FACTORS INFLUENCING STUDENTS' MATHEMATICS ACHIEVEMENT AND THEIR CHOICE TO STUDY FURTHER MATHEMATICS

A THESIS

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DECLARATION

I hereby declare that this thesis entitled "FACTORS INFLUENCING STUDENTS' MATHEMATICS ACHIEVEMENT AND THEIR CHOICE TO STUDY FURTHER MATHEMATICS" is an original piece of work done by me for the award of the degree of Doctor of Philosophy in Psychology. I also declare that this thesis or any part of it has not been submitted by me for the award of any degree, diploma, title or recognition before.

Akanksha Soni

Patiala

Akanksha Soni

CERTIFICATE

I hereby certify that this thesis entitled "FACTORS INFLUENCING STUDENTS' MATHEMATICS ACHIEVEMENT AND THEIR CHOICE TO STUDY FURTHER MATHEMATICS" is a record of bonafide study and research carried out by Akanksha Soni under my supervision and guidance for the partial fulfillment of the requirements for the degree of Doctor of Philosophy in Psychology. The results embodied in the thesis have not been submitted to any other University or Institute for the award of any degree, diploma, title or recognition.

Patiala

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(Thesis Supervisor)

Head and Professor

Thapar University, Patiala.

Dedicated to
My Beloved Family

(Who remained a source of Inspiration and Motivation throughout my work)

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ABSTRACT

The present study investigated the antecedents and consequences of children's math anxiety and math attitude. A total of 875 students aged 10 to 17 years (5th to 12th grades) and one parent of each (mother or father) participated in the study. The study was conducted in India, with the study sample drawn from schools in South-West Punjab. Math anxiety of parents and their children was measured using the Mathematics Anxiety Scale Short-Version (MARS-SV), the Mathematics Anxiety Scale for Elementary School Students (MARS-E), and the Mathematics Anxiety Rating Scale for Adolescents (MARS-A). Math attitude was assessed with the Attitude Towards Mathematics Inventory (ATMI). A math achievement test was constructed for each grade level based on their curriculum. Path analyses were conducted to test the suggested conceptual model and the results indicate that parental math anxiety and math attitude act as precursors to their children's math anxiety and math attitude, and further influence the math achievement of their children. Teachers' attitude toward math contributes positively to their children's math attitude. Males perform better than females in math achievement across grades. The decision to study further math depends on the kind of attitude, the children hold about math.

Keywords: Children math achievement, children math anxiety and math attitude, parental math anxiety and math attitude, teachers math anxiety and math attitude and choice to study further mathematics

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CHAPTER - 1
INTRODUCTION

1.1 General

Mathematics as a subject, is imperative for excelling in any field of study i.e. engineering, medicine and social sciences throughout the world. The foremost factor that contributes to the excellence of the education sector in our society is children's academic achievement (Moswela, 2014). A large-scale international survey that assesses students' achievement in mathematics is known as Program for International Student Assessment (PISA). It is an international evaluation process carried out by the Organization for Economic Cooperation and Development (OECD) that compares how schoolchildren stand by the side of their peers in other countries. It measures the knowledge and skills of students (15 yrs old) in reading, mathematics, and science. In 2009, out of 74 countries that were PISA tested, India stood second to last, with Kyrgyzstan receiving the lowest results. The two Indian states (Himachal Pradesh and Tamil Nadu) that participated on the global stage were placed 72nd and 73rd (of 74) in both reading and math, and 73rd and 74th in science (PISA, 2009). The issue of poor student performance in mathematics and their corresponding downfall in higher levels of education has become a major concern for academicians.

The present study uncovers the mechanism underlying the relationship of personal and environmental factors to mathematics achievement and decisions for the future whether to study/ not to study mathematics. Children's mathematics achievement is greatly influenced by the personal and environmental factors (Mahanta, 2014; Nicolaidou & Philippou, 2003). The downfall of mathematics at the tertiary level has become a concern for our Indian society (Garg & Gupta, 2003). The think tank of education talks volume to enhance the educational quality, however less is often done in reality. For many children, a negative attitude towards mathematics serves as an impediment in their future goals. This attitude is affected by the child's educational context at home as well as at school. An ineffective base at primary level serves as the stumbling block at higher level of education.

One of the major factors that significantly contribute to low mathematics achievement is math anxiety (Woodard, 2004). Unfortunately, math anxiousness leads decline in mathematics achievement (Ashcraft, Krause, & Hopko, 2007), avoiding math courses (Eccles, 1984). Matriculated students, who are high on math anxiety, show low achievement as compared to the students who either have moderate or low math anxiety (Zakaria & Nordin, 2008). Math anxious individuals respond to the current curriculum with boredom and discouragement by developing a perception that success in math depends on innate ability,

which they simply do not possess. Math anxiety is negatively related with competence as, when math anxiety increases then competence in mathematics decreases (Ashcraft, 2002). Another study by Tapia and Marsh (2004), showed that students who had no math anxiety significantly scored higher in enjoyment, self-confidence and motivation as compared to those with some or high math anxiety.

Children's attitude towards mathematics greatly affects their perception regarding their own mathematical competence. Researchers have demonstrated that a significant positive relationship exists between students' mathematics achievement and their attitude towards problem solving (Mohd, Mahmood, & Ismail, 2011; Nicolaidou & Philippou, 2003). Students' math attitude plays a predominant role in participation as well as in their mathematics achievement (Tapia, 1996). Moses, Kudzai, and Emily (2001), found that the main reason for dropping high school mathematics is a student's belief that mathematics is an exceptionally complex and tiresome subject.

A crucial role is played by family in determining academic achievement and children attitude. Parental support and encouragement in mathematics learning contributes positively to mathematics achievement (Cruz, 2012). There is a valuable parental impact on their educational aspirations of children's; it is much stronger than that of peers (Davies & Kandel, 1981). If parents don't value mathematics, their ward surely cannot be expected to value mathematics either. Parents have been identified as a vital force in their children's mathematics education. Rossnan (2006), showed that the prior negative experiences of students for mathematics learning in the classroom or at home can be the major reason for math anxiety.

Even the teachers' involvement has an immense influence on mathematics achievement and attitudes towards mathematics of students'. Teachers' positive attitude towards teaching mathematics contributes remarkably in shaping their students' attitude towards the subject as well as in mathematics performance (Mensah, et. al, 2103; Stanslause, et.al, 2013). It is high time to improve the mathematics performance in schools not only to benefit the economic infrastructure by infusing youngsters with numerical skills that is required for workplace, but it will also socially benefit a large number of young people by opening the gateways to higher education.

1.2 Motivation for the Study

The subject of mathematics is rudimentary for success of a nation. It is a pre-requisite tool for comprehending subjects and an essential element in public decision-making as well as for participation in the knowledge economy. The main reason for studying mathematics at an

advanced level is that it opens up the avenues of the human mind for all kinds of skills and development. Mathematics, in itself, has all the ingredients that make it a universal language shared by all human beings. Mathematical concepts like algebra, geometry, calculus etc. remain same regardless of where we are.

The second decade of the 20th century owes a lot to Srinivasa Ramanujan, a mathematician, the Number Theory genius, whose innovation turned the attention of the mathematical world to India. He serves as a representative of the transition between the traditional and the modern mathematics in India. The former Prime Minister Manmohan Singh, paid tribute to the mathematics genius, Ramanujan's on his 125th birth anniversary by declaring 22nd December as National Mathematics Day and the year 2012 was declared the the National Mathematics Year. Several young men and women with natural mathematics ability are unable to pursue the discipline at higher level (Venkartaramanan, 2011).

There is a sharp stepping down of the students in areas of mathematics, social sciences, and humanities, leading to shrinkage of these departments. The drastic changes that are visible in higher education among the upper sections of Indian society have led to stagnation of jobs in the state sector. However, career opportunities in the corporate and informal sectors have grown tremendously. The present investigation focuses on factors influencing students' mathematics achievement and their choice to study further mathematics. The above mentioned factors motivated the researcher to venture this study.

The above mentioned studies indicate that personal factors (children's math anxiety and attitude toward mathematics) and environmental factors (parental role, teachers' role) contribute to the children's mathematics achievement. As the review of literature, presented in Chapter two indicates, previous studies are limited on several aspects: (i) Although attempts have been made to delineate individual factors (such as personal and environmental factors) affecting children's math performance, the underlying mechanism through which these factors operate in influencing math performance is not clear, (ii) there exists literature pertaining to the home environment, parenting style, parental education and socio - economic influence on mathematics achievement. However, the influence of environmental variables (parental math anxiety and attitudes) on their children's math anxiety and math attitude is an area that is less touched upon and (iii) There are only few studies that points out the factors conducive for choosing mathematics for further studies.

To address the first limitation, this study investigates the effect of a wide range of variables, namely, parental math anxiety, parental math attitude, children math anxiety, children math attitude, and mathematics achievement. The study attempts to fill the void due

to the first limitation of existing literature by investigating the underlying mechanism that link parental math anxiety, math attitude, children math anxiety, and math attitude to children's mathematics achievement.

This study primarily aims at exploring the interrelationships between the various variables included in the study and investigates how environmental factors (parental math anxiety and parental math attitude) influence personal factors (children's math anxiety and math attitude) that further influence children's mathematics achievement. To sum up, the present study attempts to identify the linkages between parental math anxiety and attitude and their children's math anxiety, math attitude, and math achievement.

The present study also investigates the causal connections between: (a) parental math anxiety and the subsequent math anxiety and math achievement of their children; and, (b) parental math attitude and the corresponding math attitude and math achievement of their children. It is proposed that parents' math anxiety and math attitude act as precursors to their children's math anxiety and math attitude, which further influences children's math achievement. Parental math anxiety has been found to be one of the contributing factors in creating math anxiety in their wards, which further affects math achievement of children. Similarly, parents' positive attitude towards mathematics has profound influence in developing a similar attitude towards math in their children, which further helps in enhancing children's mathematics performance.

In addition to this, the present study throws light of various personal factors like (Children's Math Achievement, Children's Math anxiety and Children Math Attitude) that can influence a students' choice to study further mathematics.

1.3 Objectives of the present research

The present research has five principal research objectives:

1. To study the impact of parental math anxiety and parental math attitude on their children's math achievement.
2. To develop the conceptual framework to understand the linkage between parental math anxiety and parental math attitude with children's math anxiety and children's math attitude in different grade group and gender.
3. To study the effect of teacher's math anxiety and math attitude on math achievement of children.
4. To compare gender differences in math achievement.
5. To identify the best predictor for the choice to study further mathematics.

1.4 Conceptual Model Rationale

According to Bandura's model of observational learning (1971), children acquire their behavior by observing the behavior of others, including parents, teachers, and friends. Most parents also succor as role models for their children, and children tend to adopt the beliefs, attitudes, values, and emotions of their parents. Reiss (1965, cited by Bandura, 1989) pointed out that parents tend to pass on their values and behavior to their own offspring. The study by Festa and Ginsberg (2011), found that parental anxiety is related to higher level of social anxiety in children. In addition to this, the contribution of environmental factors in creating high level of math anxiety has been investigated by Shaikh (2013). Also, the democratic style of parenting has been found to ameliorate test anxiety among students (Thergaonkar & Wadkar, 2007). A study conducted in twins by Eley et al., (2015) on anxiety clearly indicated that children and adolescents learn anxious behavior from their parents through modeling instead of genetic transmission. Based on the above studies, it was predicted that parental math anxiety is positively related to children's math anxiety and parental math attitude positively influences children's math attitude.

Dahmer (2001), noted that parental math anxiety contributes negatively to their children's mathematics achievement. Although parenting practices do not play a major part in the development of anxiety disorder-related that are related to children's behaviors, they do have an effect on anxiety related behaviors (McLeod et al., 2007). The way parents' feel about mathematics seems to be reflected in the kind of messages they convey about math to their children (Gunderson, 2012). According to Ford et al., (1998) school and family jointly foster a positive attitude about mathematics which further helps children to learn mathematics in school. Similarly, supportive attitude of parents has been found to have significant influence on reading performance of children (Rabia & Yaari, 2012). Based on the above premises, it was predicted that parental math anxiety is negatively related to children's math attitude and parental math attitude negatively influences children's math anxiety.

The body of research on math anxiety has consistently shown the negative impact of math anxiety on children mathematics achievement (Ashcraft & Moore, 2009; Richardson & Suinn, 1972). However, studies on attitude towards mathematics have consistently shown positive relationship with academic performance (Bramlett & Herron, 2009; Nicolaidou & Philippou, 2003). Therefore, the present researcher predicted that children's math anxiety is negatively related to math achievement and children's math attitude positively influences their math achievement.

Path analyses were performed to test the model fit using Amos 20.0 as shown in Figure 1, which made six predictions. A recursive model was attempted for the present study; with all presumed causal effects specified as unidirectional only, so that no two variables are causes of each other.

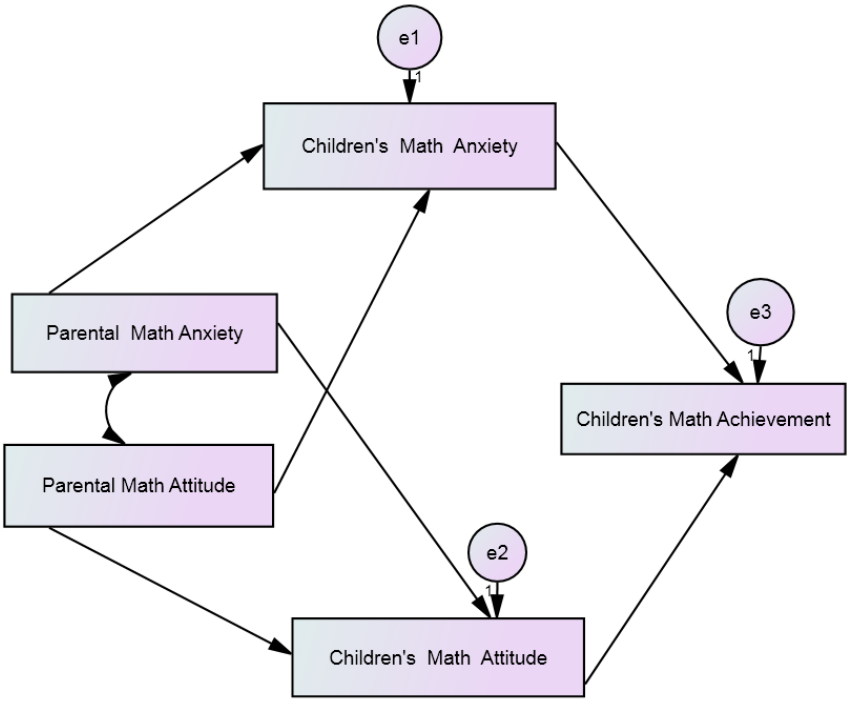

Figure 1: The general proposed path model of Environmental/ Personal Variables and children's mathematics achievement

1.5 Hypotheses

Hypotheses forwarded for statistical analyses are presented along with the specific models (Figure 2- 5).

1.5.1 Effect of Parental Math anxiety, Parental Math Attitude on Children's Mathematics Achievement

Based on the model in Figure 2, the following hypotheses were formulated:

H_{1a} **:** Parental math anxiety is positively related to children's math anxiety.

H_{1b} **:** Parental math anxiety is negatively related to children's math attitude.

H_{1c} : Parental math attitude negatively influences children's math anxiety.

H_{1d} **:** Parental math attitude positively influences children's math attitude.

H_{1e} : Children's math anxiety is negatively related to math achievement.

H_{1f} : Children's math attitude positively influences their math achievement.

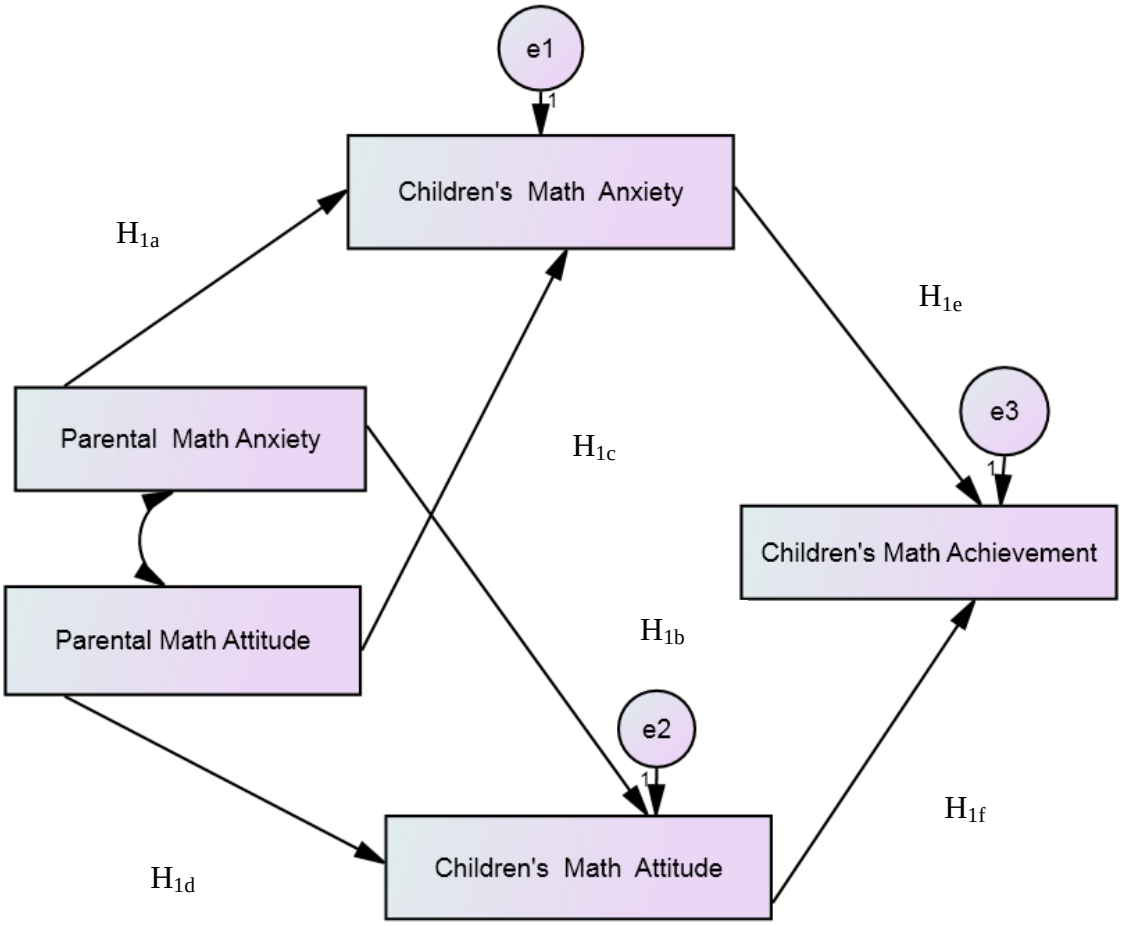

Figure 2: Proposed path model between Parental Math anxiety, Parental Math Attitude and children's mathematics achievement

1.5.2 Effect of Parental Math anxiety, Parental Math Attitude and Grade on Children's Mathematics Achievement

Based on the model in Figure 3 the following hypotheses were formulated:

H_{2a}: Parental math anxiety is positively related to younger children's math anxiety as compared to older children.

$H_{2b:}$ Parental math anxiety is negatively related to younger children's math attitude as compared to older children.

$H_{2c:}$ Parental math attitude negatively influences younger children's math anxiety as compared to older children.

$H_{2d:}$ Parental math attitude positively influences younger children's math attitude as compared to older children.

H_{2e}: Children's math anxiety is negatively related to their math achievement.

$H_{2f:}$ Children's math attitude positively influences their math achievement.

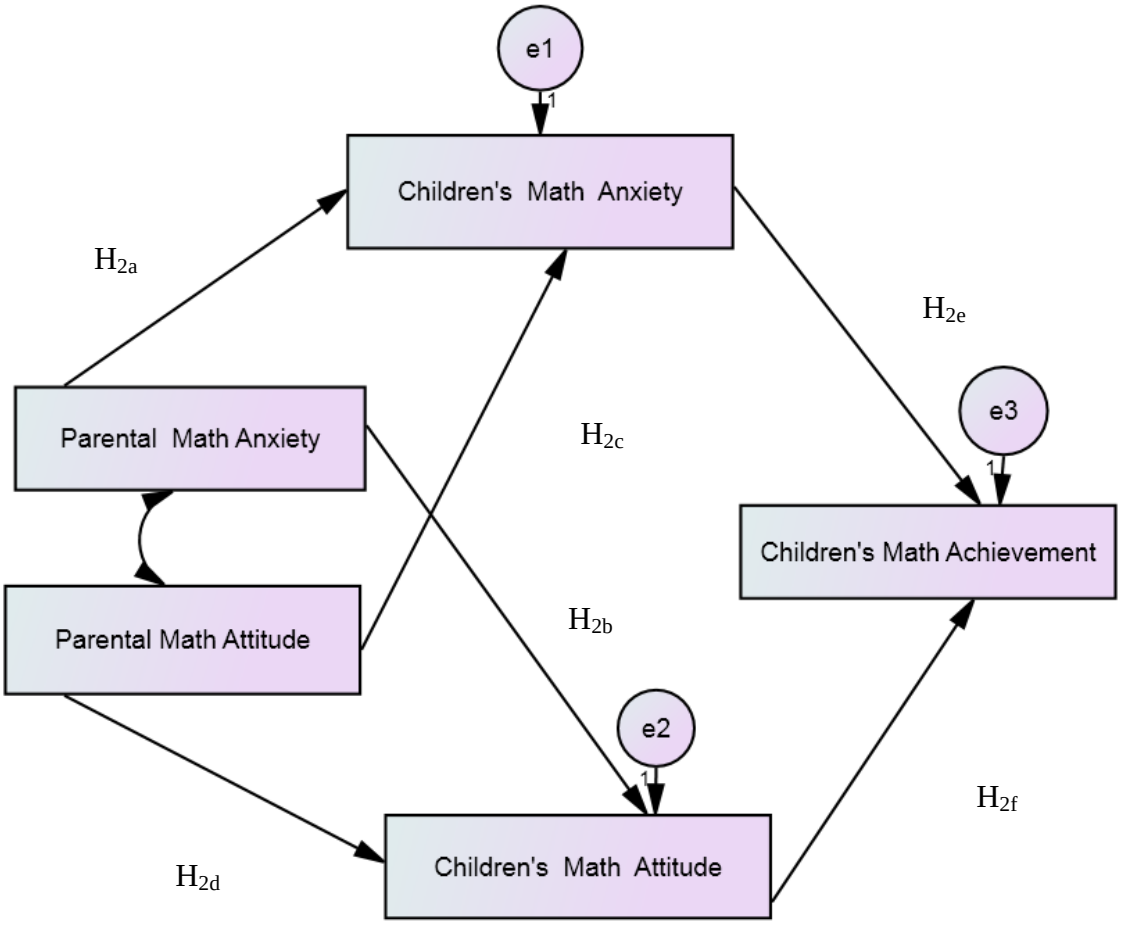

Figure 3: Proposed Path Model between Parental Math anxiety, Parental Math Attitude and Grade on Children's Mathematics Achievement

1.5.3 Effect of Parental Math anxiety, Parental Math and Gender on Children's Mathematics Achievement

Based on the model in Figure 4 the following hypotheses were formulated:

H_{3a}: Parental math anxiety is positively related to Boys/Girls math anxiety.

H_{3b} : Parental math anxiety is negatively related to Boys/Girls math attitude.

H_{3c} : Parental math attitude negatively influences Boys/Girls math anxiety.

H_{3d} : Parental math attitude positively influences Boys/Girls math attitude.

H_{3e} : Boys/Girls math anxiety is negatively related to math achievement.

H_{3f} : Boys/Girls math attitude positively influences their math achievement.

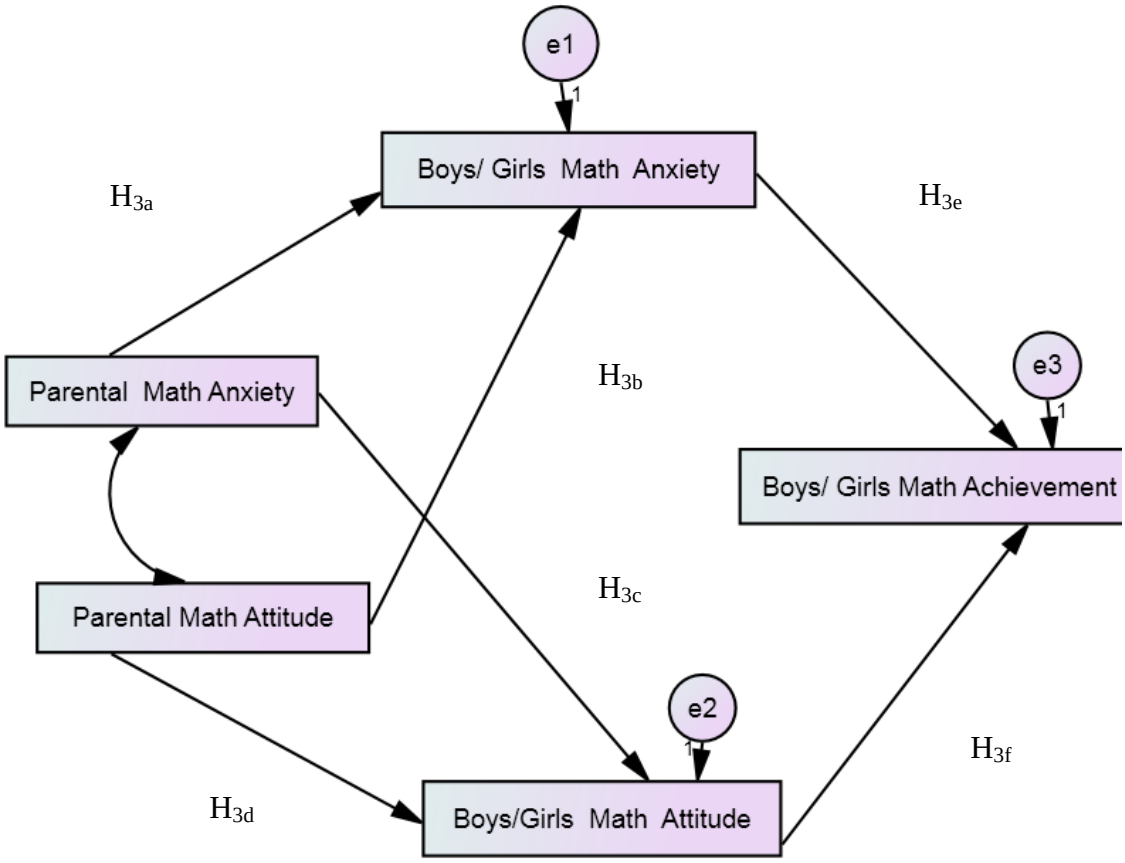

Figure 4: Proposed Path Model between Parental Math anxiety, Parental Math Attitude and Grade on Boys/ Girls mathematics achievement

1.5.4 Effect of Teachers math anxiety, Teachers math attitude and children mathematics achievement

Based on the model in Figure 5 the following hypotheses were formulated:

H_{4a} : Teachers math anxiety is positively related to children's math anxiety.

H_{4b} : Teachers math anxiety is negatively related to children's math attitude.

H_{4c} : Teachers math attitude negatively influences children's math anxiety.

H_{4d} : Teachers math attitude positively influences children's math attitude.

H_{4e} : Children's math anxiety is negatively related to math achievement.

H_{4f} : Children's math attitude positively influences their math achievement.

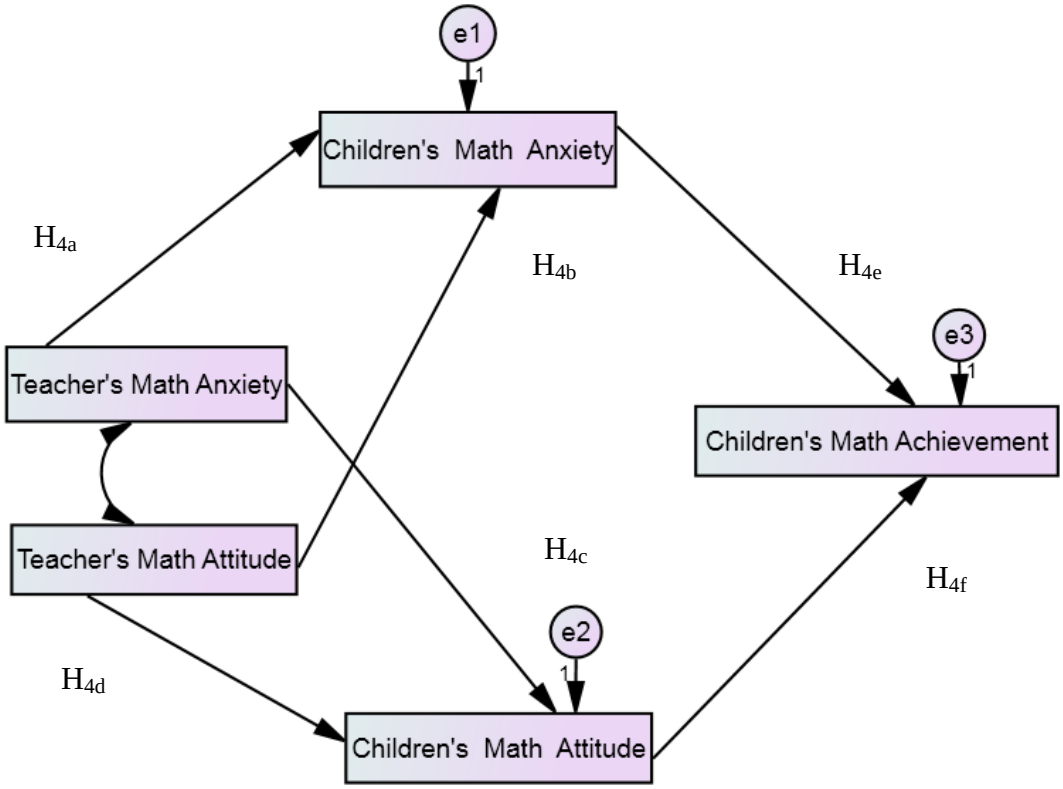

Figure 5: Proposed Path Model between Teachers Math anxiety, Teachers Math Attitude and on Children's Mathematics Achievement

1.5.5 Gender differences in Mathematics Achievement

According to the reports of OECD (2014), the gender gap in mathematics performance has remained consistent over consequent PISA assessment, with boys outshining females in math. This gap is further reflected in their attitude towards the subject. Anderson and Heinesen (2013), found that male students score well in subjects that illustrate on systemizing abilities and females on empathizing abilities. Grissom (2004), stated that during elementary school older age students perform better than their younger classmates, however this difference disappears as the students reach higher grade. Students belonging to below 19 years group had comparatively higher grade point average score in mathematics as compared

to above 19 years (Jabor et al., 2011). Younger children are more positive in their beliefs and perform well in math and reading than older children (Wigfield et al., 1989).

Based on the above studies following hypothesis was formulated:

$H_{5:}$ Males perform better than females in mathematics achievement.

1.5.6 Factors influencing children choice to study further mathematics

According to Kinyota, (2013) there are several factors that contributes significantly towards students choice of career decision in sciences stream like overall marks, knowledge about the subject, self – efficacy as well as school resources. Scarpello, (2005) reported that students' who are high on mathematics anxiety and low on mathematics and career efficacy are less likely to pursue their career in mathematics courses.

Based on the above premises the following hypotheses were formulated:

$H_{6:}$ Math attitude of 11^{th} and 12^{th} grade children affects their choice to study further mathematics.

1.6 Significance of the study

Parents are considered as the first institution of a child. Children pass most of their time with their parents and learn from them. Involvement of parents enhances scholastic achievement of their children. Parents play a significant role by actively supporting and reinforcing the education of their child. The present study highlights the key determinants that influence children's mathematics achievement. It also throws light on how children math attitude influence their choice to study further mathematics. The present study can make the parents cognizant about their own emotional state and attitude while dealing with children in their academic matters. Parents should be advised to develop a positive attitude towards children while upbringing them in their early days of schooling. Socializers (like parents and teachers) serve as role models, whose behavior is closely observed and replicated by their children.

The present study advances the previous findings by demonstrating the influences of personal and environmental factors on children's math achievement. In Indian setting, we have few studies highlighting the influence of environmental factors on children's math achievement. The study also accentuates the role of parents and their contribution in children math performance. The findings of the study can also bring fruitful results in field of education.

1.7 Organization of the Thesis

The thesis is presented in six chapters. Chapter One is the introductory chapter providing the background to the research and identification of the key aspect under investigation.

Chapter Two presents a review of the literature. This chapter includes (i) studies related to children's math anxiety, math attitude, and mathematics achievement and (ii) studies pertaining to parental math anxiety and math attitude.

Chapter Three highlights the method and design of the investigation. There is a description of the procedure, of the sample being measured, and of the measurement tools used.

Chapter Four provides results of impact of children's math anxiety, math attitude, and parental math anxiety and math attitude on children's mathematics achievement, which were measured quantitatively.

Chapter Five presents the discussion of the results of personal and environmental factors influencing children's mathematics achievement.

Chapter Six explicates the summary of the results, presented together with limitation of the study, the implication of the research findings, and suggestions for further research and conclusions.

A comprehensive list of references used and appendices related to the research methodology and design completes the thesis.

CHAPTER - 2

REVIEW OF LITERATURE

Mathematics proficiency has been recognized as a quintessential skill – both in professional and personal fields. Throughout the world, the subject of mathematics is used as an indispensable tool in several fields of social sciences, medicine, engineering, and natural sciences. Math anxious individuals lead their entire lives and profession away from mathematics discipline, leaving their career and future perspective at crossroads. There are visible differences in classroom between those who can master math and those who struggle with it. Yet, this challenge has been met, quite erroneously, by making mastery of math even more difficult.

The main objective of this chapter is to examine the influence of numerous personal and environmental factors on children's math achievement. Two key personal factors are math anxiety (Richardson & Suinn, 1972) and attitude toward mathematics (Nicolaidou & Philippou, 2003). Environmental factors include the role of teachers (Olatunde, 2009), and parental role (Cruz, 2012).

2.1 Theories related to Personal and Environmental Factors

2.1.1 Attentional Theory:

Leone and Revelle (1985) have thrown light on the Attentional theory of Mandler and Sarson (1952). It was proposed that whenever an individual encounters a test situation, he/ she have two options:

a. either to complete a task, so that anxiety can be reduced

b. encountering a realm of thoughts that are full of inadequacy, helplessness, insufficiency that compel a person to quit the task.

Mandler and Sarson (1952) further hypothesized that an individual who is less anxious, focuses more on task completion. On the other hand more anxious individual engages in task interfering responding.

2.1.2 Processing Efficiency Theory

Eysenck and his colleagues in (2007) had proposed a processing efficiency theory. It further elaborated the work in the field of working memory capacity. The processing efficiency model is based on the two assumptions:

a. The component of worry

b. The mechanism of working memory.

The worry component is accountable for performance effectiveness and efficiency. It usually occurs in a tense situation and is more liable to occur in an individual of high trait anxiety. Thus, it influences the working memory either by limiting its attentional resources or by motivating, so as to avoid the stressful situation. The second component is of working memory mechanism that is based on the original model of Baddeley. There are three major parts of working memory viz Phonological loop (process sound of words), Visuospatial sketchpad (processes visual and spatial information) and Central executive, that supervises the other two components. Therefore, according to this theory, the component of worry affects the central executive of working memory resulting in task inefficiency under stressful conditions.

2.2 Theories of Attitude

2.2.1 Social Learning Theory

Bandura (1971), propounded the social learning theory to describe learning experience. There are four ways according to which individual acquire behaviours or information from others. Firstly, to learn something through observation, one needs to direct attention to appropriate models. Secondly, the person may be able to remember what others have done. Thirdly, there is a need for production processes i.e. transformation of memory representation into appropriate actions. Fourthly, motivation plays an immense role to acquire knowledge through observation learning.

On the basis of this theory, the foundation of the study was built to determine the role of environmental factors i.e. parental math anxiety and math attitude in influencing their children math anxiety and math attitude that further leads to math achievement. In his observational theory, Bandura (1971), demonstrated that behavior is acquired by watching others, such as parent, mentor, and friend who serve as a model for the learner. The model displays a behavior and the latter tries to imitate that behavior. Parents serve as invariable role models whose behaviors are easily copied by their children. In a nutshell, parents' attitude directly affects children's attitude as student. Parents' attitude is, in turn, influenced by their culture and belief system.

2.2.2 Expectancy Value Theory

The Expectancy Value Theory was proposed by Wigfield and Eccles, (2000) on the basis of Expectancy Value Model propounded by Eccles and his colleagues in 1980's. The main focus of the theory was on two main construct from the previous theory i.e expectation of success and subjective task value, as these two variables directly influences achievement choices. It is based on the individual belief about the degree of confidence to accomplish an academic task as well as its usefulness to pursue the task. These are further influenced by the previous past experiences as well as socialization influences.

The present investigation takes a step forward to know the factors that influence children's math achievement. If children are math anxious, it will negatively influence their math achievement and can lead to avoidance of math course. As personal factors i.e. children math anxiety and math attitude are not the only factors that influence the math performance. Environmental factors i.e parental math anxiety and math attitude equally play a significant role in their children math achievement.

2.3 Personal Factors in Children's Math Achievement

2.3.1 Anxiety and Math anxiety

Anxiety is a general feeling of apprehension that tends to cause physical as well as psychological discomfort in an individual. On the one hand, physical discomforts may include increased heart rate, heavy breathing, palpitation etc and on the other hand psychological discomfort consists of negative thoughts, unnecessary worry about future threat or worry.

The concept of state- trait anxiety was coined by Spielberger, Gorsuch and Lushene (1970). According to them State Anxiety is "a transitory emotional state or condition of the human organism that is characterized by subjective, consciously perceived feeling of tension and apprehension and heightened autonomic nervous system".

Trait anxiety refers to "relatively stable individual differences in anxiety proneness that is to difference between people in the tendency to respond to situation perceived as threatening with elevation in A- State Anxiety". (Spielberger, Gorsuch and Lushene, 1970, as cited by Joseph, 2004).

Students' mathematics anxiety tends to decrease their mathematics achievement and serves as a stumbling block in their academic performance. According to Truttschel (2002), math anxiety poses to have deleterious effects on college students, encompassing feelings of

tension and fear of rejection. The scrutiny of literature has demonstrated the deleterious effect of students math anxiety like cognitive reactions that consist of intrusive thoughts (Hunt et al., 2014), decline in working memory (Ashcraft & Kirk, 2001), and affective reactions such as avoidance of courses and careers with math (Scarpello, 2005).

For more than 30 years, mathematics anxiety, in particular has been studied as a subject of immense importance in mathematics education. It has been defined and described in the relevant literature in numerous as well as different terms. The empirical investigation of math anxiety was pioneered by Richardson and Suinn (1972) as "a feeling of tension and anxiety that interferes with the manipulation of numbers and the solving of the mathematical problems in a wide variety of ordinary life and academic situations" (p. 551).

2.3.2 Relationship between Math anxiety and Math Achievement

Children's math anxiety seems to be a critical variable affecting their performance and mathematics achievement. The body of research on mathematics anxiety has consistently demonstrated the negative relationship anxiety and mathematics achievement (Ashcraft, Krause, & Hopko, 2007; Kumar & Karimi, 2010; Richardson & Suinn, 1972). Students performance in math can be severely influenced by negative feelings associated with math anxiety (Bekdemir, 2010; Ho et al., 2000; Ma, 1999). According to Spark (2011), students as well as teachers display discomfort during performance of math tasks due to mathematics anxiety. Students math anxiety contributes negatively to their math achievement, as when math anxiety increases there is a sharp decline in math achievement and females are more math anxious as compared to their male counterparts (Woodard, 2004). A significant negative relation exists between mathematics anxiety and mathematics achievement in college students (James et al., 2013). According to Zakaria and Nordin (2008), matriculation students who were high in math anxiety scored low in mathematics achievement compared with students who had moderate or low math anxiety.

When the math is performed under timed, high – stakes conditions there is an effective drop in performance both in laboratory and educational settings (Aschraft & Moore, 2009). According to Mohamed and Tarmizi (2010), senior students are more fearful about mathematics as compared to junior students. As, mathematics anxiety occurs as an impediment to mathematics performance. Students with low math anxiety demonstrate more self - confident and seems to be highly motivated to learn mathematics as compared to students with high math anxiety (Marsh & Tapia, 2004).

2.4 Attitude towards Mathematics

According to Hannula (2002), "attitude is not seen as a unitary psychological construct, but as a category of behavior that is produced by different evaluative processes. Students may express liking or disliking of mathematics because of emotions, expectations or values" (p. 30). Tapia (1996), opined that the kind of attitude students holds towards mathematics plays a dominant role in their participation as well as in achievement in mathematics. Tapia constructed Attitude Towards Mathematics (ATMI) in order to assess attitude towards mathematics. ATMI is used explicitly by various researchers and academicians to measure students attitude towards the subject.

2.4.1 Relationship Between Math Attitude and Math Achievement

Students' perception of mathematical competences is influenced by their attitude towards mathematics. A review of the relevant literature showed that positive relationship exists between students' attitude and academic performance (Bramlett & Herron, 2009; Nicolaidou & Philippou, 2003). Students who secure higher grade in mathematics in previous years have more positive attitude towards mathematics, i.e. with growing success in mathematics, positive attitude towards the subject is also increased (Pachemska et al., 2015). Students' who believe strongly in the utility of mathematics, study the subject with understanding and that is reflected in their high math performance (Eleftherios & Theodosios, 2007).

Das et al., (2015) demonstrated that it is imperative to develop positive attitude towards mathematics for better performance in the subject. Students' attitude toward mathematics has been considered as the significant variable influencing achievement in mathematics (Mohamed & Waheed, 2011). Moses, Kudzai, and Emily (2001), found that the main reason for dropping high school mathematics is a student's belief that mathematics is an exceptionally complex and tiresome subject. Students' beliefs and dispositions significantly influence their mathematical self-beliefs and their experiences effect its development (Dimarakis, Bobis, Way & Anderson, 2014).

Studies have shown a positive relationship between students' mathematics attitude and their mathematics achievement (Mata et al., 2012 & Yee, 2010). The students who consider mathematics as interesting, advantageous subject and perceived their excellence in the subject were more successful in science as compared to social courses (Sirmaci, 2010). Adeyinka and Kaino (2012), found that positive attitude towards mathematics contributes significantly to mathematics achievement and males perform well as compared to their female counterpart. Students positive attitude towards solving a problem contributes significantly in their mathematics achievement (Mohd & Mahmood, 2011).

According to Schreiber (2002), students who are engaged in advanced mathematics and physics courses had a positive attitude towards mathematics and thus perform better in the subject. Kloosterman and Cougan (1994), found that students in the upper-elementary grades were able to proclaim their beliefs more evidently than students in the lower grades. Moreover, students' who enjoyed math were also confident of their math abilities.

2.5 Environmental Factors

Environmental factors play an important role in determining the mathematics achievement and attitudes of children. Researchers have identified various environmental variables that could possibly explain how the environmental factors influence students' mathematics achievement. This includes family structure, parents' occupation and education, parental socio- economic status, parental involvement, parenting style, home atmosphere, parental math attitude, parental anxiety, teachers' biases, and uncooperative sibling.

2.5.1 Parental Involvement and Academic Achievement

According to Desforges and Abouchaar (2003), parental support and involvement contributes positively in their children's on their children achievement. In addition to this, Hoover-Dempsey and Sandler (1997), children's academic self-efficacy, intrinsic motivation to learn, and social self-efficacy are influenced by parental involvement that further enhances their children achievement. The involvement of parents in based on the viewpoint that children's success in school depends upon several factors like home, school, and community in a bidirectional manner (Bronfenbrenner & Morris, 1998, cited by Vukovic et al., 2013). Chan and Koo (2011), found a strong connection between parenting style and children's academic achievement. Parents indulge in home work with involvement as they have the belief that they should get involved, it will create a positive impact, and even their children want their involvement (Hoover- Dempsey, et al., 2001). Hill and Tyson (2009), reported that academic socialization like parental involvement, communication, educational value and learning strategies contributes positively to their children achievement. Parental involvement serves as a crucial predictor of mathematics and science achievement (Ademola & Olajumoke, 2009). Education level of parents as well as gender significantly contributes to their children mathematics score (Schreiber, 2002).

Researchers have provided immense support that younger children academic achievement is strongly related with their parental involvement (Fan & Chen, 2001; Nye, Tuner, & Schwartz, 2006). According to Grolnick, Ryan and Deci (1991), children's attributes and behaviours, are primarily influenced by parental involvement, which in turn

affect academic achievement. Parental involvement has salient effect on secondary school students' academic achievement (Jeynes, 2007). According to Davis – Kean (2005), parental education and family income contributes indirectly to their children's academic achievement through their beliefs and behaviours. There exists a positive relationship between parents' educational expectation for their children and students' educational aspirations (Ozturk & Singh, 2006).

2.5.2 Role of Parental Math anxiety

The kind of feelings that parents' have towards math are likely to impact the messages they convey about math to their children (Gunderson et al., 2012). Therefore, parental math anxiety positively influences their children's math anxiety. McLeod, et al (2007), found a link between parenting practices and child's anxiety related behavior. Parental math anxiety transfers math anxiety to their wards, which in turn negatively influences their wards' math performance. Lack of involvement has also been ascribed to the increasing complex nature of math as students proceed through the grades, with parents missing the content knowledge or teaching skills required to encourage their children (Sheldon & Epstein, 2005). A minor but important role is played by parenting practices in the developmental course of children's anxiety disorder (McLeod et al., 2007; Wood et al., 2003).

2.5.3 Role of Parental Math Attitude

An important role is played by family in determining the academic achievements and attitudes of children. Parental support and encouragement in learning mathematics is positively related to mathematics achievement (Cruz, 2012). Fan and Chen (2001), found that parental involvement directly influence their children academic achievement. Aunola et al. (2003), discovered that parental beliefs in children's competence in mathematics is positively related to children's high math performance. Parental mathematics attitude has significant influence on children's achievement and behavior (Eccles, 1983).

The level of importance placed by parents on mathematics has a tremendous impact on the mathematics performance of their children. If parents do not value mathematics, their ward(s) are unlikely to value mathematics either. It is also believed that parents' own understanding about the value of science and mathematics impacts their children's motivation to pursue these fields in the future (Jacob et al., 2005). The way parents spend their quality time and the choices they make transmit significant messages to their children about values. Children whose parents had a close bond with them that continued into adolescence developed a positive perception of parental support. The level of bonding is therefore an indicator of desired positive development in the child (Jacobs et al., 2005). A study by Yee

and Eccles (1988), states that a children being successful or unsuccessful in math performance depends on their parents' beliefs, expectations, and causal attribution. In contrast, Kleanthous and Williams (2010), found that there exists a parental influence on their children's inclination to mathematics, but not on mathematics achievement and their plans to study mathematics in the future.

Parents have been identified as a vital force in their children's mathematics education. Eccles et al., (1982) found that children's attitudes were influenced more by their parents' attitudes about their abilities than by their own past performance. Rossnan (2006), noted that the prior negative experiences of student's to learn math in the classroom or at home can be the major reason for math anxiety. Another study found that students' math grades were negatively related to parental academic pressure and support (Levpuscek & Zupancic, 2009). Children's attitudes toward mathematics are greatly influenced by the essence of environment provided at home by their parents (Balli, 1998; Parsons, Adler, & Kaczala, 1982).

Parents associate the importance of math with boys to a great extent as compared to girls and also anticipate that they have a wider scope of success in math skills careers (Eccles et al., 1990). Parents supporting gender stereotype for math hold lower perception of competence for their daughters as compared to their sons (Jacobs & Eccles, 1992).

2.6 Role of Teachers Math anxiety

Math anxiety passes from teachers to students (Sovchik, 1996 as cited Aslan, et al., 2013). Math anxious teachers are more likely to influence girl's math achievement, although not affecting during initial year of school (Beilock, et al., 2010). Elementary school teachers' math anxiety is positively related to their anxiety about teaching mathematics (Hadley & Dorward, 2011). On the contrary, Aslan, Ogun and Tas (2013), have pointed out that teachers' mathematics anxiety did not contribute significantly to children's mathematics achievement.

2.7 Role of Teachers Math Attitude

Teachers' mathematics beliefs are pivotal in bringing about a change in curriculum and educational reform (Handal & Herrington, 2003). Mathematics teachers play positive role in enhancing students' participation in classroom activities through teaching styles, quality of teaching, and classroom assessment (Al-Qaisi, 2010). Chesebro (2003), found that teacher clarity servers as an important factor in students' learning, their apprehensions, and affect. Teachers possess a positive attitude towards mathematics and hence make their students less math anxious (Sunita & Rani, 2013). Teachers' attitude towards mathematics plays a immense role in shaping the attitude of students towards learning of mathematics (Olatunde,

2009). Lamb and Fullarton (2001), reported that classroom factor comprising teachers involvement notably influenced children's mathematics achievement.

Several aspects of school context like student-to-student interaction, teachers academic and behavior expectations, significantly influence their student attitudes and behaviors (Akey, 2006). Maat and Zakaria (2010), identified that students' who pose a higher perception of learning environment hold a positive attitude toward mathematics. The role of teachers is important in affecting students' attitude toward mathematics. Midgley et al., (1989) reported that students' value for math increased, when they moved from less supportive to more supportive teachers after transition to high school, and decreased for those experiencing opposite pattern of change. Teachers' attribution has a positive significant effect on students' achievement in mathematics (Al- Agili et al., 2013). According to Alkan (2013), teachers play a key role in reducing children's math anxiety by motivating pupils, making math relevant, reviewing topics by examples and exercises. Mji and Makgato, (2006) reported that there are several factors that serve as direct factors with poor performance in mathematics and physical science like teaching strategies, content knowledge, laboratory influence, and non completion of syllabus.

2.8 Gender Differences

2.8.1 Gender Differences in Math Achievement

There is a common perception in our society that males are more capable in mathematics than females. According to Hair and Benbow (1995), glucose metabolic rate in temporal lobe was positively related with math reasoning score in men rather than women. Benbow (1988), found substantial sex differences in girls and boys who were identified as "mathematically precocious". According to Else-Quest et al. (2010), females around the world demonstrate low confidence in their mathematical abilities and are less likely to pursue careers in sciences as compared to boys. Wigfield and Meece (1988), reported that girls' reacted more negatively to math from 6^{th} through 12^{th} grade than those of boys. According to Meece et al., (1982) due to sex differences in math achievement very few women elect advanced level math courses.

The kind of negative stereotype about their ability to perform in math tends to influence their performance (Blanton, Christie & Dye, 2002). It has also been indicated that stereotypical threats substantially interfere with women's math performance (Spencer et al., 1999). According to Niederle and Vesterlund (2010), in mixed competition performance of women as compared to men is low as not only they fail to perform well in competition, they even shy from competitive environment.

2.8.2 Gender Differences in Math anxiety

Gender has been found to be a significant factor that can explain differences in math anxiety. Chipman, Krantz, and Silver, (1992) found that undergraduate women avoided careers in math and science due to mathematics anxiety. Males students have been found to display lesser math anxiety than females (Tapia & Marsh, 2004; Woodard, 2004). Women experience greater threat in situations, when their gender identity is linked with math performance (Schmander, 2002). Undurti (1998), reported that women low achievement depends not on absolute internal trait but on social cultural and structural factors.

2.8.3 Gender Differences in Math Attitude

Owiti (2011), reported a significant gender difference in attitude towards mathematics. Boys depict more positive attitude towards mathematics than girls. Primary school students pose a positive attitude toward learning of mathematics. In addition to this, boys hold a positive attitude towards math as compared to girls (Kiptum et al., 2013).

Students' positive attitude towards mathematics influences math performance. However, gender difference in their math attitude was not evident (Mohamed & Waheed, 2011). When standardized psychometric tests are given to primary school age students, there was no gender difference in specialized math abilities (Lachance & Mazzocco, 2006). There was no gender difference in the cognitive abilities at the foundations of mathematics and scientific thinking (Spelke, 2005).

2.8.4 Grade Differences in Math Achievement

Grissom (2004), stated that during elementary school older age students perform better than their younger classmates, however this difference disappears as the students reach higher grade. Students belonging to below 19 years group had comparatively higher grade point average score in mathematics as compared to above 19 years (Jabor et al., 2011). Wigfield et al., (1989) found that younger elementary school children are more positive in beliefs regarding math and reading than older elementary school children. Children acuity of their ability and worthiness of mathematics becomes more negative across the ages 5^{th} to 12^{th} grade (Eccles, Adler et al., 1983; Wigfield, 1984).

2.9 Choice to study further Mathematics

Students' disposition toward mathematics influences their decisions to choose advanced mathematics and pursue their careers in mathematics courses in higher education. Students' choice for choosing careers in engineering and science are influenced deeply by their parents and teachers (Dick & Rallis, 1991). Students' attitude towards mathematics influences their academic success and mathematics achievement (Mubeen et al., 2013). Students' perception

of their mathematics ability influences their choice to pursue science, technology, engineering and mathematics degree (Nix et al., 2015). According to Belbase (2015), "Images of mathematics as perceived by a person, develop his or her *positive* or *negative* attitude towards mathematics. These images have a significant impact on one's choice of mathematics as a major in higher education". Watt et al., (2006) reported that interest, liking for math, ability related beliefs, and different kind of values are the potent variables influencing adolescents' choice for senior high math participation. Halpern et al., (2007) reported that several factors like early experience, biological factors, and cultural context influences the decision of women and men to pursue their career in science and math.

There are several personal and environmental factors that significantly contribute to children math achievement. There is an extensive body of literature that supports the fact that children math anxiety contributes negatively to their mathematics achievement. In addition to this, attitude towards mathematics shapes the children math performance. Even, the tremendous role played by parents in shaping their academic carrier can't be ignored. Previous researchers have highlighted the fact that parental involvement, parenting style and home environment influences their children math performance.

The detrimental effect of math anxiety is hampering the math achievement of children has not been much emphasized in Indian context. Though there are studies related to math anxiety and parental involvement, no comprehensive attempts have been made to understand the effect of various factors that contributes to math anxiety in children. This study has significant implication for parents, teachers and educators. Many children quit math courses or don't venture to take math courses for their higher study due to math anxiety. The significance of math as a tool in understanding any subject is not percolated among parents and children.

2.10 The Present Study

The literature clearly indicates that math anxiety affects the mathematics performance of children. Children's attitude toward mathematics also has a profound influence on their math performance. Although attempts have been made to delineate individual factors (such as personal and environmental factors) affecting children's math performance, the underlying mechanism through which these factors operate in influencing math performance is not clear. The present study highlights that, in addition to determining measures to reduce children's math anxiety, there is a need to focus on parental math anxiety and attitudes as these act as precursors to children's math anxiety and math attitude. Therefore, it is important to identify

the linkages between parental math anxiety and attitude and their children's math anxiety, math attitude, and math achievement.

The present study aimed at investigating the following causal connections: (a) Parental math anxiety and the subsequent math anxiety and math achievement of their children; and, (b) parental math attitude and the corresponding math attitude and math achievement of their children. Although some studies in the literature do relate to parental math attitude and the subsequent math achievement of their children, the present study is unique in two aspects: (i) Parental math attitude and math anxiety were objectively measured using standardized tests unlike, the studies by Alkan, (2013), He, (2007) and Rockliffe (2001), where parental and children's math anxiety/ math attitude were assessed by conducting interviews with parents and the responses reported by their children. In addition to this, choice to study further mathematics

The conceptual framework for the present study was based on studies that demonstrated the individual relationships between parental math anxiety and attitudes, and children's math anxiety and attitudes, and children's math achievement. Betz (1978) and Ma (1999), found a negative relationship between math anxiety and math achievement across all grade levels. In addition, Mohd and Mahmood (2011), found that a positive attitude toward problem solving plays an important role in mathematics achievement. Parental involvement is accepted to have a significant impact on a student's mathematics achievement and attitude toward mathematics (Aunolo, Nurmi, Lerkkanen & Puttonen, 2003). Based on the above findings, the research framework was formulated for the present study to explain the connection between parental math anxiety and math attitude, and their children's math anxiety, math attitude, and math achievement.

2.11 Summary of the Chapter

Chapter Two provided an overview of the literature on personal and environmental factors influencing children's math achievement. Literature on math anxiety mainly provides evidence on the negative effects of math anxiety (poor math performance, math avoidance behaviour, physical reactions, and cognitive consequences). Research on math attitudes emphasizes the importance of developing positive dispositions toward math and relates positive attitudes toward math with higher math achievement. In addition to this, various theories pertaining math anxiety and math attitude had been discussed thoroughly. Also, large-scale assessment results on trends in gender differences in mathematics achievement, math attitudes, and math anxiety were discussed. At the last, some studies are discussed related to children's math attitude influencing choice to study further mathematics.

CHAPTER 3
METHODOLOGY

The present investigation aim was to study the impact of parental math anxiety and parental math attitude on their children's math achievement and to develop the conceptual framework to understand the linkage between parental math anxiety and parental math attitude with children's math anxiety and children's math attitude in different grade group and gender. It also aims to study the impact of teacher's math anxiety and math attitude on math achievement of children. It also compares the gender differences in math achievement. In addition to this, to study the effect of children's math attitude on their choice to study further mathematics of 11^{th} to 12^{th} grade students.

The structure of the chapter is as follows. Section 3.1 is the description of the sampling method. This is followed in Section 3.2 with an explanation of the structure and content of the tools used. The survey method used in this study is explained in Section 3.3. explains the development of a conceptual structural model formulated from the studies that demonstrated the individual relationships between parental math anxiety and attitudes, and children's math anxiety and attitudes, and children's math achievement. Section 3.4 is the analytical strategy used in this research, which includes descriptive analysis and statistical analysis. Structural equation modeling (SEM) and Logistic Regression are presented in the statistical analysis section.

3.1 Research Design

In the present study, quasi-experimental design was used and quantitative research was conducted to assess the outcomes of the Mathematics Anxiety Rating Scale for Elementary School Students (MARS-E), Math anxiety Rating Scale for Adolescents (MARS-A), Mathematics Anxiety Scale Short Version (MARS-SV), Attitudes Toward Mathematics Inventory (ATMI), Math Achievement Test and Choice to study further Mathematics. The main reason for opting a quasi-experimental design was based on several constraints (i.e., time, and accessibility of site and participants). The data was collected using cross- sectional study and was analyzed using following tools:

3.2 Sampling

The sample comprised 875 students in grades 5 through 12 at various schools in the Patiala Sahodhya School Complex, and included one parent (father/mother) of each student. The Patiala Sahodhya School Complex is a cluster of Central Board of Secondary Education (CBSE) affiliated schools in and around Patiala district (Punjab). It primarily covers the

Patiala, Rajpura, Nabha, Samana, and Gobindgarh districts of South-West Punjab. The Patiala Sahodhya School Complex consists of forty- five schools.

Participants were selected through a two-stage selection process. Initially, 38 Sahodhya schools out of 45 were randomly selected based on the consent from trustees, managerial board as well as principal of the respective schools. Then, from each district, 10% of the schools were selected through random sampling. Permission was sought from the principal of each school to conduct the study. School authorities were asked to provide the enrolment lists for students in grades 5 to 12, from which 100 students from each school were selected by means of stratified sampling.

A written informed consent was obtained from parents. The children whose parents gave consent were permitted to participate in the study. Of the selected students, 96% completed the questionnaire.

3.3 Instruments used for data collection

The following section describes the instruments used in this research. Within this study, the subsequent instruments were used to collect data on math anxiety, attitudes toward math, math achievement and choice to study further mathematics.

3.3.1 Mathematics Anxiety Rating Scale for Elementary School Students (MARS-E)

This scale was constructed by (Suinn, Taylor & Edward, 1988) to measure the degree to which fifth and sixth grade students experienced math anxiety in specific life situations. MARS-E is a 26 item 5-point Likert type scale ranging from 1 to 5 i.e. (strongly disagree to strongly agree). The scale had a Cronbach's alpha of 0.80.

For each statement, students marked how bothered, nervous, anxious, or tense they felt. The total score was calculated by taking the sum of the ratings for all 26 items, giving a lowest possible total score of 26 (signifying low anxiety), and a highest score of 130 (extreme anxiety) (Suinn, Taylor & Edward, 1988).

3.3.2 Mathematics Anxiety Rating Scale for Adolescents (MARS-A) (Suinn & Edward, 1982). The scale was developed 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 Cronbach's alpha of this measure was 0.82. This instrument consists of 98 items related to school and everyday life situations that involve math or dealing with numbers, and is administered to students from grades 7 through 12.

For each situation, students indicated how anxious or tense they felt by selecting from a 5-point Likert scale ranging from 1 to 5 i.e. (not at all to very much). The level of math anxiety was calculated by taking the sum of the scores for each item. A MARS-A score of 98

indicates low math anxiety, while a score of 490 signifies extreme math anxiety (Suinn and Edwards, 1982).

3.3.3 Mathematics Anxiety Scale Short Version (MARS-SV) (Suinn & Wiston, 2003). The MARS-SV comprises 30 items that were taken directly from the original 98-item MARS. The MARS-SV was administered to parents to assess their mathematics anxiety. Each item on the scale represented a situation that aroused anxiety within a subject. The reliability coefficient of this measure was 0.76.

The total scores were calculated by taking the sum of the ratings for the 30 inventory items. The level of parental math anxiety was calculated by using a 5-point Likert scale ranging from 1 to 5 i.e. (strongly disagree to strongly agree). A score of 30 was the lowest possible score (low parental math anxiety) and the highest possible score was 150 (high parental math anxiety) (Suinn & Wiston, 2003).

3.3.4 Attitude Toward Mathematics Inventory (ATMI) (Tapia, 1996). The fourth data collection instrument administered in the present study was the ATMI, administered to both children and their parents. The inventory consists of 40 statements regarding individuals' perceptions about their own math ability, value, enjoyment, and the relevance of math in their everyday lives. The Cronbach's alpha of this measure was 0.81.

The responses were measured using a 5-point Likert scale i.e (strongly disagree to strongly agree). The ATMI has a lowest possible total score of 40 (negative attitude toward mathematics) and a highest possible score of 200 (positive attitude toward mathematics).

3.3.5 Math Achievement Test. The level of attainment of any or all mathematics skills, that is estimated by performance on a test. The math achievement test comprised two parts: children's math score in a school final examination (part 1), and a math achievement test constructed for each grade (part 2). A composite score of math achievement was obtained by adding the two math scores (marks obtained in the final examination and marks obtained in the math achievement test). Strong positive relationship existed between the math score in the final examination and the math achievement test ($r = 0.87$, $p < 0.001$).

Children's math score in a school final examination (Part 1)

According to CBSE norms, for each subject there is a Continuous Comprehensive Evaluation (CCE) on the basis of which students' marks are awarded. The CCE involves (i) a formative assessment (FA) and (ii) a summative assessment (SA). Formative assessment is a tool for teachers to constantly monitor the students progress. It may include quizzes, projects, assignments, and class tests. There are four formative assessments conducted in an academic year. The summative assessment is the assessment of performance at the end of each term.

Summative assessments are in the form of a pen-paper test, conducted in September and March at the end of each term. For the present study, 80% of 100 marks were taken. The assessment criterion is described in the Table 1 below.

Table 1: The Assessment Criteria of Mathematics Achievement

Term	Type of assessment	% of weight	Term-wise weight		Total
First term – (April to September)	Formative Assessment – 1	10%	Formative assessment(1+2)	20%	Formative Assessment = 40%
	Formative Assessment – 2	10%			
	Summative Assessment – 1	30%	Summative assessment – 1	30%	
Second term – (October to March)	Formative Assessment – 3	10%	Formative assessment(3+4)	20%	Summative Assessment = 60%
	Formative Assessment – 4	10%			
	Summative Assessment – 2	30%	Summative assessment – 2	30%	Total = 100 marks

Note: CBSE guidelines for the scheme of Continuous and Comprehensive Evaluation CCE. The above mentioned criterion is applicable to all CBSE affiliated schools throughout India (www.cbse.nic.in).

The components for math achievement of students in grades 5 to 7 are: algebraic expression, data handling, geometry, and bar graphs. These involve basic mathematical skills that deal with the fundamentals of mathematics. For students in grades 8 to 10, basic components are statistics and probability, comparing quantities, mensuration, number system (real numbers), exponents, and powers. This includes some components that are involved in higher mathematics.

Math achievement test constructed for each grade (Part 2)

A math achievement test was constructed for each grade level to evaluate children's math achievement. It comprised 20 questions based on the current math curriculum. All questions were approved by mathematics experts (mathematics teachers from different schools approached to construct the math achievement test for each grade). Items that showed high inter-rater reliability were selected. The inter-rater reliability of the math achievement test was 0.80.

3.3.6 Choice to study further Mathematics

The researcher developed the questionnaire related to Choice to Study Further Mathematics for 11^{th} and 12^{th} grade level. The questionnaire contained two items. The dependent variable selected for modeling is choice to study further mathematics. It is a discrete variable with 1 =

yes to study further mathematics and 0 = no to study further mathematics. Although many factors are involved in this outcome, we have selected three main factors: Children Mathematics Achievement (C M Ach), Children Math anxiety (C M Anx) and Children Math Attitude (C M Att). All these are continuous variable.

3.4 Procedure

The researcher approached schools in the Patiala Sahodhya School Complex and explained the purpose of the study to the authorities, who then assisted in data collection. A letter was sent to parents seeking permission for their children to be part of the study. After parents gave consent, their children were provided with the tests and were tested for math anxiety, math attitude, and math achievement. Information was gathered from parents by sending them the math anxiety and math attitude inventory through their wards. Participants were administered the measures discussed above. The scoring was carried out according to the standardized manuals of the respective tests. Data were analyzed using SPSS Version 20.0 and the AMOS Version 20.0. The results were interpreted in light of the conceptual model developed in Chapter 1.

3.5 Statistical Analyses

3.5.1 Descriptive statistics:

Descriptive statistics as shown in Table 1 indicates the mean and standard deviation of children's and parental math anxiety, math attitude.

3.5.2 Correlation:

Correlation analysis was used to test how or to what extent variables such as parents' math anxiety, children's math anxiety, parents' math attitude, children's math attitude, and children's Math achievement are associated with each other.

3.5.3 Regression:

The major reason used to study the effect of teachers math anxiety and math attitude on children's math anxiety and math attitude.

3.5.4 t- test:

The main purpose for using the analysis was to test whether a significant gender difference in math achievement scores existed in lower middle grade, middle grade and secondary grade students.

3.5.5 Structural equation modeling (SEM)

Indices	Model Fit Criteria	Researcher
1. Root Mean Square Error of Approximation (RMSEA)	• RMSEA < 0.05 indicating good fit, • RMSEA < 0.08 indicating a moderate fit, • RMSEA > 0.10 showing poor fit.	• Browne and Cudeck, 1993.
2. Normed Chi-square (CMIN= χ^2 /df)	• Ranging from less than 2 to less than 5	• Ullman, 2001, • Schumacker and Lomax, 2004.
3. Tucker-Lewis index (TLI), also known as Non-Normed Fit Index (NNFI)	• NNFI ≥ 0.95 as the cut off for good model fit, • NNFI ≥ 0.9 indicates acceptable fit.	• Hu and Bentler, 1999.
4. Goodness-of-fit Statistic (GFI)	• A value of GFI = 1.00 indicates perfect fit, • 0.95 good fit, • 0.90 acceptable fit.	• Jöreskog and Sorbom 1993.
5. Comparative Fit Index (CFI)	• CFI ranges from 0 to 1, • CFI ≥.9 indicating good fit.	• Bentler, 1990, • Byrne, 1998, • Tabachnick and Fidell, 2007.

There are different indices for assessing fitness of a model using AMOS.20

Note: The acceptable indices of Structural Equation Modeling were studied thoroughly using AMOS manual of Structural Equation Modeling Using AMOS An Introduction (2012).

The major reason for using the analysis was to test a conceptual model that depicts the connectivity of Independent variables (parents' math anxiety, children's math anxiety, parents' math attitude and children's math attitude) with dependent variable (Children's Math achievement). The conceptual model provides quantification of the relationships between each of the exogenous as well as the endogenous variables. Parental math anxiety and math attitude were exogenous variables in this model. Children's math anxiety, math attitude and their math achievement were the endogenous variables here. In Amos, researchers can present their model in a path diagram to show hypothesized relationships among different variables.

3.5.6. Logistic Regression

The dependent variable selected for modeling was choice to study further mathematics. The three independent variables were Children Mathematics Achievement (C M Ach), Children Math anxiety (CM Anx), and Children Math Attitude (CM Att). All these variables were continuous variable.

Binary logistic regression was used to study the dependent variable as binary (dichotomous) and independent variables are continuous. The statistical significant of the independent predictor was tested using Wald- Chi Square statistics. If the predictor p-value is smaller than 0.05 then it is significant. The appropriateness of model was estimated using Hoesmer- Lemeshow test. If the χ^2value is insignificant, then it indicates goodness of fit.

CHAPTER 4

RESULTS

The present chapter highlights the results of the data analysis. The standardized tests used for measuring variables were unidimensional. Statistical analyses included correlation statistics to study the relationships between the research variables. T- test was computed to determine any grade/gender difference in mathematics achievement. Path analyses was conducted to understand the linkage between parental math anxiety and math attitude with their children's math anxiety and attitude that further influence children's math achievement and logistic regression was investigated to study the effect of independent variables on choice to study further mathematics. The following section provides detailed information regarding the findings from each of these tests.

4.1 Descriptive Statistics

Descriptive statistics setting out the means and standard deviations (SD) of children's and parents' math anxiety and math attitude are shown in Table 2. For parents' math anxiety, the mean was 52.60 and the SD was 23.85. For children's math anxiety, the mean was 45.77 and SD was 25.47. The mean score for parents' math attitude was 151.08 and the SD was 23.67, while the mean and SD for children's math attitude were 152.13 and 23.47, respectively. The mean score for children's math achievement was 71.35 and the SD was 14.30.

Table 2 Means (M) and standard deviations (SD) of independent and dependent variables (N = 875)

Variables	M	SD
Independent Variable PM Anx	52.60	23.85
CM Anx	45.77	25.71
PM Att	151.08	23.67
CM Att	152.13	23.47
Dependent Variable CM Ach	71.35	14.30

*Note: PM Anx: parental math anxiety; CM Anx: children math anxiety; PM Att: parental math attitude; CM Att: children math attitude; CM Ach: children math achievement.

4.2 Correlation

The product–moment correlation was computed to get an idea of the strength of relationships among the variables. Table 3 shows that all the relationships were strong ($r > 0.50$) and statistically significant ($p < .01$).

Table 3 Correlation between Children Math Achievement, Children Math anxiety, Children Math Attitude, Parental Math anxiety and Parental Math Attitude (N = 875)

Variables	CM Ach	CM Anx	CM Att	PM Anx	PM Att
CM Ach	1	-.71**	.79**	-.69**	.73**
CM Anx	-	1	-.72**	.83**	-.72**
CM Att	-	-	1	-.73**	.89**
PM Anx	-	-	-	1	-.74**
PM Att	-	-	-	-	1

p<0.01**

*Note: CM Ach: children math achievement; CM Anx: children math anxiety; CM Att: children math attitude; PM Anx: parental math anxiety; PM Att = parental math attitude

4. 3 Conceptual Model for Parental Math anxiety and Math Attitude

The results of path analysis are depicted related to the influence parental math anxiety and math attitude on their children's math achievement. The results confirmed our expectation that parental math anxiety and math attitude act as precursors to children's math anxiety and attitude that further influence children's math achievement. The significance of the relationships is apparent from Fig. 6. The data confirms all hypotheses in the model presented in Table 4.

Table 4 Regression weights for the Path of Parental Math anxiety and Parental Math Attitude

	Estimate	S.E	C. R.	P
Children Math anxiety <--- Parental Math anxiety	.70	.03	23.90	.000
Children Math Attitude <--- Parental Math Attitude	.77	.02	34.89	.000
Children Math Attitude <--- Parental Math anxiety	-.15	.02	-6.94	.000
Children Math anxiety <--- Parental Math Attitude	-.26	.03	-8.86	.000
Children Math Achievement<--- Children Math anxiety	-.16	.01	-10.54	.000
Children Math Achievement <--- Children Math Attitude	.36	.01	21.77	.000

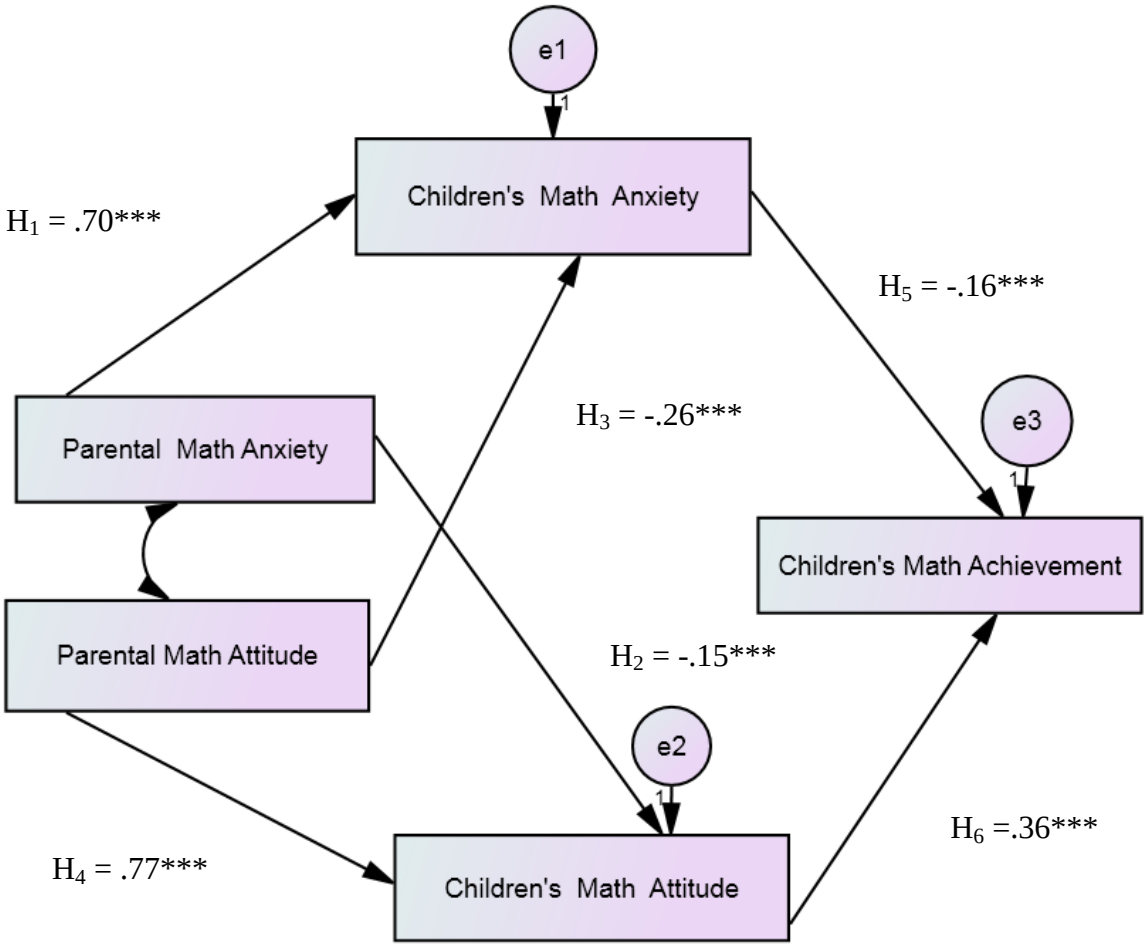

Figure 6: Path Values for Parental Math anxiety and Parental Math Attitude of Children

Figure 6 shows that parental math anxiety and math attitude act as precursor to children's math anxiety and attitude that further influence children's math achievement. The results confirm all hypotheses in the model. The default model 1 fits the data (χ^2/df= 17.18/3 = 5.72, GFI=0.99, CFI= 0.99, RFI=0. 99, TLI= 0.99, RMSEA=0.07). The RMSEA value came out to be 0.07 indicating a moderate model fit. The Chi square value came out to be significant. In view of this, we considered the Absolute Fit Index, (RMSEA) and Incremental Fit Index (CFI, GFI, TLI, RFI) to gauge the goodness of fit. In the present analysis, the RMSEA was found to be 0.07 which indicates a moderate fit. The CFI, GFI, TLI, and RFI were found to be greater than 0.90 which further signify the goodness of fit model.

Parental math anxiety was a significant predictor of children's math anxiety (H_1: $\beta = 0.70$, $p < 0.001$) and children's math attitude (H_2: $\beta = -0.15$, $p < 0.001$) in the expected direction. Similarly, parental math attitude significantly predicted their children's math attitude (H_4: $\beta = 0.77$, $p < 0.001$) and children's math anxiety (H_3: $\beta = -0.26$, $p < 0.001$). In addition, children's math anxiety and math attitude significantly influenced their

math achievement (for children's math anxiety, H_5: $\beta = -0.16$, $p < 0.001$; for children's math attitude, H_6: $\beta = 0.36$, $p < 0.001$).

4.4 GRADE DIFFERENCES

4.4.1 Conceptual Model for Parental Math anxiety and Math Attitude (Lower Middle Students)

In this section, we analyze the path that connects independent variables parental math anxiety, parental math attitude, children's math anxiety, and children's math attitude to children's math achievement in different grade groups.

The results confirmed our expectation that parental math anxiety and math attitude act as precursors to younger children's math anxiety and attitude that further influence their math achievement. The significance of the relationships is given in Fig. 7. The results confirm all hypotheses in the model presented in Table 5.

Table 5 Regression weights for the Path of Parental Math anxiety and Parental Math Attitude of Lower Middle Grade Students

	Estimate	S.E	C. R.	P
Children Math anxiety <--- Parental Math anxiety	.87	.04	19.77	.000
Children Math Attitude <--- Parental Math Attitude	.78	.04	17.87	.000
Children Math Attitude <--- Parental Math anxiety	-.14	.04	-3.21	.000
Children Math anxiety <--- Parental Math Attitude	-.21	.04	-4.49	.000
Children Math Achievement<--- Children Math anxiety	-.09	.02	-3.86	.000
Children Math Achievement <--- Children Math Attitude	.35	.03	13.69	.000

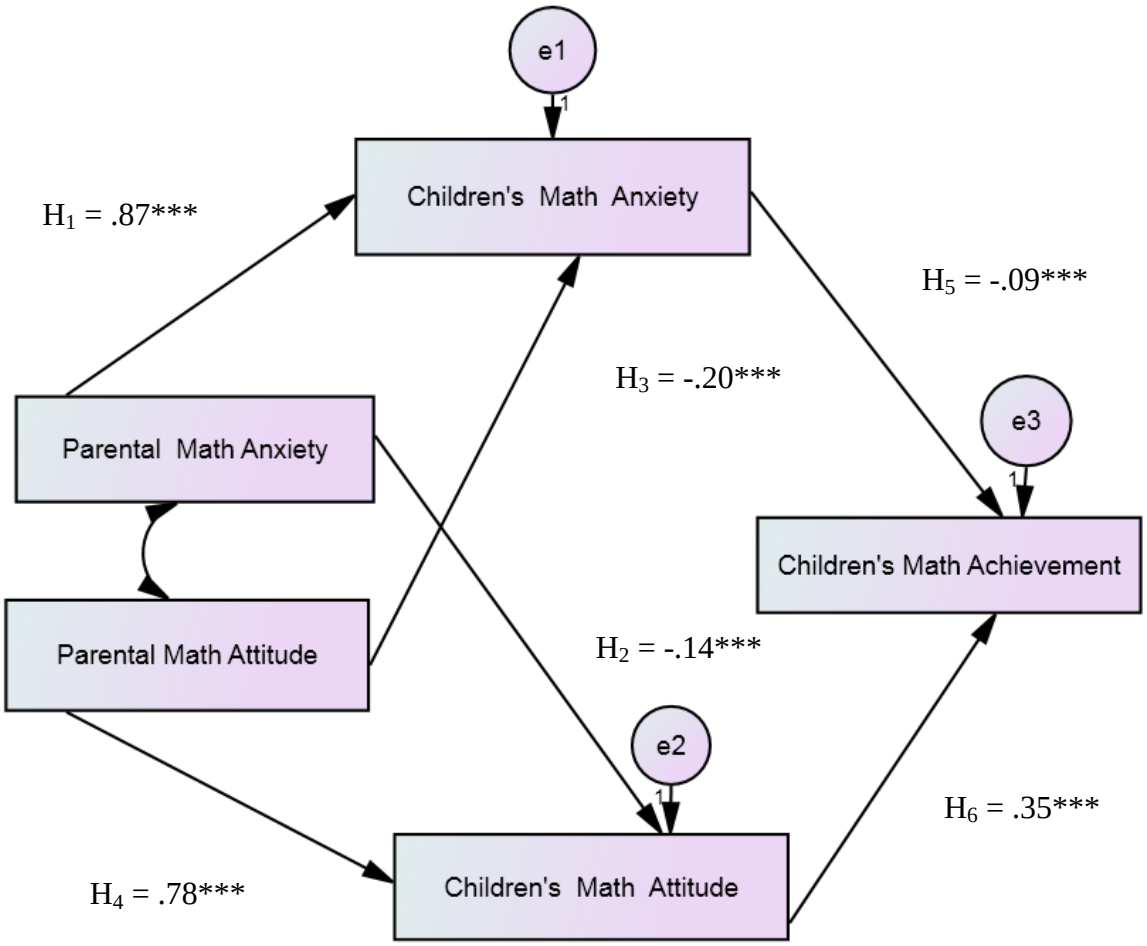

Figure 7: Path Values for Parental Math anxiety and Parental Math Attitude of Lower Middle Grade Students

Figure 7 shows that parental math anxiety and math attitude act as precursor to children's math anxiety and attitude that further influence children's math achievement. The results confirm all hypotheses in the model. The default model 1 fits the data (χ^2/df= .54/3 = .18, GFI= 1, CFI= 1, RFI= 1, TLI= 1, RMSEA=0.00). The RMSEA value came out to be 0.00 indicating a good model fit. The chi square value came out to be insignificant. The CFI, GFI, TLI, RFI were found to be greater than 0.90 which further signifies the goodness of fit model.

Parental math anxiety was found to be a significant predictor of children's math anxiety (H_1: $\beta = 0.87$, $p < 0.001$) and children's math attitude (H_2: $\beta = -0.14$, $p < 0.001$). Similarly, parental math attitude was a significant predictor of children's math attitude (H_4: $\beta = 0.78$, $p < 0.001$ and children's math anxiety (H_3: $\beta = -0.20$, $p < 0.001$). Finally, children's math anxiety and math attitude significantly influenced their math achievement (for children's math anxiety, H_5: $\beta = -0.09$, $p < 0.001$; for children's math attitude, H_6: $\beta = 0.35$, $p < 0.001$).

4.4.2 Conceptual Model for Parental Math anxiety and Math Attitude of Middle Grade Students

Table 6 Regression weights for the Path of Parental Math anxiety and Parental Math Attitude of Middle Grade Students

	Estimate	S.E	C. R.	P
Children Math anxiety <--- Parental Math anxiety	.73	.04	16.41	.000
Children Math Attitude <--- Parental Math Attitude	.84	.03	28.94	.000
Children Math Attitude <--- Parental Math anxiety	-.16	.03	-4.93	.000
Children Math anxiety <--- Parental Math Attitude	-.24	.04	-5.95	.000
Children Math Achievement<--- Children Math anxiety	-.26	.02	-10.79	.000
Children Math Achievement <--- Children Math Attitude	.35	.02	15.09	.000

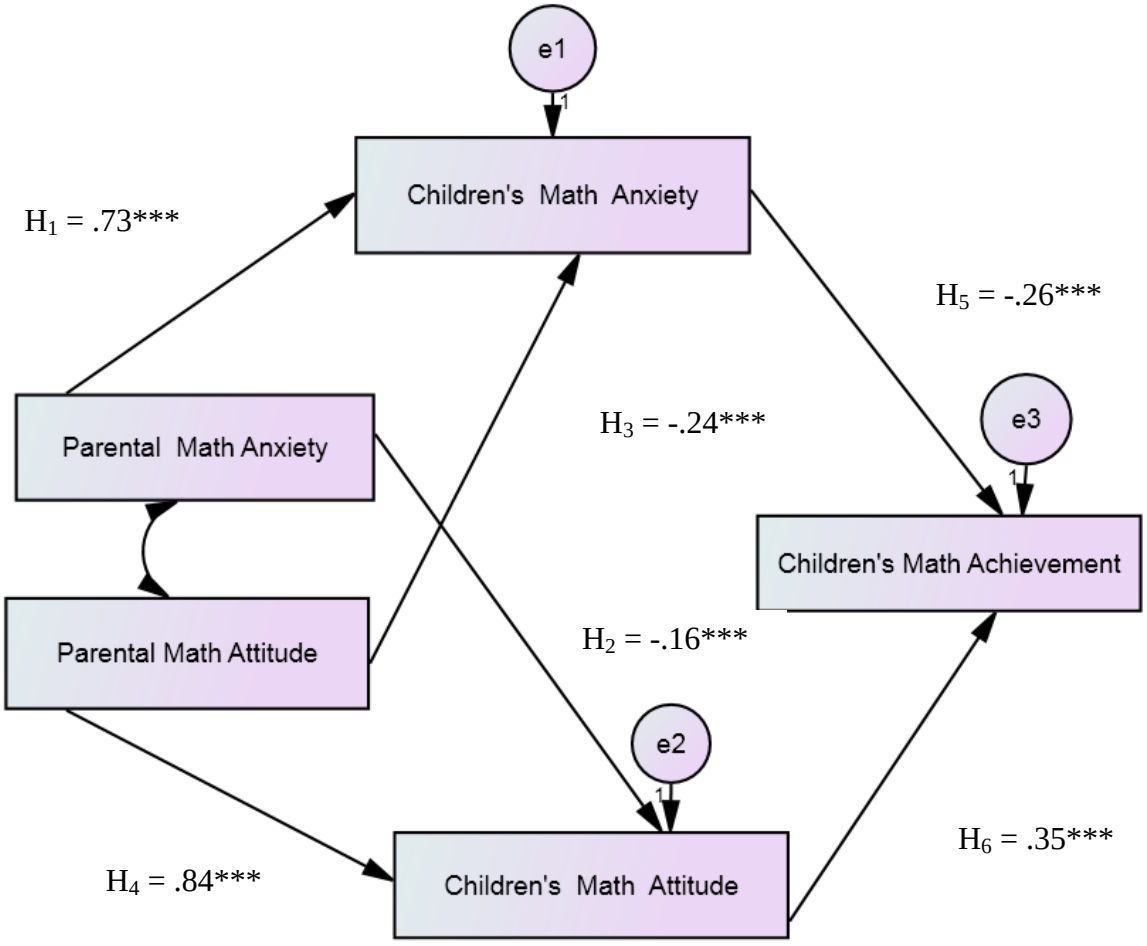

Figure 8: Path Values for Parental Math anxiety and Parental Math Attitude of Middle Grade Students

Figure 8 shows that parental math anxiety and math attitude acts as precursor to children's math anxiety and attitude that further influence their math achievement. The data confirm all hypotheses in the model. The default model 1 fits the data (χ^2/df= 8.97/3 = 2.99, GFI=0.99, CFI= .99, RFI=0. 98, TLI= 0.99, RMSEA=0.08). The RMSEA value came out to be 0.08

indicating a moderate model fit. The chi square value came out to be significant. Therefore, we have considered the Absolute Fit Index, (RMSEA) and Incremental Fit Index (CFI, GFI, TLI, RFI) to gauge the goodness of fit. In this case, the RMSEA was found to be 0.08 which indicates the moderate fit. The CFI, GFI, TLI, RFI were found to be greater than 0.90 which further signifies the goodness of fit model.

Parental math anxiety was found to be a significant predictor of children's math anxiety (H_1: $\beta = 0.73$, $p < 0.001$) and children's math attitude (H_2: $\beta = -0.16$, $p < 0.001$). Similarly, parental math attitude was a significant predictor of children's math attitude (H_4: $\beta = 0.84$, $p < 0.001$) and children's math anxiety (H_3: $\beta = -0.24$, $p < 0.001$). In addition, children's math anxiety and math attitude significantly influenced their math achievement (for children's math anxiety H_5: $\beta = -0.26$, $p < 0.001$; for children's math attitude H_6: $\beta = 0.35$, $p < 0.001$).

4.4.3 Conceptual Model for Parental Math anxiety and Math Attitude for Secondary Grade Students

Table 7 Regression weights for the Path of Parental Math anxiety and Parental Math Attitude for Secondary Grade Students

	Estimate	S.E	C. R.	P
Children Math anxiety <--- Parental Math anxiety	.68	.07	10.03	.000
Children Math Attitude <--- Parental Math Attitude	.51	.04	11.21	.000
Children Math Attitude <--- Parental Math anxiety	-.31	.04	-7.50	.000
Children Math anxiety <--- Parental Math Attitude	-.19	.08	-2.54	.000
Children Math Achievement<--- Children Math anxiety	-.20	.02	-8.62	.000
Children Math Achievement <--- Children Math Attitude	.30	.03	9.90	.000

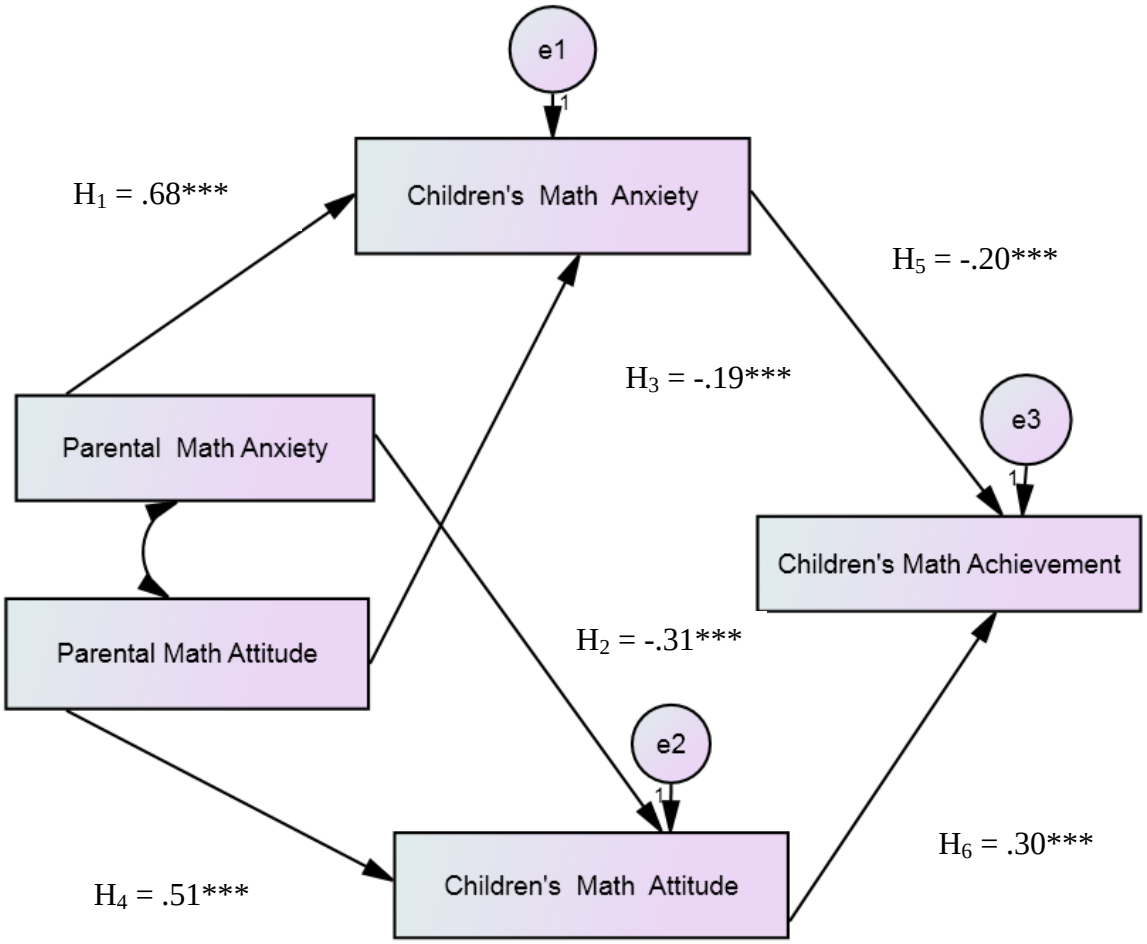

Figure 9: Path Values for Parental Math anxiety and Parental Math Attitude of Secondary Grade Students

Figure 9 shows that parental math anxiety and math attitude act as precursor to children's math anxiety and attitude that further influence children's math achievement. The default model 1 fits the data (χ^2/df= 5.97/3 = 1.99, GFI=0.99, CFI= .99, RFI=0. 98, TLI= 0.99, RMSEA=0.06). The RMSEA value came out to be 0.06 indicating a moderate model fit. The chi square value came out to be significant. Thus, we have considered the Absolute Fit Index, (RMSEA) and Incremental Fit Index (CFI, GFI, TLI, RFI) to gauge the goodness of fit. In this case, the RMSEA was found to be 0.06 which indicates the moderate fit. The CFI, GFI, TLI, RFI were found to be greater than 0.90 which further signifies the goodness of fit model. Parental math anxiety was found to be a significant predictor of children's math anxiety (H_1: $\beta = 0.68$, $p < 0.001$) and children's math attitude (H_2: $\beta = -0.31$, $p < 0.001$). Similarly, parental math attitude was a significant predictor of children's math attitude (H_4: $\beta = 0.51$, $p < 0.001$) and children's math anxiety (H_3: $\beta = -0.19$, $p < 0.001$). In addition, children's math anxiety and math attitude significantly influenced their math achievement (for children's math anxiety H_5: $\beta = -0.20$, $p < 0.001$; for children's math attitude H_6: $\beta = 0.30$, $p < 0.001$).

4.5 GENDER DIFFERENCES

4.5.1 Conceptual Model for Parental Math anxiety and Math Attitude of Boys

In this section, we present the results of path analysis. The major reason for using this analysis was to test the conceptual model that depicts the connectivity of independent variables (parents' math anxiety, Boys/ Girls math anxiety, parents' math attitude, and Boys/ Girls math attitude) with the dependent variable (Boys/ Girls math achievement). The conceptual model provides quantification of the relationship between each of the exogenous and the endogenous variables. Parental math anxiety and math attitude are exogenous variables in this model, while Boys/ Girls math anxiety, math attitude, and their math achievement are the endogenous variables. The significance of the relationships is given in Fig. 10. The data confirms all hypotheses in the model presented in Table 8.

Table 8 Regression weights for the Path of Parental Math anxiety and Parental Math Attitude of Boys

	Estimate	S.E	C. R.	P
Boys Math anxiety <--- Parental Math anxiety	.69	.04	17.30	.000
Boys Math Attitude <--- Parental Math Attitude	.76	.03	27.66	.000
Boys Math Attitude <--- Parental Math anxiety	-.14	.04	-4.93	.000
Boys Math anxiety <--- Parental Math Attitude	-.14	.04	-3.67	.000
Boys Math Achievement<--- Boys Math anxiety	-.18	.02	-8.50	.002
Boys Math Achievement <--- Boys Math Attitude	.33	.02	15.31	.000

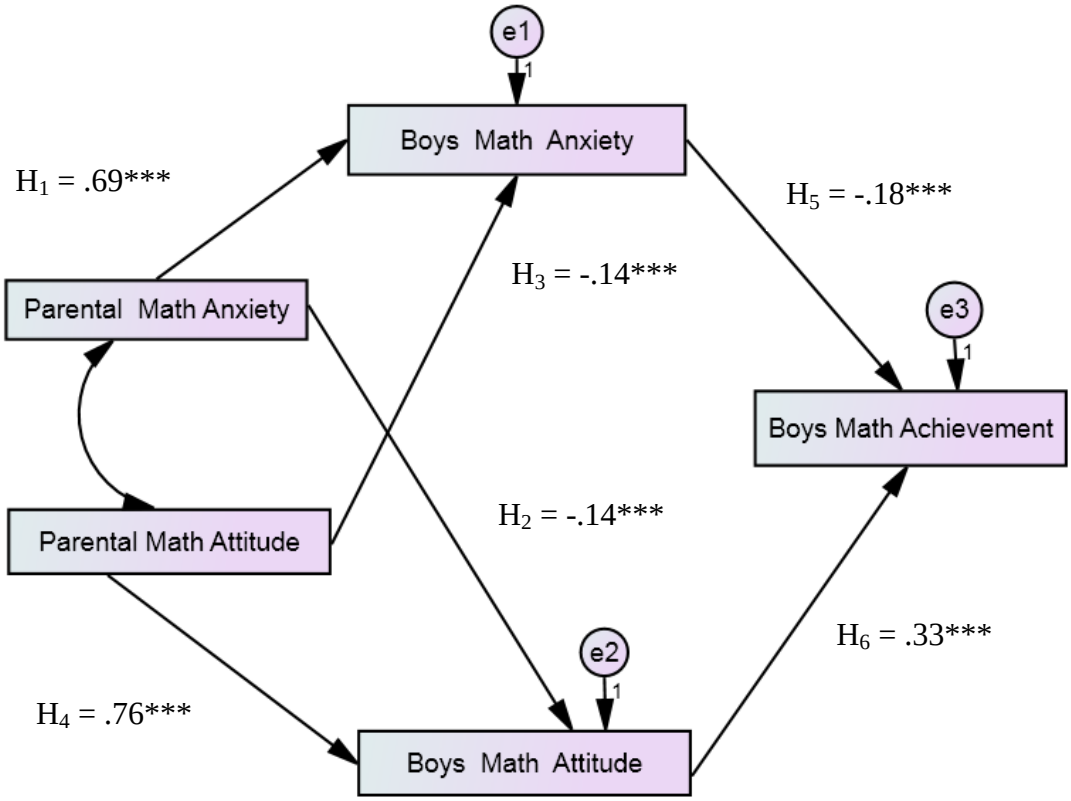

Figure 10: Path Values for Parental Math anxiety and Parental Math Attitude of Boys

Figure 10 shows that parental math anxiety and math attitude act as precursor to boys math anxiety and attitude that further influence boy's math achievement. The default model 1 fits the data (χ^2/df= 19.77/3 = 6.59, GFI=0.98, CFI= 0.99, RFI=0. 97, TLI= 0.97, RMSEA=0.10). The RMSEA value came out to be 0.10 indicating a poor model fit. However, Incremental Fit Index (CFI, GFI, TLI, and RFI) were found to be greater than 0.90.

Parental math anxiety was found to be a significant predictor of boys math anxiety (H_1: β = 0.69, $p < 0.001$) and boys math attitude (H_2: $\beta = -0.14$, $p < 0.001$). Similarly, parental math attitude was a significant predictor of boys math attitude (H_4: $\beta = 0.76$, $p < 0.001$) and boys math anxiety (H_3: $\beta = -0.13$, $p < 0.001$). In addition, boys math anxiety and math attitude significantly influenced their math achievement (for boys math anxiety, H_5: β = - 0.18, $p <$ 0.001; for boys math attitude H_6: $\beta = 0.33$, $p < 0.001$).

4.5.2 Conceptual Model for Parental Math anxiety and Math Attitude of Girls

Table 9 Regression weights for the Path of Parental Math anxiety and Parental Math Attitude of Girls

	Estimate	S.E	C. R.	P
Girls Math anxiety <--- Parental Math anxiety	.70	.04	16.38	.000
Girls Math Attitude <--- Parental Math Attitude	.74	.03	22.09	.000
Girls Math Attitude <--- Parental Math anxiety	-.11	.03	-3.18	.000
Girls Math anxiety <--- Parental Math Attitude	-.41	.04	-9.37	.000
Girls Math Achievement<--- Girls Math anxiety	-.14	.02	-6.16	.000
Girls Math Achievement <--- Girls Math Attitude	.39	.03	14.02	.000

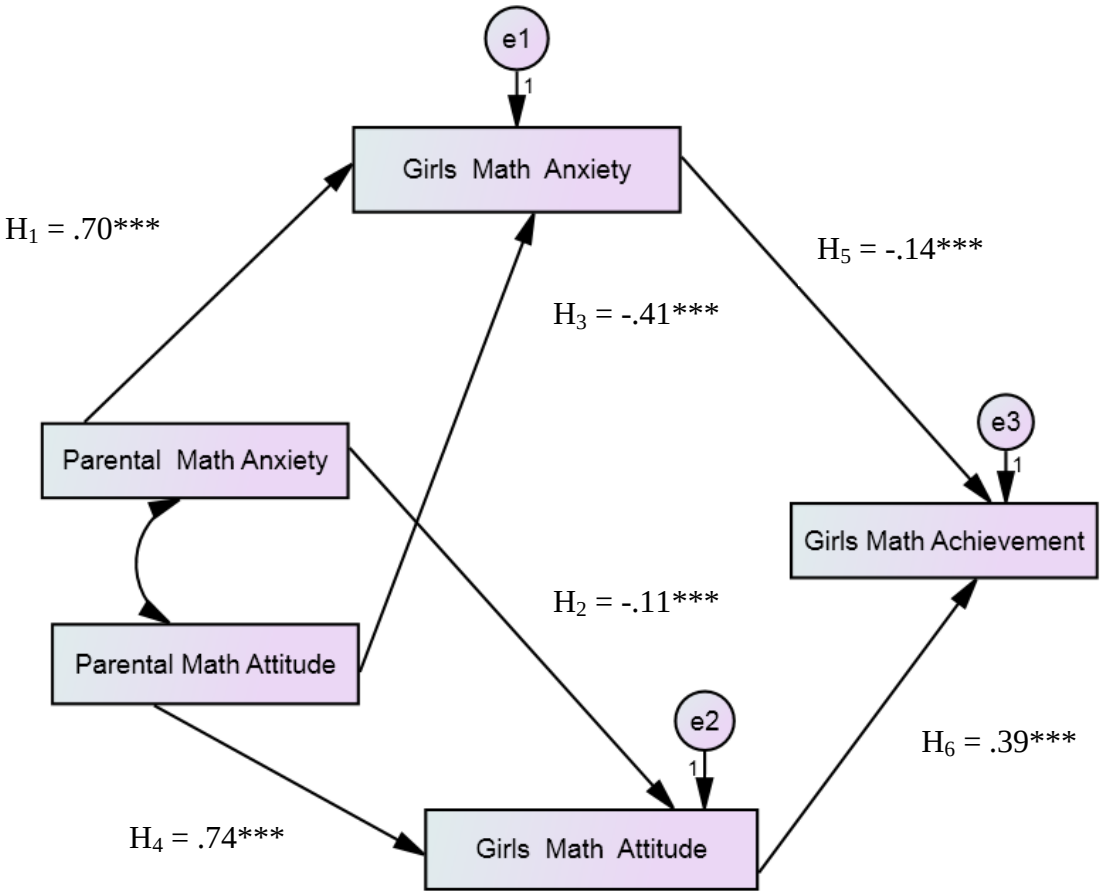

Figure 11: Path Values for Parental Math anxiety and Parental Math Attitude of Girls

Figure 11 shows that parental math anxiety and math attitude act as precursors to girls math anxiety and attitude that further influence girl's math achievement. The default model 1 fits the data (χ^2/df= 4.54/3 = 1.51, GFI=0.99, CFI= 0.99, RFI= 0.99, TLI= 0.99, RMSEA=0.04). The RMSEA value came out to be 0.04 indicating a good model fit. The Chi square value

came out to be insignificant. The CFI, GFI, TLI, RFI were found to be greater than 0.90 which further signifies the goodness of fit model.

Parental math anxiety was found to be a significant predictor of girls math anxiety (H_1: $\beta = 0.70$, $p < 0.001$) and girls math attitude (H_2: $\beta = -0.11$, $p < 0.001$). Similarly, parental math attitude was a significant predictor of girls math attitude (H_4: $\beta = 0.74$, $p < 0.001$) and girls math anxiety (H_3: $\beta = -0.41$, $p < 0.001$). In addition, girls math anxiety and math attitude significantly influenced their math achievement (for girls math anxiety, H_5: $\beta = -0.14$, $p < 0.001$; for girls math attitude, H_6: $\beta = 0.39$, $p < 0.001$).

4.5.3 Conceptual Model for Parental Math anxiety and Math Attitude of Lower Middle Grade Boys

Table 10 Regression weights for the Path of Parental Math anxiety and Parental Math Attitude of Lower Middle Grade Boys

	Estimate	S.E	C. R.	P
Boys Math anxiety <--- Parental Math anxiety	.79	.07	11.35	.000
Boys Math Attitude <--- Parental Math Attitude	.78	.05	15.37	.000
Boys Math Attitude <--- Parental Math anxiety	-.16	.05	-2.89	.004
Boys Math anxiety <--- Parental Math Attitude	-.16	.06	-2.46	.01
Boys Math Achievement<--- Boys Math anxiety	-.10	.03	-3.04	.002
Boys Math Achievement <--- Boys Math Attitude	.30	.03	9.14	.000

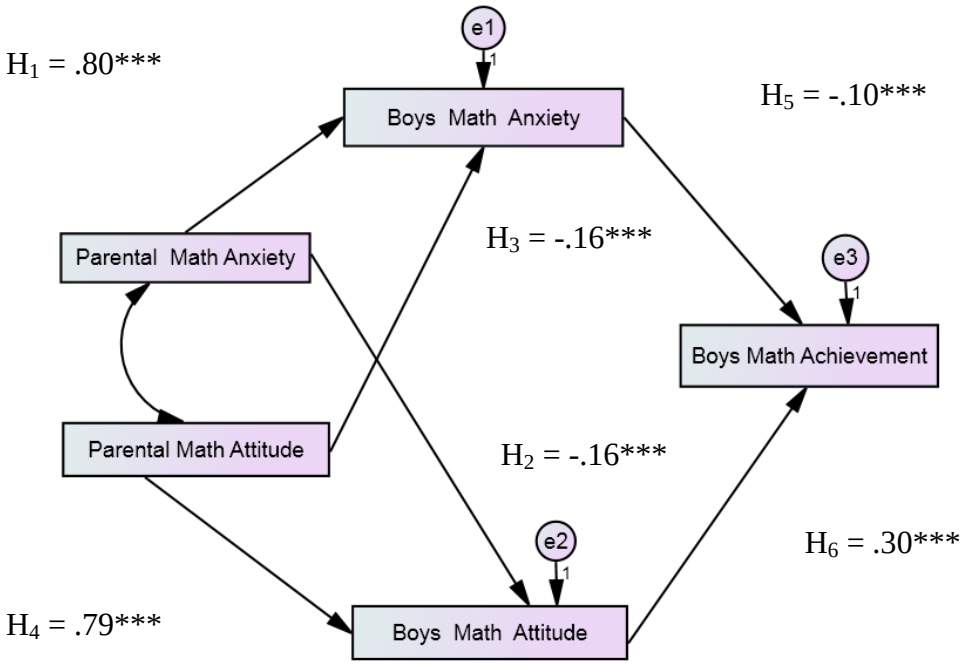

Figure 12: Path Values for Parental Math anxiety and Parental Math Attitude of Lower Middle Grade Boys

Figure 12 shows that parental math anxiety and math attitude act as precursor to boys math anxiety and attitude that further influence boy's math achievement. The data confirm all hypotheses in the model. The default model 1 fits the data (χ^2/df= 4.44/3 = 1.48, GFI=0.99, CFI= 0.99, RFI=0. 97, TLI= 0.99, RMSEA=0.05). The RMSEA value came out to be 0.05 indicating a good model fit. The Chi square value came out to be significant. Therefore, we have considered the Absolute Fit Index, (RMSEA) and Incremental Fit Index (CFI, GFI, TLI, RFI) to gauge the goodness of fit. In this case, the RMSEA was found to be 0.05 which indicates the good fit. The CFI, GFI, TLI, RFI were found to be greater than 0.90 which further signifies the goodness of fit model.

Parental math anxiety was found to be a significant predictor of boys math anxiety (H_1: $\beta = 0.80$, $p < 0.001$) and boys math attitude (H_2: $\beta = -0.16$, $p < 0.001$). Similarly, parental math attitude was a significant predictor of boys math attitude (H_4: $\beta = 0.79$, $p < 0.001$) and boys math anxiety (H_3: $\beta = -0.16$, $p < 0.001$). In addition, boys math anxiety and math attitude significantly influenced their math achievement (for boys math anxiety, H_5: $\beta = -0.10$, $p < 0.001$; for boys math attitude, H_6: $\beta = 0.30$, $p < 0.001$).

4.5.4 Conceptual Model for Parental Math anxiety and Math Attitude of Lower Middle Grade Girls

Table 11 Regression weights for the Path of Parental Math anxiety and Parental Math Attitude of Lower Middle Grade Girls

	Estimate	S.E	C. R.	P
Girls Math anxiety <--- Parental Math anxiety	.89	.05	16.36	.000
Girls Math Attitude <--- Parental Math Attitude	.78	.07	11.07	.000
Girls Math Attitude <--- Parental Math anxiety	-.02	.06	-0.36	.72
Girls Math anxiety <--- Parental Math Attitude	-.26	.05	-4.66	.000
Girls Math Achievement<--- Girls Math anxiety	-.07	.03	-2.05	.04
Girls Math Achievement <--- Girls Math Attitude	.42	.04	10.14	.000

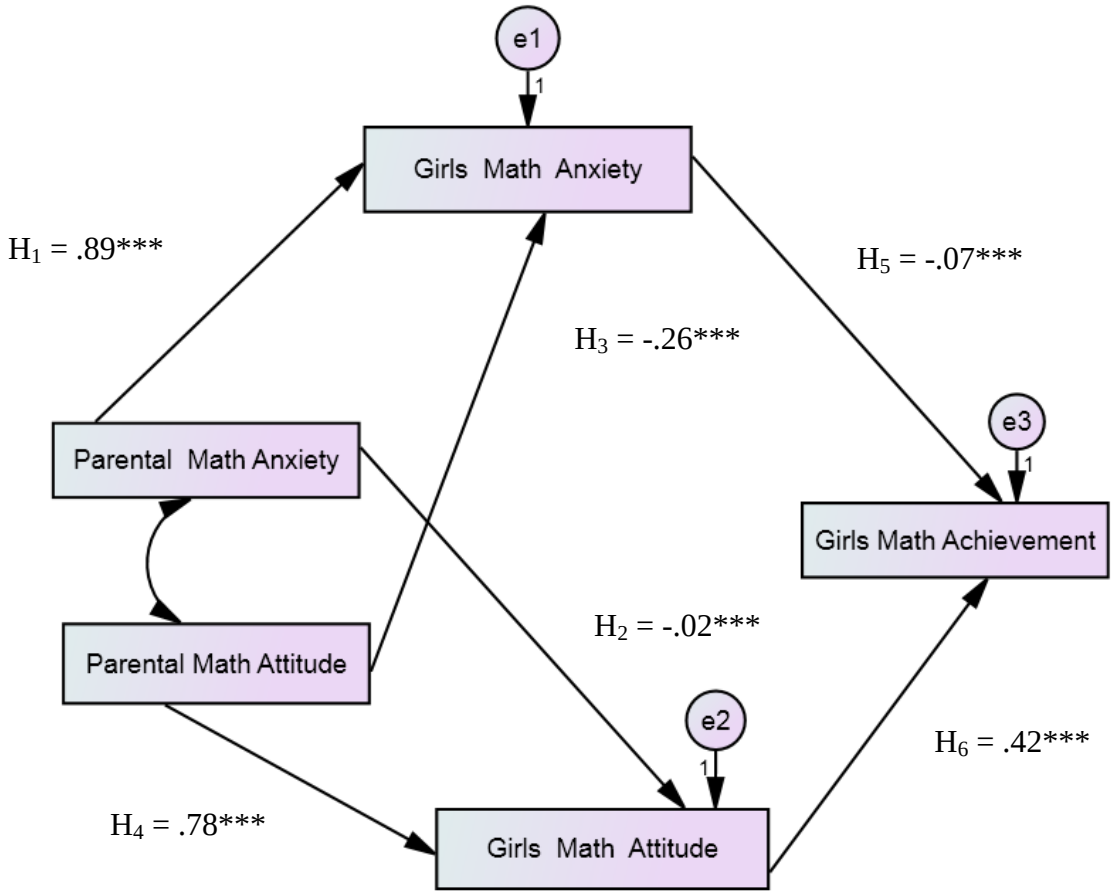

Figure 13: Path Values for Parental Math anxiety and Parental Math Attitude of Lower Middle Grade Girls

Figure 13 shows that parental math anxiety and math attitude act as precursor to girls math anxiety and attitude that further influence girls math achievement. The data confirm all hypotheses in the model. The default model 1 fits the data (χ^2/df= 1.01/3 = .34, GFI=0.99, CFI= 0.99, RFI=0. 97, TLI= 1.00, RMSEA=0.00). The RMSEA value came out to be 0.00 indicating a perfect model fit. The Chi square value came out to be insignificant. The CFI, GFI, TLI, RFI were found to be greater than 0.90 which further signifies the goodness of fit model.

Parental math anxiety was found to be a significant predictor of girls math anxiety (H_1: $\beta = 0.89$, $p < 0.001$) and girls math attitude (H_2: $\beta = -0.02$, $p < 0.001$). Similarly, parental math attitude was a significant predictor of girls math attitude (H_4: $\beta = 0.78$, $p < 0.001$) and girls math anxiety (H_3: $\beta = -0.26$, $p < 0.001$). In addition, girls math anxiety and math attitude significantly influenced their math achievement (for girls math anxiety, H_5: $\beta = -0.07$, $p < 0.001$; for girls math attitude, H_6: $\beta = 0.42$, $p < 0.001$).

4.5.5 Conceptual Model for Parental Math anxiety and Math Attitude of Middle Grade Boys

Table 12 Regression weights for the Path of Parental Math anxiety and Parental Math Attitude of Middle Grade Boys

	Estimate	S.E	C. R.	P
Boys Math anxiety <--- Parental Math anxiety	.75	.05	13.67	.000
Boys Math Attitude <--- Parental Math Attitude	.82	.04	22.37	.000
Boys Math Attitude <--- Parental Math anxiety	-.18	.04	-4.68	.000
Boys Math anxiety <--- Parental Math Attitude	-.06	.05	-1.22	.22
Boys Math Achievement<--- Boys Math anxiety	-.25	.03	-7.13	.000
Boys Math Achievement <--- Boys Math Attitude	.39	.03	12.18	.000

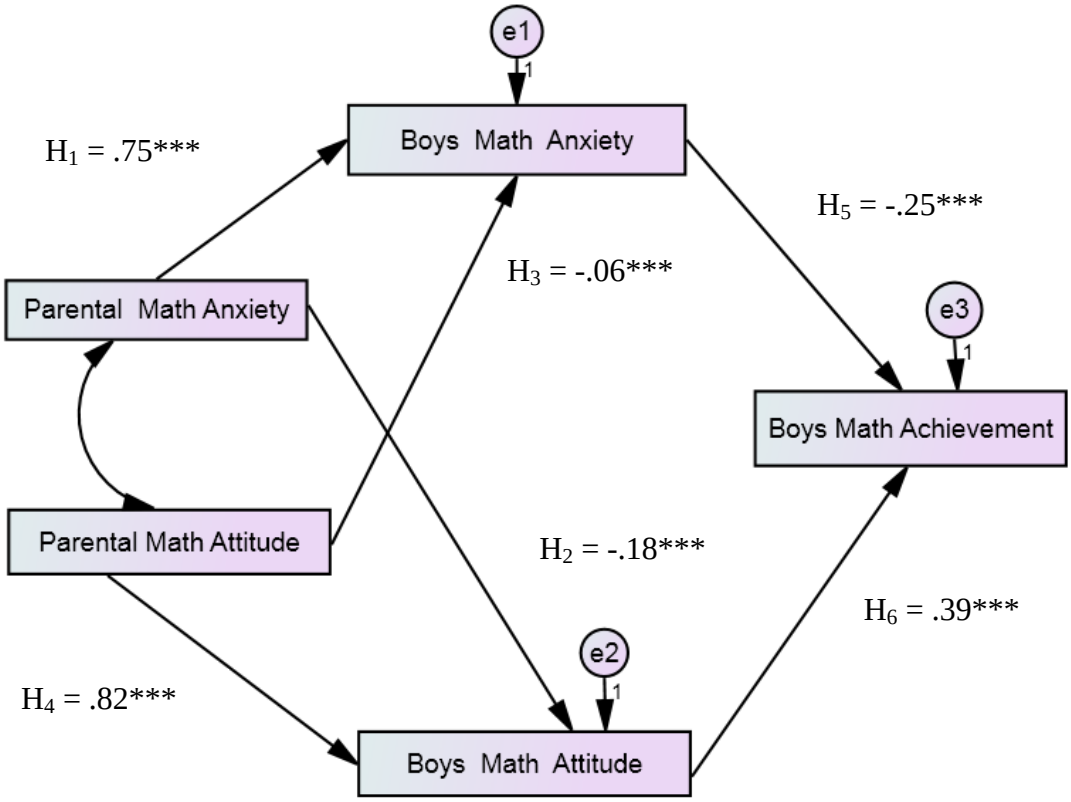

Figure 14: Path Values for Parental Math anxiety and Parental Math Attitude of Middle Grade Boys

Figure 14 shows that parental math anxiety and math attitude act as precursor to boys math anxiety and attitude that further influence boy's math achievement. The data confirm all hypotheses in the model. The default model 1 fits the data (χ^2/df= 20.98/3 = 6.99, GFI=0.99, CFI= 0.98, RFI=0. 93, TLI= 0.94, RMSEA=0.19). The RMSEA value came out to be 0.19 indicating a poor model fit.

Parental math anxiety was found to be a significant predictor of boys math anxiety (H_1: $\beta = 0.75$, $p < 0.001$) and boys math attitude (H_2: $\beta = -0.18$, $p < 0.001$). Similarly, parental math attitude was a significant predictor of boys math attitude (H_4: $\beta = 0.82$, $p < 0.001$) and boys math anxiety (H_3: $\beta = -0.06$, $p < 0.001$). In addition, boys math anxiety and math attitude significantly influenced their math achievement (for boys math anxiety, H_5: $\beta = -0.25$, $p < 0.001$; for boys math attitude, H_6: $\beta = 0.39$, $p < 0.001$).

4.5.6 Conceptual Model for Parental Math anxiety and Math Attitude of Middle Grade Girls

Table 13 Regression weights for the Path of Parental Math anxiety and Parental Math Attitude of Middle Grade Girls

	Estimate	S.E	C. R.	P
Girls Math anxiety <--- Parental Math anxiety	.70	.07	10.43	.000
Girls Math Attitude <--- Parental Math Attitude	.80	.05	16.91	.000
Girls Math Attitude <--- Parental Math anxiety	-.10	.05	-1.98	.05
Girls Math anxiety <--- Parental Math Attitude	-.42	.06	-6.96	.000
Girls Math Achievement<--- Girls Math anxiety	-.28	.03	-8.21	.000
Girls Math Achievement <--- Girls Math Attitude	.37	.04	9.42	.000

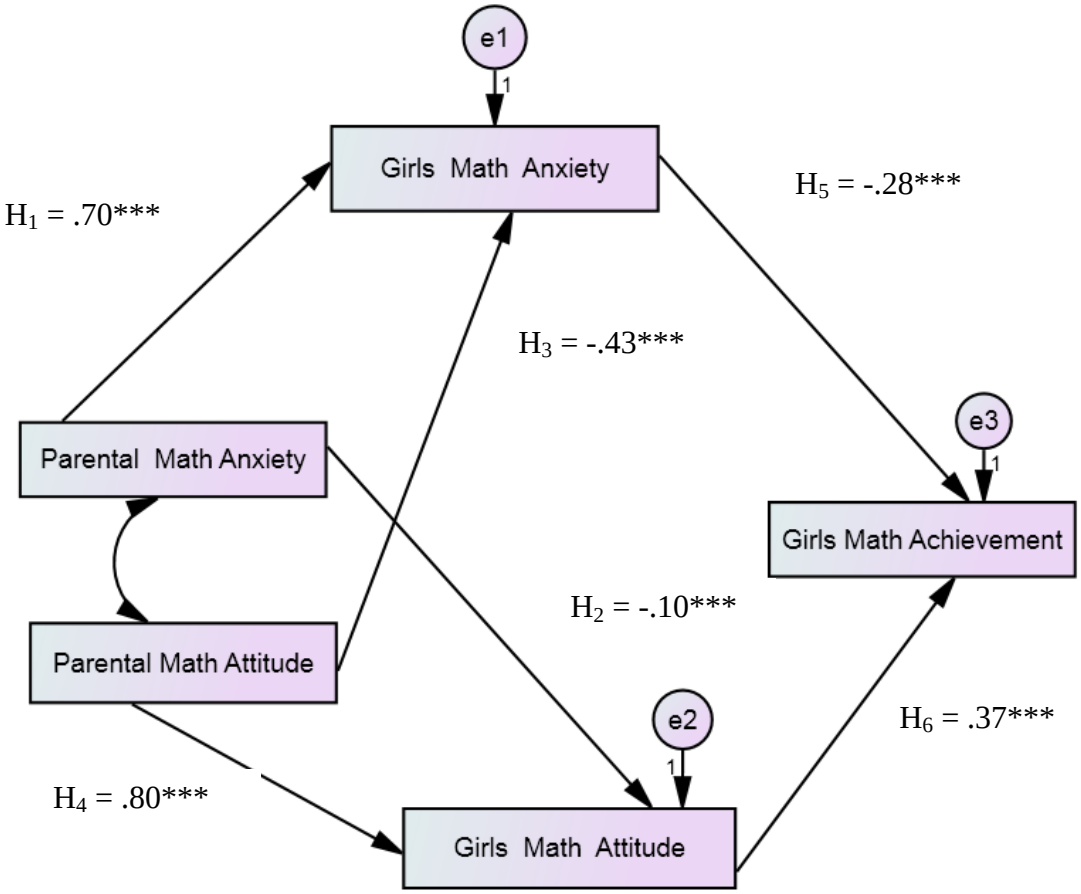

Figure 15: Path Values for Parental Math anxiety and Parental Math Attitude of Middle Grade Girls

Figure 15 shows that parental math anxiety and math attitude act as precursor to girls math anxiety and attitude that further influence girls math achievement. The default model 1 fits the data (χ^2/df= 1.01/3 = .34, GFI=0.99, CFI= 1.00, RFI=0. 99, TLI= 1.00, RMSEA=0.00). The RMSEA value came out to be 0.00 indicating a perfect model fit. The Chi square value came out to be insignificant. The CFI, GFI, TLI, RFI were found to be greater than 0.90 which further signifies the goodness of fit model.

Parental math anxiety was found to be a significant predictor of girls math anxiety (H_1: $\beta = 0.70$, $p < 0.001$) and girls math attitude (H_2: $\beta = -0.10$, $p < 0.001$). Similarly, parental math attitude was a significant predictor of girls math attitude (H_4: $\beta = 0.80$, $p < 0.001$) and girls math anxiety (H_3: $\beta = -0.43$, $p < 0.001$). In addition, girls math anxiety and math attitude significantly influenced their math achievement (for girls math anxiety, H_5: $\beta = -0.28$, $p < 0.001$; for girls math attitude, H_6: $\beta = 0.37$, $p < 0.001$).

4.5.7 Conceptual Model for Parental Math anxiety and Math Attitude of Secondary grade boys

Table 14 Regression weights for the Path of Parental Math anxiety and Parental Math Attitude of Secondary Grade Boys

	Estimate	S.E	C. R.	P
Boys Math anxiety <--- Parental Math anxiety	.67	.09	6.85	.000
Boys Math Attitude <--- Parental Math Attitude	.53	.06	8.52	.000
Boys Math Attitude <--- Parental Math anxiety	-.22	.06	-3.91	.000
Boys Math anxiety <--- Parental Math Attitude	-.12	.10	-1.16	.25
Boys Math Achievement<--- Boys Math anxiety	-.20	.03	-6.29	.000
Boys Math Achievement <--- Boys Math Attitude	.33	.04	7.59	.000

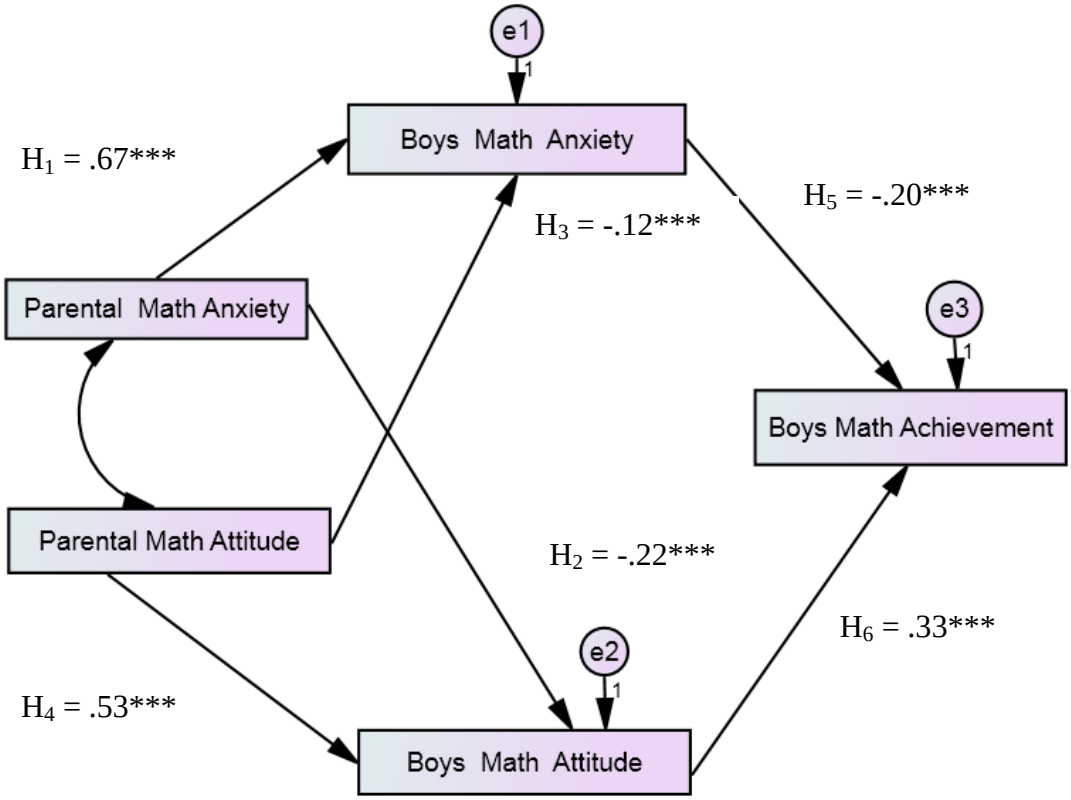

Figure 16: Path Values for Parental Math anxiety and Parental Math Attitude of Secondary Grade Boys

Figure 16 shows that parental math anxiety and math attitude act as precursor to boys math anxiety and attitude that further influence boy's math achievement. The default model 1 fits the data (χ^2/df= 4.76/3 = 1.58, GFI=0.99, CFI= 0.99, RFI=0. 97, TLI= 0.99, RMSEA=0.06). The RMSEA value came out to be 0.06 indicating a moderate model fit. The Chi square value came out to be significant. Therefore, we have considered the Absolute Fit Index, (RMSEA) and Incremental Fit Index (CFI, GFI, TLI, RFI) to gauge the goodness of fit. In this case, the RMSEA was found to be 0.06 which indicates the moderate fit. The CFI, GFI, TLI, RFI were found to be greater than 0.90 which further signifies the goodness of fit model.

Parental math anxiety was found to be a significant predictor of boys math anxiety (H_1: β = 0.67, $p < 0.001$) and boys math attitude (H_2: $\beta = -0.22$, $p < 0.001$). Similarly, parental math attitude was a significant predictor of boys math attitude (H_4: $\beta = 0.53$, $p < 0.001$) and boys math anxiety (H_3: $\beta = -0.12$, $p < 0.001$). In addition, boys math anxiety and math attitude significantly influenced their math achievement (for boys math anxiety, H_5: β = - 0.20, $p <$ 0.001; for boys math attitude, H_6: $\beta = 0.33$, $p < 0.001$).

4.5.8 Conceptual Model for Parental Math anxiety and Math Attitude of Secondary Grade Girls

Table 15 Regression weights for the Path of Parental Math anxiety and Parental Math Attitude of Secondary Grade Girls

	Estimate	S.E	C. R.	P
Girls Math anxiety <--- Parental Math anxiety	.70	.07	10.43	.000
Girls Math Attitude <--- Parental Math Attitude	.80	.05	16.91	.000
Girls Math Attitude <--- Parental Math anxiety	-.10	.05	-1.98	.05
Girls Math anxiety <--- Parental Math Attitude	-.42	.06	-6.96	.000
Girls Math Achievement<--- Girls Math anxiety	-.28	.03	-8.21	.000
Girls Math Achievement <--- Girls Math Attitude	.37	.04	9.42	.000

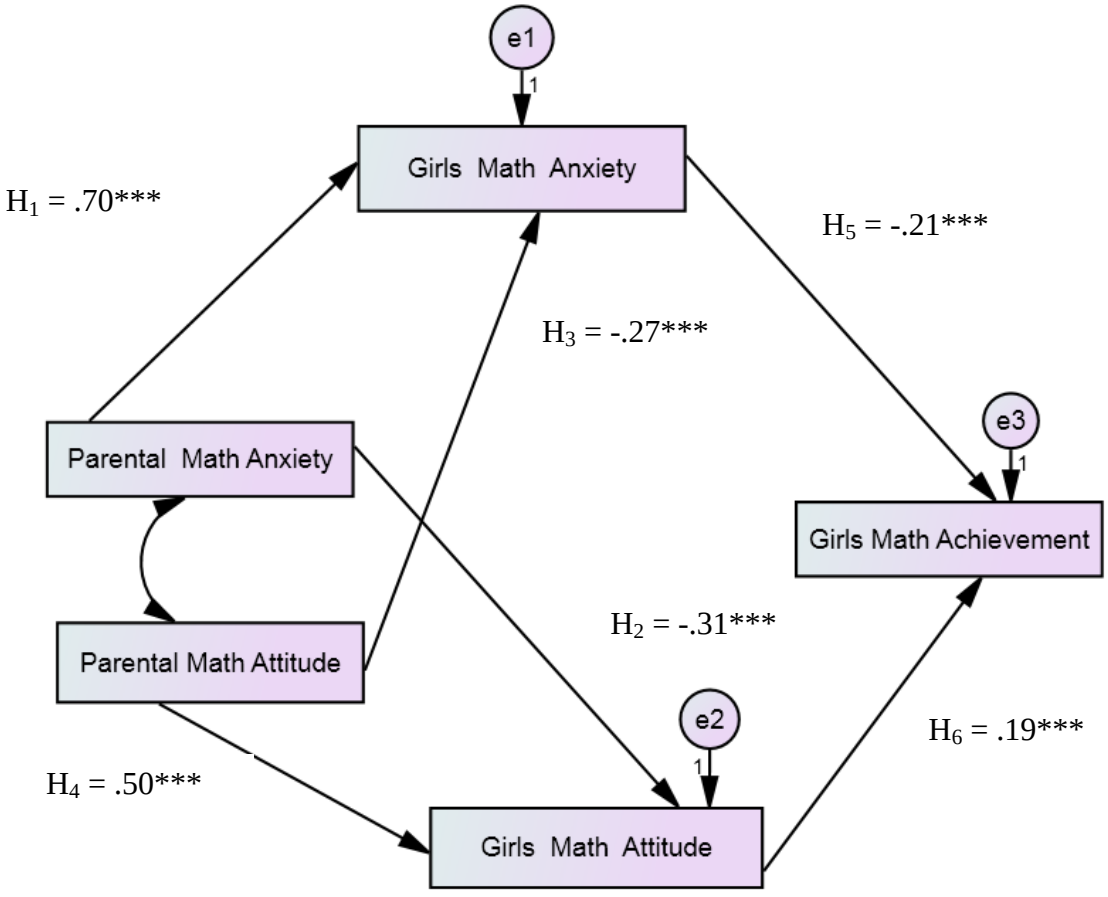

Figure 17: Path Values for Parental Math anxiety and Parental Math Attitude of Secondary Grade Girls

Figure 17 shows that parental math anxiety and math attitude act as precursor to girls math anxiety and attitude that further influence girl's math achievement. The default model 1 fits the data (χ^2/df= 4.93/3 = 1.64, GFI=0.99, CFI= 0.99, RFI=0. 97, TLI= 0.99, RMSEA=0.07).

The RMSEA value came out to be 0.07 indicating a moderate model fit. The Chi square value came out to be significant. The CFI, GFI, TLI, RFI were found to be greater than 0.90 which further signifies the goodness of fit model.

Parental math anxiety was found to be a significant predictor of girls math anxiety (H_1: $\beta = 0.70$, $p < 0.001$) and girls math attitude (H_2: $\beta = -0.31$, $p < 0.001$). Similarly, parental math attitude was a significant predictor of girls math attitude (H_4: $\beta = 0.50$, $p < 0.001$) and girls math anxiety (H_3: $\beta = -0.27$, $p < 0.001$). In addition, girls math anxiety and math attitude significantly influenced their math achievement (for girls math anxiety, H_5: $\beta = -0.21$, $p < 0.001$; for girls math attitude, H_6: $\beta = 0.19$, $p < 0.001$).

4.6 Effect of Teachers math anxiety and attitude on children math achievement

4.6.1 Descriptive Statistics

Means and standard deviation of Teachers math anxiety and math attitude are presented in Table 16.

Table 16 Means (M) and standard deviations (SD) of Teachers math anxiety and math attitude (N = 875)

Variables	M	SD
TM Anx	46.79	21.12
TM Att	167.39	11.38

*Note: T M Anx: teachers math anxiety; T M Att: teachers math attitude

4.6.2 Correlation

Correlations among the variables children math achievement, children math anxiety, children math attitude, teachers math anxiety and teachers math attitude appear in Table 17.

Table 17 Correlation between Children Math Achievement, Children Math anxiety, Children Math Attitude, Teachers Math anxiety and Teachers Math Attitude (N = 875)

Variables	CM Ach	CM Anx	CM Att	TM Anx	TM Att
CM Ach	1	-.71**	.79**	.08*	.04
CM Anx	-	1	-.72**	.02	-.15**
CM Att	-	-	1	-.05	.21**
TM Anx	-	-	-	1	-.80**
TM Att	-	-	-	-	1

p<0.01, p<0.05***

*Note: CM Ach: children math achievement; CM Anx: children math anxiety; CM Att: children math attitude; TM Anx: teachers math anxiety; TM Att: teachers math attitude

4.6.3 Conceptual Model for Teachers Math anxiety and Math Attitude

In this section, we analyze the path that connects independent variables teachers math anxiety, teachers math attitude, children's math anxiety, and children's math attitude to children's math achievement in different grade groups.

The results didn' t confirmed our expectation that teachers math anxiety and math attitude act as precursors to children's math anxiety and attitude that further influence their math achievement. The path values are given in Fig. 18. The regression weights of the model are presented in Table 18.

Table 18 Regression weights for the Path of Teachers Math anxiety and Teachers Math Attitude

	Estimate	S.E	C. R.	P
Children Math anxiety <--- Teachers Math anxiety	-.30	.07	-4.58	.000
Children Math Attitude <--- Teachers Math Attitude	.97	.11	8.74	.000
Children Math Attitude <--- Teachers Math anxiety	.36	.06	6.04	.000
Children Math anxiety <--- Teachers Math Attitude	-.78	.12	-6.33	.000
Children Math Achievement<--- Children Math anxiety	-.16	.01	-14.55	.000
Children Math Achievement <--- Children Math Attitude	.36	.01	30.04	.000

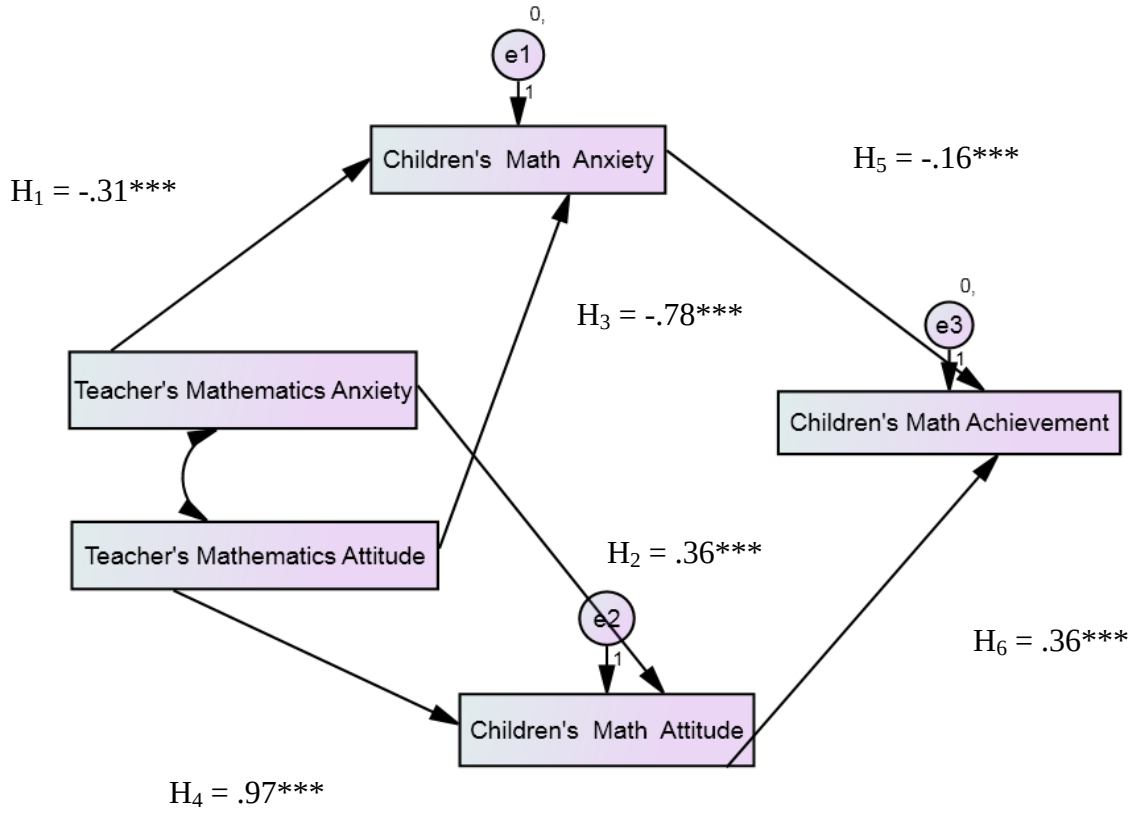

Figure 18: Path Values for Teachers Math anxiety and Parental Math Attitude of Children

Figure 18 shows the default model 1 fits the data (χ^2/df= 636.87/3 = 212.29, GFI=0.75, CFI= 0.75, RFI=0.18, TLI= 0.18, RMSEA=0.49). The RMSEA value came out to be 0.49 indicating a poor model fit.

Teachers math anxiety was found to be a significant predictor of children math anxiety (H_1: $\beta = 0.31$, $p < 0.001$) and children math attitude (H_2: $\beta = 0.36$, $p < 0.001$). Similarly, teachers math attitude was a significant predictor of children math attitude (H_4: $\beta = 0.97$, $p < 0.001$) and children math anxiety (H_3: $\beta = -0.78$, $p < 0.001$). In addition, children math anxiety and math attitude significantly influenced their math achievement (for children math anxiety, H_5: $\beta = - 0.16$, $p < 0.001$; for girls math attitude, H_6: $\beta = 0.36$, $p < 0.001$).

As the model was unfit. Therefore, we tried to fit the model through modification indices by removing H_2 (Children Math anxiety <--- Teachers Math Attitude) and H_3 (Children Math anxiety <--- Teachers Math Attitude) hypotheses. The path values are given in Fig. 19. The regression weights of the model are presented in Table 19.

Table 19 Regression weights for the Path of Teachers Math anxiety and Teachers Math Attitude (Modification Indices)

	Estimate	S.E	C. R.	P
Children Math anxiety <--- Teachers Math anxiety	.03	.04	.75	.45
Children Math Attitude <--- Teachers Math Attitude	.43	.06	6.37	.000
Children Math Achievement<--- Children Math anxiety	-.16	.01	-14.55	.000
Children Math Achievement <--- Children Math Attitude	.36	.01	30.04	.000

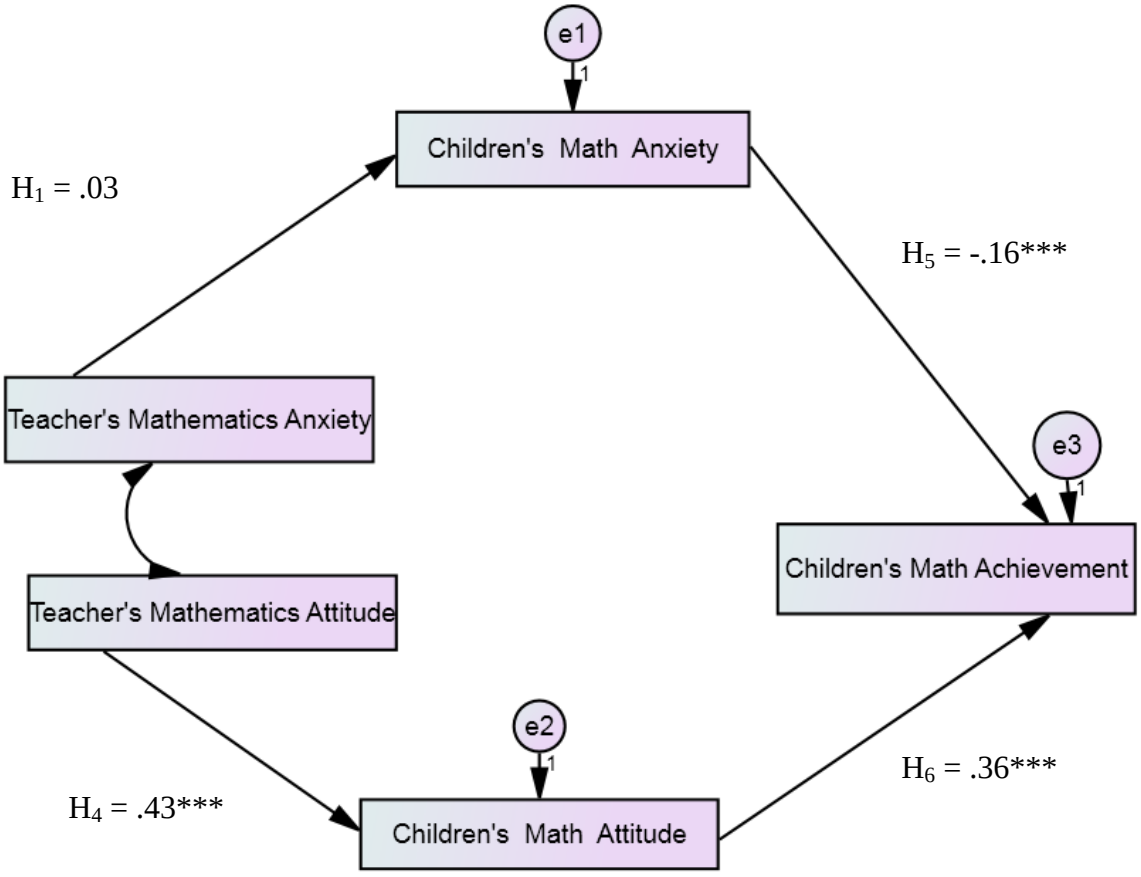

Figure 19: Path Values for Teachers Math anxiety and Parental Math Attitude of Children (Modification Indices)

Figure 19 shows the default model 1 fits the data (χ^2/df= 711.82/5 = 142.36, GFI=0.75, CFI= 0.73, RFI=0.45, TLI= 0.45, RMSEA=0.49). The RMSEA value came out to be 0.40 indicating a poor model fit.

Teachers math anxiety was found to be a insignificant predictor of children math anxiety (H_1: $\beta = 0.03$, $p = 0.45$). Similarly, teachers math attitude was a significant predictor of children math attitude (H_4: $\beta = 0.43$, $p < 0.001$). In addition, children math anxiety and math attitude significantly influenced their math achievement (for children math anxiety, H_5: $\beta = -0.16$, $p < 0.001$; for girls math attitude, H_6: $\beta = 0.36$, $p < 0.001$).

As the model was again unfit even by doing modification. Therefore, the regression analyses was carried in order to Effect of Teachers Math anxiety and Teachers Math Attitude on Children Math anxiety and Children Math Attitude.

4.6. 4 Regression

Results of regression analysis presented in Table 20 show that teachers' math anxiety had no effect on students' (boys' and girls') math anxiety.

Table 20 Results of Regression Analysis to Test the Effect of Teachers Math anxiety on Boys and Girls Math anxiety.

Variables	N	B	β	Adjusted R^2	F
TM Anx (combined)	875	.03	.02	.001	.56
TM Anx (Boys only)	468	.04	.03	.001	.66
TM Anx (Girls only)	407	.02	.01	.002	.07

Dependent Variable: children math anxiety; boys math anxiety; girls math anxiety

*Note: C M Anx: children math anxiety; B M Anx: boys math anxiety; G M Anx: girls math anxiety; T M Anx: teachers math anxiety

Table 21 Results of Regression Analysis to Test the Effect of Teachers Math Attitude on Boys and Girls Math Attitude.

Result of regression analysis, presented in Table 21 indicate that teachers' math attitude contributes (i) 4% ($R^2 = 0.04$, $p<0.001$) of variance in children's math attitude and (ii) 9% ($R^2 = 0.09$, $p<0.001$) of the variance in boys' math attitude. can be attributed to teachers math attitude. The influence of teachers' math attitude on girls' was non - significant.

Variables	N	B	β	Adjusted R^2	F
TM Att (combined)	875	.43	.21	.04	40.57***
TM Att (Boys only)	468	.56	.30	.09	45.51***
TM Att (Girls only)	407	.13	.07	.002	1.82

p<0.001* ** Dependent Variable: children math attitude; boys math attitude; girls math attitude

*Note: C M Att: children math attitude; B M Att: boys math attitude; G M Att: girls math attitude; T M Att: teachers math attitude

4.7 t – test of Children's Math Achievement

The mean and standard deviations of lower middle, middle, and secondary grade students appear in Table 22.

Table 22 Mean (M) and standard deviations (SD) and t- test value of children's math achievement for males and females

	N			Means			SD			t-value	Sig
Grades	M	F	Total	M	F	Total	M	F	Total		
LMG	152	137	289	78.13	70.40	74.46	11.94	13.54	13.28	5.15**	.001
MG	166	140	306	78.81	64.07	72.07	14.66	16.15	17.00	8.36**	.001
SG	150	130	280	70.64	63.58	67.36	10.76	9.47	10.76	5.79**	.001
Total	468	407	875	75.97	66.04	71.35	13.13	13.74	14.30		

*Note: LMG: lower middle grade; MG: middle grade: SG: secondary grade

Result of t- test analysis, presented in Table 22 indicate that there was significant gender difference in math achievement score in lower middle grade students (i) males (M = 78.13, SD = 11.94) and females (M = 70.40, SD = 13.53); t (287) = 5.15, p = .001, in middle grade students (ii) males (M = 78.81, SD = 14.66) and females (M = 64.07, SD = 16.15); t (304) = 8.36, p = .001 and secondary grade students (iii) for males (M = 70.64, SD = 10.76) and females (M = 63.58, SD = 9.46); t (278) = 5.79, p = .001.

4. 8 Choice to study further Mathematics

Logistic regression analysis was computed to investigate the effect of three independent variables on choice to study further mathematics. The dependent variable selected for modeling was choice to study further mathematics, which was a discrete (binary) variable with two responses: 1 = 'yes' to study further mathematics and 0 = 'no' to study further mathematics. The independent variables were children mathematics achievement (C M Ach), children math anxiety (CM Anx), and children math attitude (CM Att). All these variables were continuous variable. The results of the logistic regression are presented in Table 23.

Table 23 Logistic Regression Analysis depicting choice to study further mathematics

Variables	B	SE	Wald	df	Sig	Exp (B)
CM Ach	.06	.05	1.40	1	.24	1.07
CM Anx	-.01	.02	.36	1	.55	.98
CM Att	.49	.09	27.21	1	.000	1.64
Constant	-72.83	13.92	27.37	1	.000	.000

Variables entered CM Ach: children mathematics achievement; CM Anx: children math anxiety; CM Att: children math attitude

As Table 23 indicates, the only significant predictor of the choice to study further mathematics was children math attitude (p = .000). Thus, with every unit increase in children math attitude, the children choice to study further mathematics will be correct increase by a factor of 1.64.

Table 24 Model Summary of children's choice to study further mathematics

-2 Log Likelihood	Cox & Snell R Sq	Nagelkerke R Sq
67.32	.64	.89

Table 24 depicted the variation in the independent variables thus ranging somewhere between 64% and 89% of the variation in results.

Table 25 depicts the goodness-of-fit of the model. The non-significant chi2 (p > 0.05) indicates that the model fits the data well. Classification Table 26 revealed the predicted answer as 85 with independent variables. However, Table 27 depicted without independent variables.

Table 25 Hosmer and Lemeshow Test of goodness-of-fit of children's choice to study further mathematics

Chi Square	df	Sig
5.75	8	.67

Table 26 Classification Table of children's choice to study further mathematics

Observed		Predicted		
		Choice to study further Mathematics		Percentage correct
		0	1	
Choice to study further Mathematics	0	85	5	94.4
	1	8	182	95.8
Overall percentage				95.4

Table 27 Classification Table of children's choice to study further mathematics

Observed		Predicted		
		Choice to study further Mathematics		Percentage correct
		0	1	
Choice to study further Mathematics	0	0	90	0
	1	0	190	100.0
Overall percentage				67.9

4.9 Summary of the Chapter

Chapter Four presented the results of this study using parental, children's and teachers (math anxiety and attitude) along with children's math achievement. Generally, the findings indicated that parental math anxiety and math attitude act as precursor to children's math anxiety and attitude that further influence children's math achievement. The influence of teachers' math attitude on boys' math attitude was significant. There exists gender and grade difference in math achievement. Children's math attitude influences their choice to study further mathematics. Chapter Five will discuss the findings in greater detail.

CHAPTER 5
DISCUSSION

5.1 General Discussion

The present study aim was to investigate the role of parental math anxiety and math attitude in their children's math achievement. The findings of the study confirmed the hypotheses (H_1). As predicted, parental math anxiety positively influenced children's math anxiety and negatively affected their math attitude. These findings are in line with previous research studies, which found that the way parents' feel about math probably influence the messages they convey about math to their children (Gunderson, 2012). Although parenting practices do not play a major part in the development of behaviors that are related to children's anxiety disorder, they do have an effect on anxiety behaviors (McLeod et al., 2007). Poor scores are attained by children of unengaged and authoritarian style parents (Weiss & Schwarz, 1996). Parents' math anxiety transfers math anxiety to their children, which in turn negatively influences their children's attitude toward mathematics. Therefore, children are susceptible to math anxiety and show a negative attitude when their parents exhibit the same. This may be because parents serve as role models, whose behavior is closely observed and replicated by their children. These findings reflect observational learning theory, which suggests that children learn and replicate the behavior of parents and others (Bandura, 1971). Undoubtedly, children's biggest role models are their parents; their liking or disliking and feeling about learning significantly effect on their children. In addition, parents or teachers may give children mixed messages about mathematics (Williams, 1988, as cited in Thomas & Furner, 1997). For example, a parent may emphasize the difficulty level of mathematics, while at other times tell children how mathematics skills are important for their future achievements. The findings of the present study confirm that parents' math anxiety acts as an antecedent to their children's math anxiety and math attitude.

Our findings also confirmed the hypothesis that parental math attitude influences children's math anxiety and math attitude. Onslow (1992), highlighted that student's attitudes are strongly influenced by the attitude of their parents. The involvement of parents contributes to their children's higher academic achievement as well as to their behavior and emotional development (Cai et al., 1997). Parents on the basis of their own biases formulate notions about their child's interest and abilities (Eccles, 1993). The attitude of parents considerably influences their children mathematics performance (Hall et al., 1999). Parents' attitude can influence children that they can be successful at math by providing them adequate academic support (Cavanaugh, 2007). Parents' beliefs about their child's mathematical ability

contribute to their child's self- perception. In addition to this, parents' stereotypes as well as child's self - perception influence their mathematics performance (Jacobs, 1991). According to Reynolds and Walberg (1992), home environment and prior mathematics achievement contributes significantly to children's mathematics achievement. Davies and Kandel (1981), reported that parental influences on their children´s educational aspirations are much stronger than that of peers. According to Neuenschwander et al., (2007) parents' expectations about their child success contributes in their children's academic ability in math as well as in native language. The present findings that parental math attitude has a positive impact on children's math attitude and negative influences on children's math anxiety are consistent with these studies. Parents' positive attitude toward math, helps their children to have a positive outlook, which indirectly enhances their performance and reduces math anxiety.

The present study also found that children's math anxiety negatively influences their math achievement. This may be because math anxiety affects students' cognitive processing capacity. According to Aschcraft and Kirk (2001), high math anxiety leads to reduced working memory capacity. Eysenck and Calvo (1992), also found that anxiety has a debilitating effect on working memory as processing capacity to perform task gets reduced. In addition to this, students working memory works slowly due to math anxiety and hinders in their math performance due to their inability to block distractions (Ashcraft & Krause, 2007; Beilock & Carr, 2005). According to Legg and Locker (2009), math anxiety was moderated by meta cognition and predicted that mathematics performance would decrease as anxiety increased, except at high meta cognition levels. It was also found that cognitive load has a detrimental influence on time based prospective memory (Khan, Sharma & Dixit, 2008). Sherman and Wither (2003), found that mathematics anxiety has a deleterious effect on mathematics achievement. Students with high mathematics achievement had low math anxiety and with low mathematics achievement had high anxiety (Zakaria et al., 2012). In addition, the present study showed that children's math attitude positively influenced their mathematics achievement. This finding is consistent with earlier work on children's math attitude and math achievement. Bramlett and Herron (2009), suggested that students' positive attitude toward mathematics contributes in their high mathematics performance.

Children's enjoyment while solving math problems tends to enhance their attitude toward mathematics, which further leads to high mathematics achievement. Students' positive attitudes towards mathematics influence their readiness to learn and the merit they can get from mathematics instruction (Eshun, 2004). According to Yee (2010), students possess a positive attitude toward mathematics but lacked intrinsic motivation to perform

math. However, they are extrinsically motivated to study mathematics. The affective variables such as positive view, math confidence, utilitarian and traditional variables were significantly associated with mathematical performance (Grootenboer & Hemmings, 2007). Students' mathematical beliefs and attitude towards mathematics have profound influence on their mathematical performance (Fardin et al., 2011). Therefore, it can be inferred from the present study that parents' math anxiety and math attitude act as precursors to their children's math anxiety and attitude, which further influences children's math achievement.

5.2 Impact of Parental Math anxiety and Math Attitude across grades

The present findings confirm the proposed hypotheses (H_2) that parental math anxiety and math attitude are more in younger age group than older age groups. It was found that parental math anxiety and math attitude contributes significantly to children's math achievement in younger age group as compared to older groups. The findings of the study have revealed that parents' math anxiety and math attitude have a profound impact on younger age group. The main reason can be parents serves as the best teachers from the beginning of a child lives. They play an active role in development and education of a child. It is the stage when implicit learning occurs as a child unconsciously copies some of their parents' habits and styles of behavior. On the other hand, during adolescents, mainly peers influence a youngsters life and naturally substitute family. It can be one of the possible reasons that the impact of parent's math anxiety and math attitude is more in younger age group as compared to older age groups. In addition to this, there is a tendency of adolescents to reject the adult standards and indulge in conflict with reality or parents standards. There are some studies that provide supporting evidence although from diverse field depicting the influence of parents on young children. According to Abu- Rabia and Yaari (2012), found that parents' supportive attitude significantly contributes to reading performance of their first grade children. Brown and Ogden (2003), found a consistent association between parents' and children's eating behavior and attitude as modeling significantly influences children's behavior and thinking about food.

5.3 Impact of Parental Math anxiety and Math Attitude across gender

The present findings confirmed the proposed hypotheses (H_3) that parental math anxiety and math attitude are more in girls than boys. The study showed that parental math anxiety and math attitude contributes significantly to girls math 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 constant and strong connection between parenting style and their children's school enrollment and academic achievement. Mcleod, Wood and Weisz (2007) found a parenting practices were related with children anxiety related behavior. The major reason for students' math anxiety was the prior negative experiences of learning mathematics in the classroom or at home (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) found that parental academic involvement and teachers behaviors contribute positively to students' math grades. The findings can be explained in terms of the immense role of the parents in the development of mathematics skills in children and substantial closeness and physical proximity of girls to their parents especially in the Indian context. Parents invariably serve as role models for their daughters. Hembree (1990), found that women poses to be more math anxiety than men that may further account to some gender related profession. The major reason behind this can be that boys consider themselves efficient in math and are therefore less math anxious.

5.4 Effect of Teacher's Math anxiety and Math Attitude on Children's Math Achievement

The conceptual model for analyzing the influence of teacher's math anxiety and math attitude on children's math achievement was unfit as the RMSEA value was too high. Therefore, a simpler analysis i.e. regression analysis was conducted in order to assess the independent influence of individual variables on dependent variables. It was found that teacher's math attitude positively contributes to math attitude of children (H_{4d}). Akey's (2006), work showed that supportive teachers with clear and high expectations about behavior play a immense role in the development of student engagement as well as perceived competence. Maat and Zakaria (2010), found that learning environment and teachers' factor significantly influence students' attitude towards mathematics. As, the students who had better perception on their teachers have better attitude towards mathematics. The value of math increased for middle school students when they had a teacher whom they perceived to be high in support (Eccles, 1993). Aslan et al. (2013), found that teachers beliefs about mathematics education contributes

significantly to their children's mathematics achievement rather than their math anxiety. Kamal and Muideen (2014), reported that attitude of chemistry teachers has significant impact on students' chemistry achievement. Teachers' attitude towards teaching of mathematics contributes significantly in shaping students' mathematics attitude (Olatunde, 2009). According to Al- Qaisi (2010), teachers play a considerable role towards enhancing students' participation in classroom activities. Therefore we can infer from the above mentioned studies that teachers attitude toward math positively influence their students math attitude.

5.5 Gender Differences in Math Achievement

The findings of the present study confirm the hypothesis (H_5) that males performed better than females on math achievement tests. The major reason can be because of the physiological dominance of brain parts. As reported by Burman et al. (2008), in his study different areas of brain gets activated, while performing several tasks like left hemisphere more deals with language and dominant in girls, while right hemisphere is activated in logic and prominent in males. According to Harris (1981), males generally perform well than females in spatial-ability test performance. The second reason can be that, males do possess positive perception towards math and are naturally inclined towards it. This result is consistent with Bauerlein and Stotsky (2005), at the elementary level the textbook that relates with literature fascinates the females rather than males. Asante (2010), showed that boys generally achieved higher than girls on standardized math tests (Eriksson & Lindholm, 2007). Males stereotyped mathematics as a male domain higher than females. Females were significantly less confident of themselves in mathematics (Fennema & Sherman, 1978).

The third reason can be parental stereotype related to their children math performance. A body of research has been conducted in the recent past related with parents gender stereotypes, and expectations regarding their children's math performance. Yee and Eccles (1988), found that parents hold different perception related to their sons and daughters math performance. Math success for daughters was attributed to their hard work and for sons it was their natural talent. Jacobs and Eccles (1992), showed that mothers supported gender stereotype opinion claiming lower math ability for daughters and higher math ability for sons on the basis on their teachers rating. Thus, it can be attributed from the above mentioned studies that parental socialization and differential treatment of parents to their sons and daughters tends to create gender differences in math achievement.

5.6 Choice to study further Mathematics

The findings confirmed the proposed hypothesis (H_6) that math attitude of 11^{th} and 12^{th} grade children affects their choice to study further mathematics. Students' ppositive attitudes towards math serve as stepping stones in math education as well as career choices. The result of the study is consistent with the findings of Ercikan et al., (2005) that sstudents' attitudes toward mathematics seems to be the strongest predictors of participation in higher level mathematics courses for students' from western countries. This can be one of the reasons that math attitude influence children's choice to study further mathematics. According to Maple and Stage (1991), there are various significant factors such as parental factors, mathematics attitudes, number of math and science course taken through the senior year have a tremendous influence on students' choice of math/ science major. There are different factors for men and women that influence their choice of science and math majors, as women it is scoring well in math and for men completing high school physics (Trusty, 2002). Several significant factors influencing students' choice for mathematics course in higher education like prior mathematics course choice and the family's inculcation (Kleanthous & Williams, 2013). Self and value perception of ability are considered to be the immediate factors influencing students' plans for pursuing maths- related courses (Watt, 2005). This is evident in the above mentioned studies that children attitude towards a subject whether (math or science) influence its decision to pursue it at higher level.

5.7 Summary of the Chapter

Chapter Five presented the findings of this study. The major findings of the study are (a) parents' math anxiety and math attitude act as precursors to their children's math anxiety and attitude, which further influences children's math achievement (b) parental math anxiety and math attitude are more in younger age group than older age groups (c) parental math anxiety and math attitude contributes significantly to girls math achievement (d) teachers attitude toward math positively influence their students math attitude (e) males performed better than females on math achievement tests and lower middle grade students (5^{th} to 7^{th} grade) have more math achievement as compared to other grade students (8^{th} to 10^{th} grade) and (11^{th} to 12^{th} grade) and (f) children' s attitude toward math of 11^{th} and 12^{th} grade influence their choice to study further mathematics. Chapter Six will discuss the conclusion, limitation, implication and future research.

CHAPTER 6

CONCLUSION AND SUGGESTIONS FOR FUTURE RESEARCH

This chapter includes the study in retrospect, major findings drawn from the analysis of data, limitation, implication, and suggestions for educational practice and for future research.

6.1 Summary

The present investigation was based on the predictions that children's mathematics achievement is influenced by personal and environmental factors. Research evidence suggested that parental math anxiety, parental math attitude, children's math anxiety, and children's math attitude influence children's mathematics achievement.

The main questions of interest in the present investigation were: Do parental math anxiety and math attitude influence children's mathematics achievement? Do children's math anxiety and math attitude influence their mathematics achievement? Do teacher's math anxiety and math attitude influence children's mathematics achievement? An enquiry into the nature of sex and grade differences for children's mathematics achievement? Is there any influence of children's math attitude on their choice to study further mathematics was also made.

Mathematics Anxiety Rating Scale for Elementary school students (MARS-E) and Mathematics Anxiety Rating Scale for Adolescents (MARS- A) were administered respectively for measuring children's mathematics anxiety and Mathematics Anxiety Scale Short Version (MARS- SV) was used to measure parental math anxiety. Parental and children attitude towards mathematics were assessed by using Attitude towards Mathematics Inventory (ATMI). Path analysis was conducted in order to find a path way using AMOS 20.

The analysis of the data revealed that parental math anxiety positively influenced children's math anxiety. Our findings also confirmed that parental math attitude positively influences children's math attitude. Further findings of the present study were that children's math anxiety negatively influences their math achievement and children's attitude toward mathematics enhances their mathematics achievement.

Parental math anxiety and math attitude serve as precursors to younger children's math anxiety and math attitude that further influence their math achievement, which was not the case with the older groups. Younger children consider parents their role model and therefore imbibe attitude, values, and beliefs from them. In addition to this, it was found that the influence of parental math anxiety and math attitude is more girls as compared to boys.

Teacher's math attitude contributes significantly to their children's math attitude. Math attitude either of teachers/ parents serves as a vital factor that contributes positively to children's math attitude and math achievement. The findings throw light on the positive attitude of teachers. If teachers possess positive attitude math then it can also enhance math attitude of children.

The present study also found that males perform better in mathematics and have higher math achievement than females. Gender was found to be important determinant of children's math achievement. There also exists significant grade difference in children's mathematics achievement. It was found that children of lower middle grade (5^{th} to 7^{th} grade) have more math achievement as compared to other groups. Similarly, math achievement of middle grade children (8^{th} to 10^{th} grade) is higher than math achievement of children of secondary grade (11^{th} to 12^{th} grade).

The present study found that whether a student will opt for/ not for higher education depends on the attitude towards math. Math attitude of children is considered to be the most important determinant for choice to study further math. The study gives the insight of the various personal and environmental factors that influence children's math achievement.

6.2 Conclusion

The major highlights of the present study was to propose a conceptual model in order to quantify the relationship between each of the exogenous variables (parental math anxiety and math attitude) and the endogenous variables (children's math anxiety, math attitude, and math achievement). The following conclusions were drawn based on the findings of the present study.

(1) It was found that parent's math anxiety and math attitude act as precursors to their children's math anxiety and math attitude, which further influences their math achievement. It has been demonstrated earlier that several personal and environmental factors influence children's mathematics achievement, but the underlying mechanism through which these factors operate was not clear. The present work proved it with conceptual model.

(2) The influence of parental math anxiety and math attitude is more in younger age group as compared to older age groups.

(3) The influence of parental math anxiety and math attitude was found to be more pronounced in the case of girl's math achievement as compared to boy's math achievement.

(4) Parental math anxiety and math attitude have a profound influence on children's math achievement as compared to teacher's math anxiety and math attitude on children's math achievement.

(5) Males perform better than females in math achievement across grades.

(6) The decision to study further math depends on the kind of attitude, the children hold about math. However, the math anxiety and math achievement has not much influence on it.

6.3 Implication of the study

The present study has implications for parents, teachers, and educators. School counselors should conduct special awareness programs for parents and teachers in schools to cognize them about the detrimental effect of their math anxiety and math attitude on children's mathematics achievement. As suggested by Stenmark et al., (1986) intervention programs especially related to math can be organized for parents to develop mathematical skills in their children. Children focused intervention programs can be useful for increasing cognitive and self- control competence for reducing math anxiety and enhancing math performance as indicated by (Hanson 1988, as cited by Rainbow, 2008). In addition to this, students's should be encouraged to be emotionally resilient. As indicated by Garg and Rastogi, (2009) that emotionally resilient students are more resilient to stress that determine their personal and professional front. Educational leaders must give special attention to the psychological needs of students that can reduce stress level. Parents and teachers should be advised to develop a positive attitude towards math (Stuart, 2000) and allow children to indulge in self paced learning (Smith, 1995) by providing positive reinforcement at each stage of their success. Teachers should attempt to identify math-anxious students, and show special concern and care by providing special classes for students who exhibit poor mathematics performance. Teachers must tackle the problems of the students patiently. They must show special concern by being caring and proving supportive environment to each child rather than highlighting their mistakes. Special programs can be organized for teachers as indicated by (Tooke & Lindstrom, 1998). Teachers should know how to teach math as math anxiety negatively influence both teaching and learning of mathematics. Teachers should incorporate real world examples and problems while teaching mathematics so that students can connect basic mathematics concept to real life. Educators and policy makers should design the mathematics curriculum in such a way so that the basic mathematical concept can be mastered more comprehensively in the formative years.

6.4 Limitation and Suggestions for Future Research

A limitation of the present study is that information was gathered from only one parent (mother or father) of each child. If both parents had completed the questionnaire related to math anxiety and math attitude, we may have been able to ascertain the differential impact of parents (mothers and fathers) on their children's math achievement.

Future research conducted to improve understanding of how children's peers' math anxiety and attitudes can influence children's math achievement has merit. In addition, it would be interesting to relate students' achievements and anxiety to their parents' beliefs and conceptions about mathematics, mathematical knowledge and mathematical thinking. A cross-cultural comparison could be attempted to determine whether the proposed conceptual model described here can be generalized to other countries.

Publications from the current investigation:

Soni, A., & Kumari, S. (2015). The Role of Parental Math anxiety and Math Attitude in their Children's Math Achievement. *International Journal of Science and Mathematics Education,* 1- 19.

Soni, A., & Kumari, S. (2015). A comparative study of math anxiety between parents and their children and its impact on the children's achievement in mathematics. *International Journal of Scientific and Engineering Research*, *6*(2), 854-866.

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