's math anxiety and their math achievement as "path c" was not statistically significant.

Insert Table 4 about here

Insert Figure 3 about here

The effect of Mother's math anxiety and daughter's math anxiety "path a" was statistically significant as depicted in **Table 5** and **Figure 4**. When Mother's math anxiety was held constant, the effect of daughter's math anxiety on their math achievement "path b" was significant. However, it was evident from "path c" that Mother's math anxiety has a direct effect on their daughter's math achievement. Indicating that daughter's math anxiety only serve as a partial mediator between them.

Insert Table 5 about here

Insert Figure 4 about here

DISCUSSION

The key purpose of the present study was to investigate whether the children's math anxiety succour as an underlying pathway in the relationship between parental math anxiety and their children's math achievement. The results of our study suggests a pathway from parental math anxiety to their children's math anxiety and math achievement. To begin with, we found that father's math anxiety has a differential influence on their son's and daughter's math anxiety and their math achievement. Father's math anxiety positively influences their son's math anxiety and negatively affects their math achievement as compared to their daughter's math anxiety and their math achievement. Meditational analysis proved the relationship between father's math anxiety and son's math achievement as mediated by son's math anxiety. The major reason could be the father's perception about their son's to be more efficient in math and the confidence that their sons will inevitably excel in the subject of math. This result is consistent with Jacobs and Eccles (1992) that parents supporting gender stereotype for math have lower expectation of math success for their daughters than for their sons and also hold lower perception of competence for their daughters, despite the children's actual grades in math.

When the impact of mother's math anxiety was taken into account, a comparison was drawn between son's and daughter's math anxiety and math achievement. It was found that mother's math anxiety positively influences their daughter's math anxiety as compared to son's math anxiety. Although surprisingly, daughter's math anxiety was not a mediator for her math achievement; rather, mother's math anxiety maintained a direct effect on the daughter's math achievement. The findings can be explained in terms of considerable closeness and physical proximity of daughters to their mothers, especially in the Indian culture. This finding further supports the notion that women tend to have higher levels of math anxiety than men, which may account to some gender related profession (Hembree, 1990).

When a comparison was drawn between father's and mother's math anxiety on their son's and daughter's, a differential impact on their son's and daughter's math anxiety and math achievement was observed. It was found that the father's math anxiety contributes positively to their son's and daughter's math anxiety and negatively to their math achievement. This supposition is further supported by Eccles et al., (1990) that parents not only rate the importance of math as greater for boys than for girls but also anticipate that boys have more natural talent in math and will have greater future success in careers requiring math skills. On the contrary, mother's math anxiety positively contributes to their son's math anxiety and negatively to their math achievement. The meditational model proved the relationship between mother's math anxiety and son's math achievement as mediated by son's math anxiety. However, in the context of daughters, their math anxiety didn't serve as an underlying pathway in the relationship between

mother's math anxiety and daughter's math achievement. These findings are consistent with previous studies which have found that despite similar math skills, females around the world have less confidence in their mathematical abilities, which could also help in explaining why young girls are less likely to pursue careers in science, technology, engineering, and mathematics than boys (Else-Quest et al., 2010). As, mother's math anxiety maintained a direct effect on their daughter's math achievement, future research is required to determine whether other social, motivational, or affective factors also mediate this relationship or not.

Thus, it can be inferred from the present study that parents serve as an invariable role model for their children as their behaviour is closely observed by their wards and replicated. When parents consider that mathematics is an arduous subject, they transfer this belief to their wards which creates negative attitude in them towards mathematics. It is proved through mediation models that the independent variable (i.e., parental math anxiety) causes the mediator (i.e., children's math anxiety) and that the mediator causes the dependent variable (i.e., math achievement).

This study further contributes to the body of research documenting a relationship between parental involvement and their children's mathematics achievement. According to Masten and Coatsworth (1998) parental contribution to the academic achievement of their wards is through parenting styles and involvement. Chan and Koo (2011) found a strong connection between parenting style and their children's academic achievement. Mcleod, Wood and Weisz (2007) found a link between parenting practices and children anxiety related behavior. Student's prior negative experiences of learning mathematics in the classroom or at home can be the major reason for math anxiety (Rossnan, 2006). Parental math anxiety transfers math anxiety to their wards, which in turn negatively influence their math performance. Another study by Levpuscek and Zupancic (2009) states that parental academic pressure and support were negatively related to a students' math grades.

Implications and Conclusion

The results drawn from this research has significant implications for educators, policy makers, teachers, parents and school counselors. It is quite evident from the study that parents play a major role in the academic achievement of their children. Parents need to be aware about their own emotional state and attitude while dealing with children in their academic matters. The kinds of interaction parents have with their children and the identifiable patterns of caretaking greatly affect their children's academic performance. The role of father and mother is equally important for the overall development of the child. The schools and teachers should try to conduct special programs related to mathematics. Even, school counselors can render their assistance by counseling math-anxious students so that they can regain their lost morale and shun math related myths. The study can facilitate educators and policy makers to design mathematics curriculum in such a way, that learning mathematics can be made more interesting to children instead of developing math phobia due to the complexity of the subject.

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Table 1a Correlation between Fathers Math Anxiety, Sons and Daughters Math Anxiety and Math Achievement

Variables	F M Anx	S M Anx	S M Ach	D M Anx	D M Ach
F M Anx	1	.80**	-.63**	.66**	-.57**
S M Anx	-	1	-.71**	-	-
S M Ach	-	-	1	-	-
D M Anx	-	-	-	1	-.84**
D M Ach	-	-	-	-	1

P > 0.01

F M Anx = Fathers Math Anxiety, S M Ach = Sons Math Achievement and S M Anx = Sons Math Anxiety, D M Ach = Daughters Math Achievement and D M Anx = Daughters Math Anxiety.

Table 1b Correlation between Mothers Math Anxiety, Sons and Daughters Math Anxiety and Math Achievement

Variables	M F M Anx	S M Anx	S M Ach	D M Anx	D M Ach
M M Anx	1	.55**	-.57**	.81**	-.80**
S M Anx	-	1	-.87**	-	-
S M Ach	-	-	1	-	-
D M Anx	-	-	-	1	-.82**
D M Ach	-	-	-	-	1

P > 0.01

M M Anx = Mothers Math Anxiety, S M Ach = Sons Math Achievement and S M Anx = Sons Math Anxiety, D M Ach = Daughters Math Achievement and D M Anx = Daughters Math Anxiety.

TABLE 2

Illustration of Bootstrap Methods for Fathers Math Anxiety and Sons Math Achievement

Path/effect	Bootstrap		
	B	SE	p
c (F MAnx → S M Ach)	-.57	.06	.001
a (F M Anx → S M Anx)	.76	.05	.001
b (S M Anx → S M Ach)	-.56	.10	.001
c'	-.14	.09	.15

Note: N= 119, F M Anx = Fathers Math Anxiety, S M Ach = Sons Math Achievement and S M Anx = Sons Math Anxiety

TABLE 3

Illustration of Bootstrap Methods for Fathers Math Anxiety and Daughters Math Achievement

Path/effect	Bootstrap Results		
	B	SE	p
c (F MAnx → D M Ach)	-.43	.06	.001
a (F M Anx → D M Anx)	.72	.08	.001
b (D M Anx → D M Ach)	-.58	.05	.001
c'	.01	.05	.85

Note: N= 104, F M Anx = Fathers Math Anxiety, D M Ach = Daughters Math Achievement and D M Anx = Daughters Math Anxiety

TABLE 4
 Illustration of Bootstrap Methods for Mothers Math anxiety and Sons Math Achievement

Path/effect	Bootstrap Results		
	B	SE	p
c (M MAnx → S M Ach)	-.37	.05	.001
a (M M Anx → S M Anx)	.46	.06	.001
b (S M Anx → S M Ach)	-.62	.04	.001
c'	-.08	.03	.013

Note: N= 127, M M Anx = Mothers Math Anxiety, S M Ach = Sons Math Achievement and S M Anx = Sons Math Anxiety

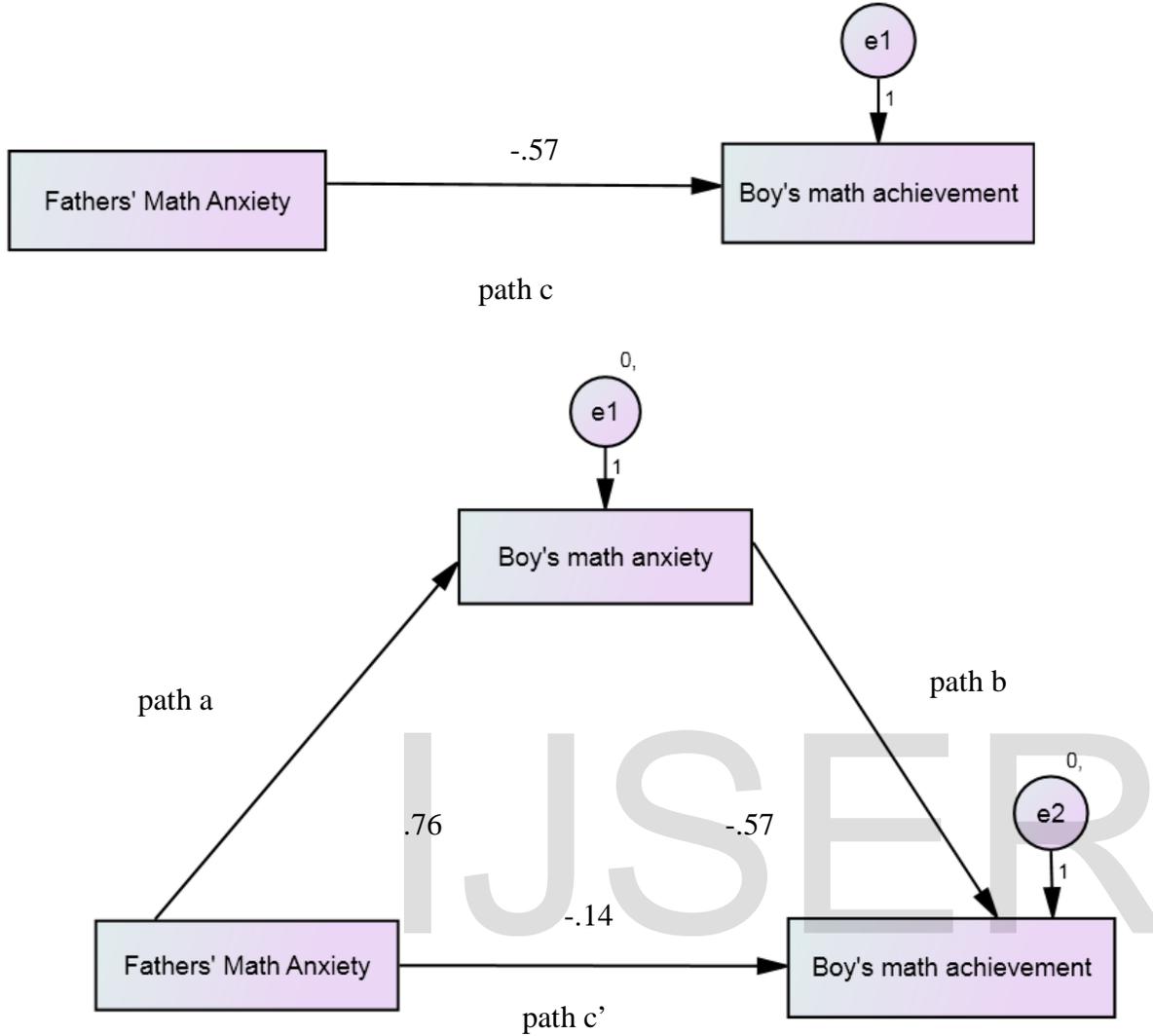
TABLE 5
 Illustration of Bootstrap Methods for Mothers Math Anxiety and Daughters Math Achievement

Path/effect	Bootstrap Results		
	B	SE	p
c (M MAnx → D M Ach)	-.65	.04	.001
a (M M Anx → D M Anx)	.81	.05	.001
b (D M Anx → D M Ach)	-.39	.06	.001
c'	-.33	.06	.001

Note: N= 130, M M Anx = Mothers Math Anxiety, D M Ach = Daughters Math Achievement and D M Anx = Daughters Math Anxiety

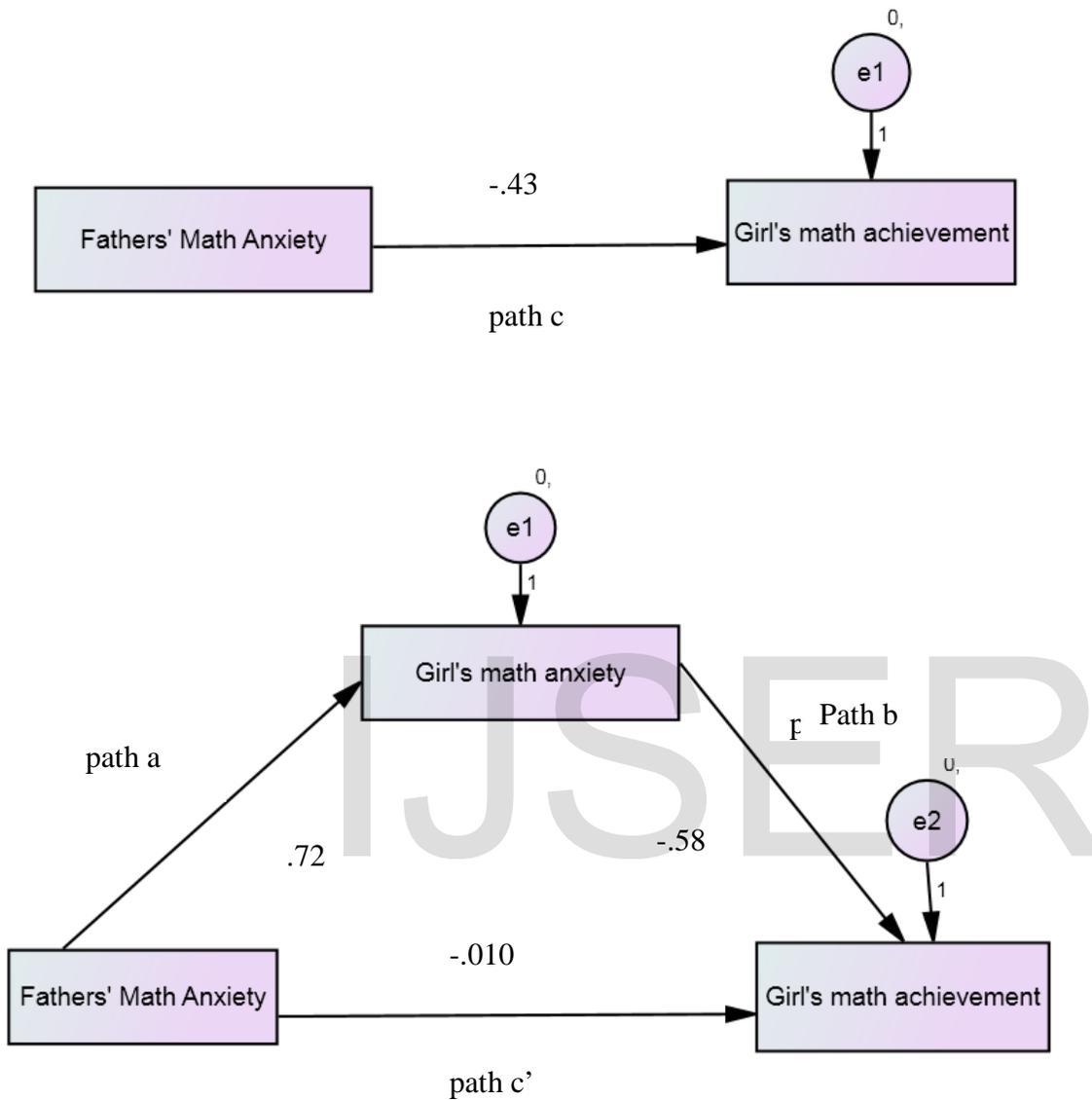
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Figure 1 Mediation Analyses: Effects of Fathers math anxiety on Boys mathematics achievement



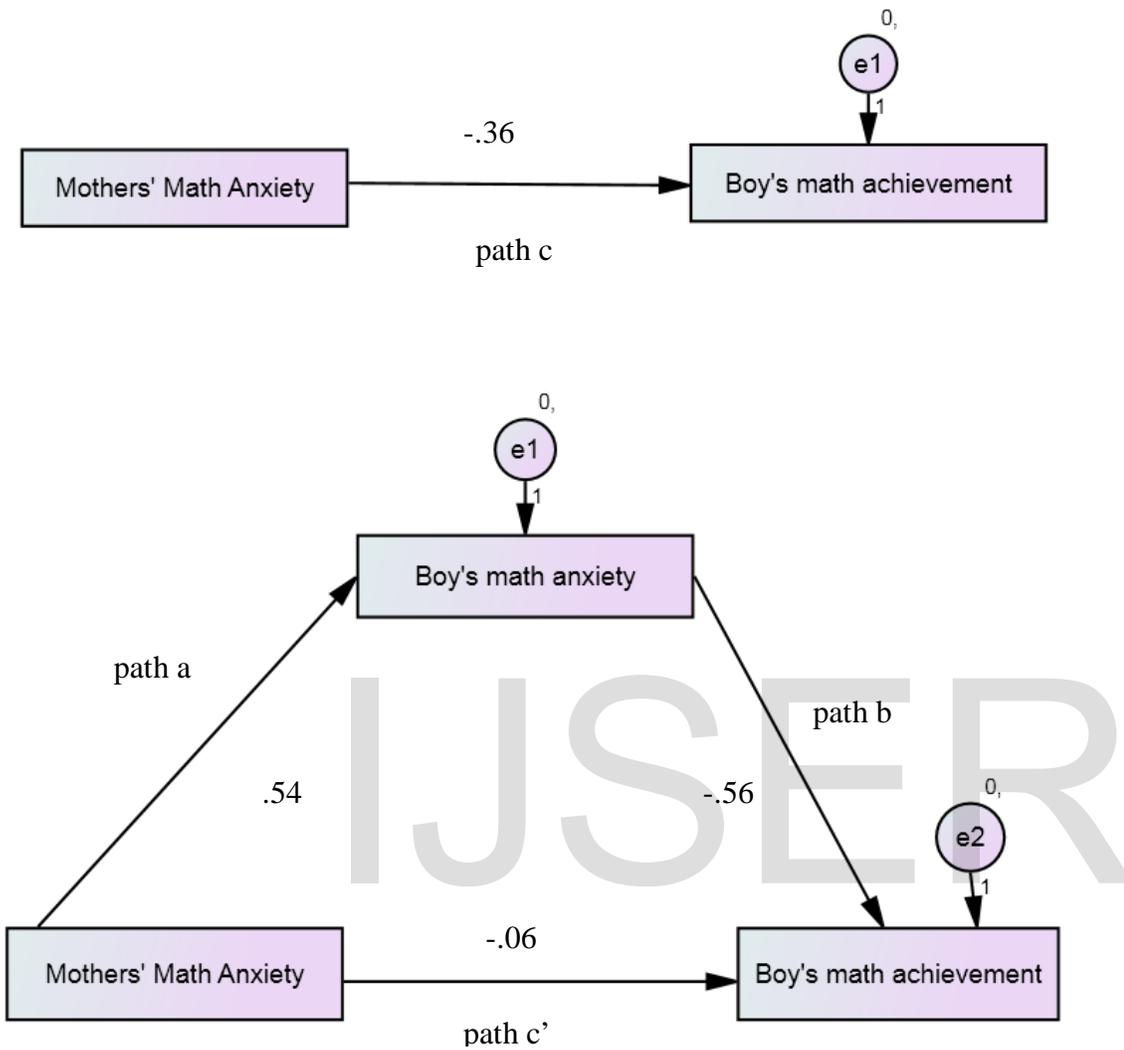
NOTES: **Top panel:** The total effect of fathers math anxiety on boys mathematics achievement is denoted by c . **Bottom panel:** The path coefficients (a , b , c') that estimate the strength of hypothesized causal associations are estimated by standardized path coefficients.

Figure 2 Mediation Analyses: Effects of Fathers math anxiety on Girls mathematics achievement



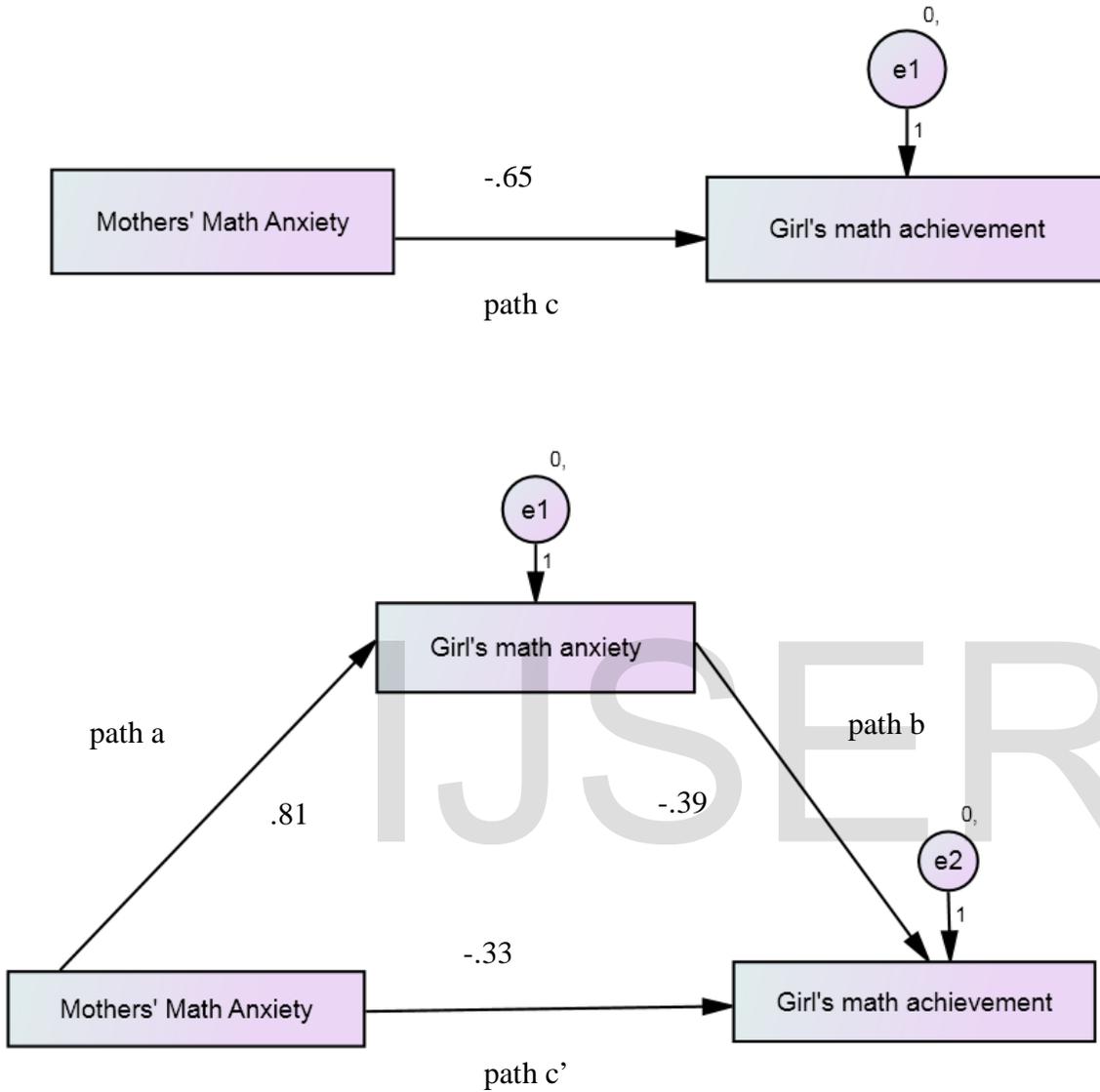
NOTES: **Top panel:** The total effect of fathers math anxiety on girls mathematics achievement is denoted by c . **Bottom panel:** The path coefficients (a , b , c') that estimate the strength of hypothesized causal associations are estimated by standardized path coefficients.

Figure 3 Mediation Analyses: Effects of Mothers math anxiety on boys mathematics achievement



NOTES: **Top panel:** The total effect of Mothers math anxiety on boys mathematics achievement is denoted by c .
Bottom panel: The path coefficients (a , b , c') that estimate the strength of hypothesized causal associations are estimated by standardized path coefficients.

Figure 4 Mediation Analyses: Effects of Mothers math anxiety on Girls mathematics achievement



NOTES: **Top panel:** The total effect of Mothers math anxiety on girls mathematics achievement is denoted by c . **Bottom panel:** The path coefficients (a , b , c') that estimate the strength of hypothesized causal associations are estimated by standardized path coefficients.

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