

THE ROLE OF PARENTAL MATH ANXIETY
IN STUDENTS' MATH ANXIETY AND PERFORMANCE

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DECLARATION OF ORIGINALITY

I, Samet Sarıgöl, certify that

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ABSTRACT

The Role of Parental Math Anxiety in Students' Math Anxiety and Performance

The current study mainly aims to clarify parental roles in students' math anxiety and performance. The relationship between anxiety and achievement has been widely studied and negative correlation was found (Hembree, 1990; Erkin et al, 2006; Devine et al., 2012). Identifying patterns of interaction between anxiety and performance along with parental involvement is at the focus. Parent-child relationship concerning anxiety was hypothesized to be grounded by control-value theory, dealing with roles of control and value appraisals in achievement emotions (Pekrun, 2006). The study was structurally planned in two phases. The first phase comprised of data collection from 335 students and their parents on measures of math anxiety, students' performance, parental involvement, subjective appraisals. The results indicated that both students' and parents' anxiety was negatively correlated with students' achievement. Students' and parents' anxiety was found to be positively correlated. Regression analysis showed that 36% of the variance in achievement can be explained by students' anxiety and their subjective control. 48% of the variance in students' anxiety can be predicted by parents' anxiety, control appraisals of both and achievement. In the second phase, 12 of the most anxious children and their parents were interviewed. Analysis of the interviews showed that parent-child contact concerning math anxiety, as an academic emotion, can be explained by control-value theory. Parental expectations and overvaluing were emerged as prominent contributors of anxiety induced by parents. The results were discussed in terms of justifying the development of clues to teachers about promoting parental involvement, aiming at increased students' learning.

ÖZET

Velilerin Matematik Kaygısının

Öğrencilerin Matematik Kaygı ve Performansları Üzerindeki Rolü

Bu çalışmanın esas amacı, velilerin matematiğe ilişkin duygu ve düşüncelerinin, çocukların matematik kaygı ve performansları üzerindeki rolünü incelemektir. Kaygı – başarı ilişkisi geçmiş çalışmalara sıklıkla konu olmuştur (Hembree, 1990; Erkin et al., 2006; Devine et al., 2012). Matematik kaygısı bağlamında, veli-öğrenci etkileşimi ve bu ilişkinin arka planında gerçekleşen dinamiğini ortaya çıkarmak, bu çalışmanın asıl odağını oluşturmaktadır. Veli-öğrenci etkileşimini açıklamak amacıyla, teorik çerçeve olarak Pekrun' un (2006) kontrol-değer kuramı belirlenmiştir. Çalışma, iki ana evre olarak planlanmıştır. Birinci aşama, 335 öğrenci ve velilerinden ölçekler aracılığıyla matematik kaygısı, matematik başarıları, veli katılımı ve öznel değerlendirme değişkenlerine ilişkin nicel verilerin toplandığı süreçtir. Nicel analizler sonucu, öğrencilerin matematik kaygı puanlarının, başarılarıyla negatif, veli kaygısıyla ise pozitif korelasyona sahip olduğu görülmüştür. Öğrenci ve veli kaygıları arasında pozitif bir korelasyon saptanmıştır. Regresyon analizinde, başarıdaki varyansın %36' lık kısmının, öğrencilerin kaygı ve öznel kontrolü ile açıklanabileceği görülmüştür. Öğrenci kaygısındaki varyansın %48'i ise, veli kaygısı, başarı, veli ve öğrenci kontrolü ile tahmin edilebileceği bulunmuştur. İkinci aşamada ise, bir önceki aşamada toplanan verilerden aracılığıyla belirlenen en kaygılı 12 öğrenci ve velileriyle eşzamanlı görüşmeler gerçekleştirilmiştir. Nitel değerlendirmeler sonucunda ise, veli-öğrenci etkileşiminin, çalışmanın teorik tabanını oluşturan kuram ile açıklanabileceği gözlenmiştir. Görüşmelerde, veli beklentisi ve aşırı değer verme, velilerin çocuklarda kaygı

oluřturabileceęi durumlar olarak ne ıkmıřtır. Matematik kaygısını bir akademik duygu olarak ele alan ve bireylerin znel deęerlendirmeleri baęlamında akademik duygu oluřumunu inceleyen kontrol-deęer kuramı erevesinde bulgular detaylı bir biimde tartıřılmıřtır. Elde edilen veriler erevesinde, ęretmenler aracılıęıyla velilerin matematik kaygılarını azaltmaya ve veli katlılımı konusunda bilinlendirilmeye ynelik mdahale ve nlemler alınması nerilmektedir.

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CHAPTER 1

INTRODUCTION

Math is a field generally perceived to be difficult. People mostly refer to traumatic math-related experiences when expressing their views on mathematics. Many learners tend to experience adverse feelings, which might cause them to avoid interaction with situations requiring employment of mathematical processes. It can be observed that many individuals articulate negative emotional reactions to cases containing mathematical procedures (Betz, 1978; Maloney & Beilock, 2012).

The ultimate goal of mathematics education is to increase students' achievement levels, enhance mathematical literacy and problem solving skills (MEB, 2018). All math learning environments and applications are supposed to serve this purpose. On the other hand, it seems that negative feelings and thoughts about math might play a detrimental role by setting an emotional barrier in children's math achievement. Affect might be accountable for preventing the students to reveal their actual performance (Hembree, 1990). Thus, it is valuable and important to deal with the negative affect for mathematics such as math anxiety and its correlates.

Math anxiety is a phenomenon which has been widely studied. It seems to be still on the focus of math educators around the globe (Ho et. al., 2000; Ramirez, Shaw & Maloney, 2018). After almost five decades, paradigm on math anxiety studies and its examination has seemed to shift from a situation specific type of anxiety to an academic emotion (Luo, Ng, Lee & Aye, 2016; Pekrun, Frenzel, Goetz & Perry, 2007). Earlier, math anxiety was examined as a type of situation-specific anxiety, which implies the emotional disturbance or discomfort. Currently, math anxiety can be studied as a type of academic emotion, which refers to prospective or

retrospective feelings appraised by control and value appraisals and experienced in academic settings (Pekrun, 2006). Thus, one of the main objectives of the present study is to examine math anxiety as the current trend, which is under the title of academic emotions.

Math anxiety can be studied as an academic emotion. A framework for explaining the antecedents and impacts of achievement emotions emerged in academic settings have been described. According to the “control-value theory of achievement emotions”, it is presumed that activation of achievement emotions heavily depends on appraisals of control and values. Basically, the theory suggests an explanation for the central role of control and value appraisals in arousals of both activity and outcome achievement emotions experienced by children (Pekrun, 2006).

The model guided the current study from two fundamental perspectives. The theory is based on the control and value appraisals. Firstly, the theory calls for a definition for the emergence of the academic emotion by referring to control and value appraisals. According to the model, math anxiety as an academic emotion appears when three core conditions on the value attached and the feeling of control are satisfied. Initially, the model claims that it is essential that the focus of the individual is to be at the failure rather than achievement. More specifically, the individual is to be concerned with the avoidance of failure instead of acquisition of success in order to experience the feeling of math anxiety. Secondly, it is necessary that math is perceived to be a valuable field. Personal subjective value of math achievement plays a role in the emergence of math anxiety. Thirdly, in addition to the subjective valences toward math, individuals must feel low or partial lack of self-control about math. Arousal of math anxiety requires one’s feeling of uncertainty about his/her own mathematical skills and competencies necessary for dealing with

math-related situations. The theory contends that when these three criteria coexist, then math anxiety can be observed. This explanation for the emergence of math anxiety helped the current study in explaining both children's and parents' math anxiety. The other aspect that the model contributes to the study is the part which deals with social and cultural determinants of achievement emotions. The model also offers an explanation related with the roles of social antecedents of academic emotions. It asserts that achievement-related expectancies of significant others are important in one's control and value appraisals. Parents are often considered to be significant figures for children. The model can be considered to be useful in explaining parent-child contact from math anxiety perspective. This model constitutes a theoretical framework for the current study.

Adults as well as children seem to suffer from the fear of interaction with mathematical issues (Maloney, Ramirez, Gunderson, Levine & Beilock, 2015; Soni & Kumari, 2017). It has been observed that adults report their adverse feelings and thoughts about mathematics pointing out past negative math-related experiences. Avoidance of daily calculations and refraining from helping their children with math homework could be the indicators of parents' math anxiety. This emotional state of parents toward math may be due to their subjective control and value appraisals, which might lead to their math anxiety levels. Parents' own level of math anxiety might play an influential role in shaping children's math anxiety and math achievement. Parents' roles in developing children's math-related views need to be investigated. It is important to understand parents' involvement in order to examine the parent-child interaction in terms of math anxiety. In explaining the interaction between parents and children, the control – value theory of achievement emotions seems to be useful.

Parents are considered to be one of the core components of education. They have important responsibilities to guide their children's educational process. Similar to children, parents have their own feelings and thoughts formed as consequences of their past negative experiences concerning math. All views belonging to the parents about math might be influencing their children's views related to mathematics through some patterns. Disclosing these patterns and managing parent-child interaction in terms of affective issues might be valuable in enhanced learning in children (Vukovic, Roberts & Green Wright, 2013; Soni & Kumari, 2017).

Parental involvement has been examined under two main groups; home-based activities and school-based involvement (Hoover-Dempsey & Sandler, 1997). Home-based activities mainly include monitoring children's learning processes, supervising children's tasks, providing assistance for their homework, holding general daily discussions related to events occurred in the school and promoting children's learning with enriched tasks consistent with their schools. School-based involvement basically covers attending school conferences, holding informal talks with teachers and being an active member of voluntary activities. As far as the current study is concerned, parental involvement at home was the only focus in examining parental roles on children's math anxiety.

Considering parents' own math anxiety levels, one of the primary objectives of this study is to clarify the parental roles on their children's math achievement and math anxiety in terms of control and value appraisals. At the end of the study, it is expected to suggest certain implications related to the boundaries of parents' roles in integrating them into educational process. The results obtained from the current study might be used to propose evidence-based guidelines for policy-makers, administrators and teachers about how to include parents into education.

The principle objective of the present study is to examine the current level of children and parents' math anxiety as well as clarifying the potential patterns of relationship between them. Math-related affect from both children's and parents' perspectives as well as the interrelations between them are at the focus of the study. Clarification of dynamic mechanisms functioning behind parent-child contact pertaining to math anxiety is counted among the main objectives of this study.

The study was structurally planned in two sections. In the first phase of the study, quantifying both children's and parents' math anxiety levels with self-report measuring instruments was aimed with the purpose of understanding whether this phenomenon was currently existent and prevalent. It was aimed to reveal the relationship between parents and children's math anxiety through quantitative analyses. A certain amount of caution was withheld for numerical values which may fail to explain the underlying pathways followed by parental math anxiety upon children's math anxiety. In their study, Maloney et. al. (2015) found that parents' math anxiety might be conveyed to their children through particularly during homework assistance. Following this study which has been an inspiration for the present study, which aims to examine the parental roles in children's math anxiety, math-anxious parents might exhibit anxiety-inducing actions influential on children's affect toward mathematics through articulation of their own views about math-related situations. Since unfolding mechanisms or models behind parent-child interaction within the scope of math anxiety were placed at the core focus of the current study, complementing the study with qualitative data was thought to be useful. The way in which parents' affective and cognitive states about mathematics influence children's views on mathematics could be uncovered through qualitative data collection tools. Based on this objective, interviews with parents and children

were planned in the second section of the study. Control- value theory was considered to be useful in explaining all phases of the study as the theoretical framework.

The study has an additional feature in particular. The participant parents of the current study correspond to the participant students of the past study conducted about 30 years ago. More specifically, toward the end of the 80's, Erol (1989) conducted a study on math anxiety within the scope of its correlates and prevalence in high school level students in Turkey. Participant of the study was composed of high school students. Until today, about 30 years have passed and the participants of Erol's study in 1989 have grown to become the parents of today. Currently, if they have children, they must be at middle school, more or less the same age as the participants of the present study. Thus, participant parents of the current study approximately correspond to the participant students of Erol (1989)'s study. This case can be regarded as an opportunity to compare the change in math anxiety from the similar participants' eyes in two different time periods. Indeed, it seems unlikely to assess this process within the scope of an exactly longitudinal study yet it could be viewed to be a cross-sectional research in two distinct sessions. The present study is expected to contribute by examining today's children and their parents who are the same age as the participants of a past math anxiety study 30 years ago when they were children.

Math anxiety might display detrimental long term influences one's life, such as; determining career pathways. Individuals with high level of math anxiety appeared to choose non-STEM fields in their apprenticeship. Considering exceptional cases in which math-anxious participants even though they are in STEM groups, non-STEM group seems to have higher math anxiety levels compared to

STEM group (Johnston-Wilder, Brindly & Dent, 2014). In today's world and economy, it seems unlikely to create new technologies, to bring feasible solutions to current global problems or to produce policies for the future without having mathematical skills and thinking. It appears that affective issues might prevent many people from choosing math-related career pathways. This has a detrimental impact on the society. Not only the cognitive dimension, but also the affective aspect should be taken into consideration in math education.

It has been one of the main concerns of international studies comparing cognitive and affective math-related variables between countries. According to 2012 PISA results math anxiety is prevalent in many countries. The results showed that, when compared with the anxiety level of learners in 2003, math anxiety levels slightly increased across several countries in nine years. The following results were obtained in the report: (a) 59% of students often worry that math courses will be difficult for them, (b) 33% of students get tense when they are obliged to do math homework, (c) 31% of students get very nervous while engaging in math problems, (d) 30% of students feel helpless when doing math problems, (e) 61% of students worry about obtaining low grade in mathematics.

This study examines parent-child interaction by treating math anxiety as a phenomenon under the title of achievement emotions, as cited in the literature. Control-value theory of achievement emotions was chosen to be the theoretical background of the study in explaining both children's and parents' math anxiety as well as the interaction between them. The theory helped the study in terms of explaining parental influences on children through subjective control and value appraisals.

CHAPTER 2

REVIEW OF RELATED LITERATURE

2.1 General overview of math anxiety

Earliest studies on math anxiety were carried out at the beginning of 1950's. Gough's work in 1954 is considered as an initial attempt for the emergence of the concept of math anxiety. In the beginning of 50's, Gough, who was a classroom teacher, observed children's negative emotional reactions during their engagement of mathematical tasks in the classroom. In order to label the phenomenon of adverse reactions for mathematics, the term "mathemaphobia" was initially proposed (Gough, 1954). It refers to unfavorable and damaging feelings and thoughts spanning several settings while contacting with math-associated conditions. A few years later, Dreger and Aiken (1957) suggested the term "number anxiety" in their study on college students. A distinct variable distinguished from general anxiety that emerged as a consequence of confronting mathematics in daily life was mentioned. Dreger and Aiken's work included development of an instrument for the measurement of math anxiety, which is considered to be a first step in this issue. This phenomenon has been a topic of interest in advancing years as well. Richardson and Suinn (1972) offered the commonly accepted definition in upcoming decades. The feeling that disables people's proper use of mathematical processes including problem solving and doing calculations in daily life and school setting were coined "math anxiety" (Richardson & Suinn, 1972).

Math anxiety is generally modeled as a two-dimensional construct in the literature. Not only cognitive aspect but affective issues are also important in the examination of math anxiety. Wigfield and Meece (1988) determined two

fundamental components of math anxiety; worry component and emotional reaction component. It was a longitudinal study whose large sample was composed of students ranging from 6th to 12th grades. Worry component was characterized as concerns and ideas emerged as a result of cognitive processes while engaging with mathematical tasks. They were mainly associated with importance and effort one invests when faced with mathematical content. In the study, it was claimed that concerns about mathematics might be even useful in enhancing math achievement in terms of increasing value given to math. Emotional reaction component corresponds to nervousness, fear, unease and discomfort felt toward math-related situations. It was found that affective component was the mainly responsible part which has a detrimental impact on perceptions toward math performance as well as math ability, and expectancies. In the study, it was asserted that these two dimensions of math anxiety were not independently separated.

Math anxiety is a construct that can be inferred through certain signals exhibited by math-anxious individuals. One symptom, which can be observed in math anxious people, is avoidance of mathematics (Hendel & Davis, 1978). Learners with feeling of math anxiety tend to prefer refraining from interacting with mathematical tasks in various situations. These cases in which avoidance occurs vary in a wide span. A student's avoidance to being engaged in a mathematical activity in class, not taking math courses or not preferring to take term paper for mathematics might be considered to be example cases of avoidance. Similar to students, the situation in which parents refrain from helping their children in their math homework also might be an indicator of their math anxiety. Resistance to interaction with mathematics-containing cases might appear to be reactions triggered by math anxiety. Indicators for avoidance of math due to math anxiety might be observed in

career planning and determining one's own future profession as well. Math-anxious individuals might be constraining their career choices according to their affective state toward math. Individuals with high math anxiety incline toward abstaining from majors, which contain moderate or high mathematical skills or requirement (Lefevre, Kulak & Heymans, 1992). It might be important for math anxious individuals whether their targeted vocations require mathematical skills and processes.

Math anxiety is seen as the reaction to mathematical content itself, evaluative form of math tests and everyday math experiences (Erktin, Donmez & Ozel, 2006). Both in-school and out of school mathematical tasks might be anxiety evoking for some people. These mathematical activities are spread to a wide range. For instance, a child's negative emotional reactions to engagement in math-related activities, solving math problems, upcoming math exams or even only being in a math lesson is seen to be situations which might activate one's math anxiety in school setting. Also, fear of facing failure or getting a low grade in a math exam, avoiding to solve a math problem in the class, feeling tension while doing math homework can be counted as anxiety-promoting situations in the educational environment. Math anxiety might be evoked not only in school setting but also in daily life math-related experiences. Basically, doing four-operation calculations in daily use might be frustrating for some people. Also, for some parents, aiding their children for math homework at home can be considered to be problematic in terms of their affective states about math. In the long term, one's avoidance of a math-related future career is an example of a case in which math anxiety might play a significant role.

2.2 Correlates of math anxiety

Not only its definition and symptoms, but correlates of math anxiety have been one of the main concerns of researchers. One of them is the relationship between math anxiety and math achievement. There is a common agreement in math anxiety literature which reveals that math anxiety is negatively associated with math achievement (Hembree, 1990; Erktin et al, 2006; Devine, Fawcett, Szucs & Dowker, 2012; Radišić, Videnović and Baucal, 2015). To some extent, the variance in children's math achievement could be explained by their anxiety levels toward math. Although the measure of relationship between math anxiety and achievement varies with different samples and contexts, a common coefficient for the entire population was sought for through estimation in some studies. Ma (1999) examined 26 studies examining the relationship between anxiety toward math and mathematics achievement, which span children from middle school to high school level, in a meta-analytic approach. In this study, correlation coefficient found in each study was accepted as the effect measure. Using practical significance, an estimated correlation coefficient for the whole population was calculated. The correlation coefficient for the relationship between math anxiety and math achievement was found to be $-.27$, which was significant at $.01$ level (Ma, 1999). More specifically, through statistical procedures of effect size, the correlation coefficient for the math anxiety-math achievement was estimated to be $-.27$. In different cultural contexts, the result that math anxiety is related to math achievement in negative direction was supported as well (Ho et al., 2000). One's affective state toward mathematical content or situations has an influential role in math achievement.

Studies have been conducted to understand whether math anxiety is a developing or maintained construct depending on grade level. It is claimed that the

negative association between math anxiety and math achievement spreads to wide range of grade levels. There exist studies yielding the result that math anxiety might be adversely affecting math achievement of learners at varying grade levels; from higher education (Wahid, Yusof & Razak, 2014; Núñez-Peña, Suárez-Pellicioni & Bono, 2013) to middle grades (Birgin, Baloğlu, Çatlıoğlu & Gürbüz, 2010) and primary years (Wu, Amin, Barth, Malcarne and Menon, 2012). Without making comparison among them, it appears that math anxiety is influential in all grade levels. Research comparatively examining math anxiety-grade level association has been conducted in the literature as well. Significant differences in cognitive component of math anxiety were disclosed between grade levels (Wigfield and Meece, 1988). However, this was not a linear relationship. They revealed that 9th grade students were the highest math anxious group while the group which has a lowest math anxiety level was the 6th grade students. On the other hand, no effect of grade level on students' math anxiety levels with respect to its emotional reaction dimension existed.

The direct effect of math anxiety on math performance in primary years of the school has only been observed in grade 3, not in grade 2. Considering both intrinsic and extrinsic factors, such as; personal characteristics, parents' and teachers' attitudes, this might lead to idea that math anxiety is an evolving and growing phenomenon possibly due to accumulation of traumatic experiences in the field (Cargnelutti, Tomasetto & Passolunghi, 2017).

Directionality of anxiety-performance interaction also appears to be uncertain in various periods of school years. The impact of math anxiety, as a distinct variable from general anxiety, on math performance has been examined in early grades. In their longitudinal study from 2 to 3 graders, Cargnelutti et al. (2017) observed that

math anxiety and math performance appeared to have a relationship in which both impact each other, noting that it still needs further comprehensive studies on it.

Not only students' math anxiety level itself, the math anxiety – math achievement relationship regarding to grade levels remains a controversial issue in math anxiety literature. In Ma (1999)'s meta-analysis, it was concluded that the association between math anxiety and math achievement is independent of grade levels. More specifically, correlation coefficient seems to not significantly differ when grade level is concerned. It is important to investigate math anxiety in various grade levels in terms of understanding its development.

Several variables associated with math anxiety were studied. Akın and Kurbanoglu (2011) conducted a study revealing a model representing the interrelationship between math anxiety, math attitude and self-efficacy. The study yielded finding that math anxiety was negatively associated with math attitude and self-efficacy. The variables which might be accountable for the emergence of the math anxiety were examined in many studies. One of these crucial variables might be the teachers' own level of math anxiety. In their study, Beilock, Gunderson, Ramirez and Levine (2010) proposed that female teachers' math anxiety may negatively affects girls' math achievement, which might lead to promotion of math anxiety in children. Teachers' behaviors and the teaching methods employed during a math class might have an important influence on the development of children's math anxiety (Bekdemir, 2010).

2.3 Gender differences

Gender difference has been of concern in math anxiety literature. Gender issues within the scope of math anxiety still seem to remain uncertain. One encounters conflicting results on this issue. Gough (1954) was the first to notice that particularly female students displayed intense emotional responses to mathematical activities and appeared unable to achieve learning due to difficulties caused by math-related affect. Similarly, several studies finding that female students reported more anxiety toward math when compared to males' reports is present (Betz, 1978; Erktin et al., 2006; Erol, 1989). In their survey amongst apprentices, Johnston-Wilder and her colleagues (2014) showed that female participants tend to be more math-anxious in proportion to male ones. Gender-oriented point of view might have impact on girls' choice concerning to math courses and math-related careers (Gunderson, Ramirez, Levine & Beilock, 2012). In such studies gender was found to be a significant predictor of major or career choice. Females tended not to choose a career pathway that involved even a moderate amount of mathematics due to their predispositions toward math even though they were as skilled and experienced as males (Lefevre et al., 1992). On the other hand, no gender differences in math anxiety were found in some studies (Haynes, Mullins & Stein, 2004; Ma, 1999; Resnick, Viehe & Segal, 1982). In Wigfield and Meece's study (1988), contradictory results were found in two distinct dimensions of math anxiety. According to the results, it was evidenced that there existed a significant difference in emotional reaction component of math anxiety. Female students reported greater math anxiety compared to males. On the other hand, no gender difference was diagnosed in worry component of math anxiety. It means that both males and females were concerned about doing math well in a

similar ways while females felt more unease, discomfort and fear toward math than males. Thus, gender issue in math anxiety remains to be clarified.

Even teachers' math anxiety were not handled to be the actual focus of the study, it was indicated elsewhere that particularly female teachers' math anxiety had been found to be impactful in math achievement of female students through their traditional stereotyped gender beliefs related with math (Beilock et al., 2010). The stereotyped perspective that "Boys are better at math than girls", had been accepted by female students (not male ones) as the consequence of their female teachers' emphasis on gender beliefs about math.

2.4 Measurement of math anxiety

Many scales were developed for the purpose of quantifying math anxiety. The most commonly used tool to measure math anxiety levels of individuals was "Math Anxiety Rating Scale (MARS)" developed by Richardson and Suinn in 1972. It has 98 items aiming to measure anxiety through asking participants to respond to various math-related situations including daily use of math, math in academic setting and problem-solving skills. One of the scales used to assess math anxiety is "Math Anxiety Scale (MAS)" (Fennema & Sherman, 1976). Another test for practically measuring math anxiety is the shortened version of Math Anxiety Rating Scale (sMARS) developed by Alexander and Martray (1989). With the development of sMARS, the total number of items included in MARS was reduced to 25 items. MARS was adapted into scales aiming to assess both adolescents' math anxiety "MARS-A" (Suinn & Edwards, 1982) and elementary students' math anxiety "MARS-E" (Suinn, Taylor & Edwards, 1988). To measure math anxiety in Turkish

context as well, Baloglu and Balgalmıs (2010) developed Turkish version of MARS, with data that adapted version was found to be reliable and valid instrument for assessing elementary school students' math anxiety. Baloglu (2005) adapted original form of MARS and shortened version of Math Anxiety Rating Scale (2010) into Turkish. Ashcraft (2002) developed a scale called "Single Item Math Anxiety (SIMA)" and composed of only one item, which is; "On a scale from 1 to 10, how math anxious are you?" The validity and reliability analyses were conducted by Núñez-Peña, Guilera and Suárez-Pellicioni (2014). The results showed that SIMA was found to be a valid and reliable scale for assessing math anxiety.

The scale used in the present study is "Math Anxiety Scale (MANX)" (Erol, 1989). It has 45 math-related situational items in 4-point Likert format. Both student and adult versions of MANX for assessing parents' and children's math anxiety were used in the present study. The psychometric properties of MANX were tested (Erkintin et. al., 2006). Results were found to be parallel with the ones previously obtained during the development of MANX.

2.5 Parental involvement

Parental expectations and attitudes toward school and mathematics learning might be playing important roles in the development of their children's own views about mathematics. PISA 2012 results showed that parents working in math-related occupations or fields were likely to have more positive propositions toward math learning. Children of these types of parents might tend to demonstrate positive attitude towards mathematics courses, which may lead to decreased math anxiety in

children. In the report, a model indicating the role of the parents in school is presented in Table 1;

Table 1. The Role of Families in Education

Home Environment and Parental Behavior	Parental Circumstances	Parental Expectations and Dispositions
➤ Discussing how the child is doing at school ➤ Eating the main meal with the child ➤ Spending time just talking with the child ➤ Obtaining mathematics materials for the child ➤ Discussing with the child how mathematics can be applied to everyday life	➤ Whether the student's father or mother works in STEM occupations ➤ The student's father is in the labor market ➤ The student's mother is in the labor market ➤ Single-parent household	➤ Expecting that the child will work in ISCO major occupation 1 or 2 at age 30 ➤ Expecting the child to complete ISCED level 5A or 6 ➤ Expecting the child to go into a mathematics-related career ➤ Expecting the child to study mathematics after completing secondary school ➤ Agreeing that it is important to have good mathematics knowledge and skills in order to get any good job in today's world

The role of families in education (OECD (2013), *PISA 2012 Results: Ready to Learn: Students' Engagement, Drive and Self-Beliefs (Volume III)*, PISA, OECD Publishing., p.151)

The relevant part of the table above to the current study is particularly the first part, which is "Home environment and parental behavior". Since parent-child relationship might be responsible for the intergenerational transition of adverse feelings about mathematics, how this relationship might be taking place in home

environment and what parents' behavior might be anxiety-inducing while engaging with their children's school works are likely to be important. On the other hand, the framework handles home environment and parental behavior disregarding affective dimension of parent-child contact. In addition to the physical environment, the emotional atmosphere created at home might be triggering negative feelings about math on children. Statistically significant results possibly obtained from the present study might be a step for potential contribution to the current table in order to comprehensively handle parental role on children. Additional column titled "parents' emotion" or "parents' affect" might extend the table to more inclusive perspective. The roles of families can be extended to a more comprehensive point. Parents' affect, which are the focus of the present study namely; parents' math anxiety, subjective values and subjective control appraisals, could be more explanatory in understanding the impacts of parental roles on children's math anxiety and math performance. Emotional environment consciously or unconsciously created by parents at home is hypothesized to be influential in children's affect. Based on evidences obtained from the current study, parents' math anxiety and subjective appraisals could be the new additional column to be added to the table.

2.6 Parental involvement process in homework

Hoover-Dempsey and Sandler (1997) presented a linear model for parental involvement process. The model is handled from parents' perspectives and composed of five levels spanning from parents' decision to students' outcomes. These are; parent's basic involvement decision, parent's preferences for involvement types,

mechanisms in which student's outcomes are impacted, mediating variables and student's outcomes.

In the parents' fundamental involvement decision phase, parents decide whether they will be involved in their children's homework, influenced by three core reasons related with parent's beliefs; parental role construction, self-efficacy and perceptions of invitations to involvement. Firstly, parents seem to perceive the involvement in children's homework to be their typical parental responsibility. They believe that being engaged with their children's homework is necessary and beneficial as well as it contributes to their children's outcomes in a positive manner. Secondly, parents' thoughts on their own abilities and skills are likely to be influential in involvement decision. Parental self-efficacy beliefs appear to be a determining criterion in decision process from parents' views. Parents with high self-efficacy generally might tend to involve more in children's assignments at home (Hoover-Dempsey & Sandler, 1997). Third reason which plays an important role in the decision process is parents' perception related with social demands surrounding them. Both children and teachers general requests and expectations from parents appear to be impactful from parents' perspectives. Taken altogether, parents seem to become involved in their children's homework within the scope of their self-efficacy beliefs because they believe that they should be involved, and that teachers and their children demand it. These three factors function in additive form rather than a multiplicative way. Therefore, inexistence or low level of any reasons does not imply that parents decide to not being involved in children's homework (Hoover-Dempsey & Sandler, 1997).

In choosing involvement forms, parents' preferences are likely to be influenced by basically three reasons (Green, Walker, Hoover-Dempsey & Sandler, 2007; Hoover-Dempsey & Sandler, 1997). Initially, parents' beliefs about their own capabilities, knowledge and skills in a specific domain appear to be effective in undertaking involvement responsibility. Parents might tend to involve more in the field in which they feel themselves more knowledgeable and comfortable compared to other domains in which they perceive themselves to be less skilled and competent. Parents' skills and knowledge seem to differ from parental beliefs about efficacy. Holding a belief about having a specific knowledge and skill might not be implying that a person has that particular knowledge and skill. Individuals with similar levels of skills and knowledge may perform differently influenced by their efficacy beliefs related with a particular domain. Secondly, parents' decision of involvement might be dependent of the time and energy they perceive to invest in other daily compulsory activities other than their children's schooling. Parents who have occupations with compelling conditions or multi-child family seem to be unlikely to involve more in children's homework. Substantial amount of their time and energy is compulsorily allocated for fundamental livelihood duties. Teachers' and children's specific requests for involvement are considered to be the third factor which might be influential in parents' involvement forms. Invitation initiated by teachers and children for a specific kind of involvement activity might result in increased parental involvement and determine which form of involvement task will be employed by parents.

The third step of the model handles the mechanisms in which students' outcomes are affected. It might take place in three ways; modeling, reinforcement

and parental instruction (Hoover-Dempsey & Sandler, 1997). Bandura (as cited in Hoover-Dempsey et al., 2001) proposed definitions for these three constructs. Parents are generally seen as prominent figures by their children and learning might occur through children's observation of their parents' behaviors, called modeling. Reinforcement deals with occurrence and maintenance of behaviors considering its association with potential consequences. Instructions parents employed during homework help might be regarded as a mechanism for parent-child contact. Parent-child interaction might be vulnerable toward instructional methods used by parents within the scope of developing children's attitudes and behaviors. Among several types, making children focused on task, fragmenting the task into small understandable pieces, conveying a new information by explanation, elaborating the task by presenting examples from various disciplines and only responding to questions posed by children could be counted as instructional activities utilized by parents (Hoover-Dempsey et al., 2001).

In fourth level of the model, the role of variables indirectly influential in parental involvement process was proposed. Parents' employment of strategies appropriate for children's developmental stages, and accurate consistency between parental actions during involvement and school expectations may act as a mediating factor in involvement process (Hoover-Dempsey and Sandler, 1997).

The model is concluded by the examination of students' potential outcomes that are affected by parental involvement (Hoover-Dempsey et al., 2001). Children's achievement and affective variables might be included in students' outcomes. There exist controversial findings in the literature when involvement-achievement interaction is concerned. In their meta-analysis study, Patall, Cooper and Robinson

(2008) synthesized the parental involvement literature and indicated studies which found out both positive and negative effects of parental involvement during homework on achievement. Rather than directly influential in children achievement, parental involvement seems to be likely impactful on children's affective and proximal outcomes (Hoover-Dempsey et al., 2001). Parents might play crucial roles in children's formation of attitudes toward both homework and subject matter as well as perceptions of efficacy beliefs.

2.7 Intergenerational roles of parental math anxiety

Not only students but also adults seem to suffer from the fear of interaction with mathematical issues. Parents' own views on mathematics might have an influential role on upcoming generations that are potentially exposed to parents' emotional reactions to math-related situations. Adults are often considered to be significant figures for children. Their reactions to math-related tasks might be influencing children's views toward math and partially accountable for increased math anxiety in children. The underlying construct of these notions and feelings might be adults' math anxiety.

Parents' own level of math anxiety might play an influential role on students' math anxiety. In the literature, there exist important results obtained in different studies. In their study, Maloney et al. (2015) evidenced that parents' math anxiety might be conveyed to their children through particularly during homework assistance. Regardless of grade level, parents are likely to act in such a way that they consider their interaction with children to be an opportunity to transmit their own views on math to children. The study yielded several findings; (a) Independent of

parents' knowledge level, parents' math anxiety was found to be negatively correlated with students' math learning, specific to math achievement. (b) Parents' math anxiety may set a barrier for students' math learning, which, in turn, might lead to an increase in children's math anxiety. (c) Incompatibility between instructional methods employed by parents and teachers for the solution to problem might be partially responsible for potential confusion in children as well as the increase in their math anxiety level. (d) Poor math skills parents have and the use of limited instructional method might be held accountable for children's poor math learning.

Contrary to the opinions that parental involvement has generally positive influences on children, Maloney et al. (2015) showed that when parents are math anxious parental involvement could backfire. Parents' anxiety evoking statement and failures to promote children's positive views on math through talks in positive ways might be associated with undesired affective outcomes in children.

Parents are generally regarded as salient figures for children and likely to play influential roles in affective states of their children. It was asserted that fear may be transmitted to upcoming generations through parent-child interactions (Elliot & Thrash, 2004). Talking about negative experiences with mathematics in the past might cause children to develop negative dispositions toward mathematics. Children bring their feelings and thoughts previously shaped by their parents to the school. Taken altogether, these emotions formed in advance might set a barrier to mathematics learning in the future academic years.

Children begin their school life after a period in which they have many experiences with their families. This period is considered to be the initial social and emotional environment for the child. Many studies showing that the foundation of

children's certain cognitive and emotional development start during early years exist in the literature. The study conducted by Gunderson and Levine (2011) proposed that parental engagement in school life is very important in terms of particularly acquisition of early mathematical skills. There are studies showing that, when compared with students' own views on mathematics and teaching method employed in the classes, parental help plays statistically significant but minimal role on students' math anxiety from students' own perceptions (Birgin et al., 2010). Nevertheless, parental role at home in the literature remains unclear and needs more research.

The present study, in particular, deals with parental roles on children in terms of math anxiety. The existence and magnitude of the relationship between parents' and children's math anxiety levels, if found, need explanations concerning to the potential transfer of negative mathematical dispositions from parents to children. How the channel of interaction emerges and functions may be critical in understanding this relationship. In order to make sense of parent-child relationship within the scope of math anxiety from a theoretical perspective, control - value theory (Pekrun, 2006) is determined to be instrumental for the current study in explaining the relationship evidenced by both quantitative and qualitative data.

2.8 Control-value theory of achievement emotions

According to "control-value theory of achievement emotions", it is presumed that activation of achievement emotions heavily depends on appraisals of control and values. Basically, the theory suggests an explanation for the central role of control and value appraisals in arousals of both activity and outcome achievement emotions

experienced by children. Fundamental concepts of the framework are handled in detail as follows;

2.8.1 Definition of achievement emotions

Emotions aroused as consequences of either achievement activity or achievement outcome are characterized as achievement emotions. Depending on the focus, two types of achievement emotions are distinguished; activity emotions and outcome emotions. Emotions concerning a continuing activity related with achievement refer to activity emotions. Enjoyment during performance of an activity, boredom during a lesson presenting low cognitive demand or anger aroused during a highly cognitively demanding assignment can be assumed to be examples of this category. Emotions appeared in concern with outcomes of activities are called outcome emotions. Two types of outcome emotions are identified; prospective (before the occurrence of activity such as; hope and anxiety) and retrospective emotions (activating after occurrence of activity for instance; pride and shame).

2.8.2 Appraisals relevant to the theory

Appraisals are assumed to be significant determining factor in emergence of achievement emotions. Among many others, two important appraisals pertaining to achievement emotions are posited in the theory; (1) subjective control and (2) subjective values. The former implies one's sense of control or beliefs related with exerting influence over activity per se as well as its consequences (for example; holding that insistence on studying a high stake exam will result in an admission to a

good high school). Cause-effect relationships between one's cognition, activity and outcomes are explained, under subjective control, through two types; causal expectancies and causal attributions. One's anticipatory or forward-looking cognition concerning the relation between causes and its potential effects in the future are named causal expectancies (for instance, a student's solving past questions by expecting its future effect on the real exam). On the other hand, in spite of the similarities between causal expectations and causal attributions in terms of explaining cause-effect relations, they are distinguished at the point that causal attributions refer to one's backward cognition pertaining to relation between causes and already occurred effect (for example; causes of failure obtained from already taken exam in the past). As for subjective value, it is characterized as value and significance attached to an activity or outcomes. Further details about subjective control (a) and subjective value (b) are presented as follows:

(a) Subjective control

Causal expectancies of outcomes

“Situation-outcome expectancy” implies expecting situation to produce its own natural outcomes unless any external intervention by self (for either positive or negative outcome production) are carried out. More specifically, it refers to roles of outer factors over emergence of outcome. For instance, admission to the high school one desires is unlikely if required effort is not invested. From children's academic achievement perspectives, situation outcome expectancies are high for failure while it is low for success.

Action-control expectancy means one's expectations that actions can be triggered and carried out. Production and performance of actions can be controlled under high action-control expectancies. A child's anticipatory thoughts pertaining to initiating the action to study for an upcoming exam could be considered under action-control expectancy. On the other hand, action-outcome expectancy refers to one's expectations that actions will have an influence on either production of positive outcomes or repulsion of negative outcomes, for instance; a student's expectations that s/he will get a high grade over an upcoming exam. Expectancies pertaining to effort invested in initiation and performance of an action corresponds to action-control outcome while expectancies that an action will eventually result in occurrence of success refer to action-outcome expectancies.

Total-outcome expectancy implies the cumulative expectancies which are established either on situation-outcome expectancy or action-control and action-outcome expectancies, or both. For example, in failure situations, if no effort is invested then failure becomes inevitable, which means situation-outcome expectancy is high. Additionally, if a student expects that s/he can put no effort in studying for an upcoming exam, then low action-control expectancy exists. Believing that studying is not the only cause for success but other variables also play a role in obtaining a good grade, then in such a situation, low action-outcome expectancy is predominant. Overall expectancies which are based on situation-outcome, action-control and action-outcome expectancies are posited to be total-outcome expectancies. Overall expectancies one holds are assumed to be important determinants of one's own controllability and potential favorable outcomes.

Causal attributions of outcomes

Causal attributions of outcomes are defined as one's retroactive cognition pertaining to association between causes and already occurred effect. Achievement or failure attributions are considered to be one of the central correlates of perceived controllability. Appraisals of causes of an already experienced effect can be attributed to either internal or external factors. Internal attributions correspond to action-control and action-outcome expectancies while external attributions are equivalent to situation-outcome expectancies.

(b) Subjective values

Subjective values imply perceived valences and importance given to an action or outcome either intrinsically or extrinsically. Attaching value to an activity or outcome independent of its acquisitions refers to intrinsic values. Extrinsic values can be posited to be valences dedicated to an activity or outcome taking its usefulness and attainments into consideration. Solving math problems only for its own sake might be of intrinsically valued situation. However, studying for a math exam to be praised by parents indicates instrumental usefulness of action, implying extrinsic values.

2.8.3 Math anxiety as an academic emotion

The control-value theory of achievement emotions relies on the main idea that achievement emotions are determined based on various antecedent appraisals. Appraisals of subjective control and subjective values seem to be significant

determinants of achievement emotions. To the theory, math anxiety is handled as a prospective outcome emotion. The key concept for prospective emotions is uncertainty. Ambiguity pertaining to the future outcomes is assumed to be an important dimension of emergence of prospective achievement emotions. The theory claims that prospective outcome emotions appear only if both expectancy and value exist at the same time. Subjective values are essential to the induction of all prospective outcome emotions. The theory posits that math anxiety emerges when individual's focus is on failure and partial lack of control exists. In brief, three prerequisites are needed for the instigation of math anxiety; moderate or low level of control, high level of subjective values and focus on failure.

2.8.4 Social and cultural antecedents of math anxiety

The theory suggests that social and cultural antecedents are assumed to be crucial determinants of achievement emotions, through being influential over individuals' appraisals of subjective control and subjective values. Perception of social environment might be associated with one's control and value appraisals. Among several dimensions, "achievement-related expectancies of others" and "induction of values" seems to be salient ones. This part of the theory seemed to be highly relevant to the current study in terms of explanations for potential influences of social factors over students. In the study, students' math anxiety was primary variable to be dealt with due to its high correlation with math achievement. Math anxiety was examined to be a phenomenon under achievement emotions. It was mainly aimed at explaining students' math anxiety through their own subjective and value appraisals. The theory suggests explanations related with the roles of significant figures surrounding

students in their subjective value and control appraisals. Parents were assumed to be the primary prominent figures in the current study. Parents' views on math as a field and its importance, their students' math performance, capabilities might play significant roles on students' values and control appraisals, which determine the academic emotion they experience.

Personal and social antecedents are important in emergence of emotions in academic settings. Boehme, Goetz and Preckel (2017), conducted an empirical study examining the role of students' subjective control and value cognitions combined with their mothers' valuing of math over predicting the instigation of test anxiety in students from the perspective of control – value theory. It was evidenced that low level of subjective control together with highly valuing to the achievement outcome or failure result in increased test anxiety. Among students with high level of subjective valences toward math, the ones with lower academic subjective control tend to have increased test anxiety scores compared to the ones with higher control levels. On the other hand, students with high level of subjective control failed to display any correlation with test anxiety, regardless of their subjective value levels. Familial valences attached to math was found to be associated with test anxiety in two pathways; directly and indirectly. Direct impact of family values to math upon test anxiety was found to be positive. That means, students whose parents assign greater value to math are appeared to be more test-anxious. However, indirect familial valuation impact on test anxiety is two-way. Parents' high level of subjective value leads to increased test anxiety through intensifying students' subjective valences. Secondly, low level of test anxiety result from increased parental subjective value by the way of its enhancement of students' subjective control over math. The total impact of familial valuation of math shows a reducing effect on test

anxiety due to its two controversial indirect impacts on test anxiety and stronger roles of control appraisals over value cognitions. Its indirect impacts besides, a direct effect of parental valuation on test anxiety in positive direction was evidenced in the same study. Highly promoted expectations related to school setting, triggered by familial valuation, create a burden which hinders students' performance.

2.9 The rationale of the study

2.9.1 Rationale for phase I

Math anxiety seems to be not only in the past but also currently a common and prevalent issue. Many studies are being conducted in order to explain this phenomenon. One purpose of the present study is to determine the current level of both students' and parents' math anxiety levels.

Students' math achievement, students' math anxiety, parents' math anxiety students' subjective control and value appraisals, and parents' subjective control and value appraisals are the variables which are at the focus of the study. This study intends to clarify how students' math achievement and anxiety can be explained by parents' math anxiety and subjective appraisals. The examination of the interaction between parents' and children's math anxiety might be helpful in preventing potential adverse impacts of parents' involvement on students' performance and anxiety.

Contrary to the intuition that parents' involvement in students' schoolwork promotes students' academic achievement, empirical evidences seem to be inadequate to reach this conclusion (Fan & Chen, 2001). Some parent-child contact might result in undesired outcomes, which is a case particular to mathematics

(Maloney et al., 2015). Math-anxious parents might exhibit anxiety-inducing actions influential on children's affects toward mathematics through the articulation of their own views about math-related situations. The present study deals with the examination of the role of parental involvement on students' math anxiety and math achievement. Based on the evidence obtained from the current study, certain guidelines relating with the roles of parents in their involvement process may be proposed.

According to the control – value theory of achievement emotions, emotions experienced in academic settings are basically determined by their antecedents called subjective appraisals. One of the aims of the study is to reveal the relationship between both parents' and students' subjective appraisals and, students' math anxiety and math performance. Knowing about the relationship between subjective appraisals and math anxiety will help to explain the formation of students' own math anxiety and roles of parents' subjective appraisals on student' math anxiety.

2.9.2 Rationale for phase II

Numerical values obtained from quantitative analyses might fail to clarify the underlying mechanisms in a relationship. In order to unfold the relationship between parents' and children's math anxiety levels, both children's and parents' thoughts on math-related affect, more tools were needed in the study. Interviews, as data collection tools, were chosen to reveal parents' and children's math-related views. The interaction between children and parents in terms of math anxiety could be observed through exclusive interviews. The objective of decoding possible pathways functioning behind parent-child interaction with respect to math anxiety is posited at

the vital portion of the current study. The main purpose of the second section is to clarify the dynamic mechanisms functioning behind parent-child contact pertaining to math anxiety.

Parental involvement is seen to be crucial for understanding parent-child interaction with respect to math anxiety. Since parent-child relationship might be responsible for the intergenerational transition of adverse feelings about mathematics, how this relationship might be taking place and what parents' views might be anxiety-inducing while engaging with their children's school works are likely to be important. The second phase of the study enabled to collect qualitative data concerning parental involvement, which helped the study to make sense of the parent-child interaction.

Math-related affective issues from both children's and parents' perspectives as well as the interrelations between them are of the focus of the current study. Clarification of dynamic mechanisms functioning behind parent-child contact pertaining to math anxiety is counted among the main objectives of this study as well. In recent studies, it seems likely to encounter the examination of math anxiety as a phenomenon embedded into achievement emotions, where framework for explaining antecedents and impacts of achievement emotions emerged in academic settings is described (Pekrun, 2006). In the second phase, it was aimed at examining the interaction between parent-child contact with respect to subjective appraisals and math anxiety. The patterns of interaction between parents and children were sought for in order to explain the relationship between them through control-value theory, which fits into the data collected. Control-value theory (Pekrun, 2006) is the theoretical background of the qualitative section.

2.10 The purpose of the study

The main objective of the present study is to investigate the role of the parents in their children's math anxiety levels that are closely associated with their math achievement. The study aims to investigate whether parents' math anxiety levels have influential roles on their children's math anxiety or how parents' math anxiety is related to their children's math anxiety and math achievement. These are the significant points this study intends to highlight.

Based on this objective, the following research questions were formulated;

Research Questions

1. What are the levels of middle school students' math anxiety, their parents' math anxiety, students' achievement, students' and parents' subjective control and value appraisals?
2. Are there any gender differences in math anxiety among students?
3. Is there any relationship between students' math anxiety, parents' math anxiety, students' achievement, students' subjective appraisals and parents' appraisals?
4. How much of the variance in students' math achievement can be explained by math anxiety, parents' involvement and subjective appraisals?
5. How much of the variance in students' math anxiety can be explained by the math achievement, parents' involvement and subjective appraisals?
6. How do parents' views on mathematics and their involvement play roles in students' views on mathematics, their math anxiety and math performance?

CHAPTER 3

METHOD

3.1 Variables and operational definitions

The ultimate goal of math education is to enhance and promote students' math performance. The current study, in particular, deals with parental roles on students' math-related anxiety and performance. Identifying the patterns of interaction between parents' and children's anxiety and performance as well as how this interaction influences students' anxiety and performance is posited at the focus of the study. In order to explain these relationships and its pathways behind, control – value theory of achievement emotions was considered, which posits that one's academic emotions are determined by subjective and value appraisals. In this section, students' and parents' math anxiety, math performance, subjective control appraisals and parental involvement will be operationally defined.

Students' math anxiety

In order to measure students' math anxiety, “Math Anxiety Scale (MANX)” (Erol, 1989) was administered to students.

Students' subjective appraisals

Participant students were asked how they perceived themselves in terms of subjective control about math. Students' subjective appraisals were determined through the

items addressing to their self-efficacy beliefs / subjective control; the former one requesting them to give their perceptions about how they like math in general and they were expected to score from 1 to 5, and the latter question in which students were requested to rank their views on how they see themselves in terms of math abilities ranging from 1 to 5 in order to assess their appraisals of controllability over math. Overall scores for control appraisals were assessed out of 10.

Parents' math anxiety

In order to assess parents' math anxiety, Math Anxiety Scale for Adults (MANX for adults) was used in the present study.

Parents' subjective appraisals

In the same manner as students, identical questions were addressed to participant parents as well. Two questions pertaining to parents' controllability about math; the first one asking how they generally like math and the other one addressing their cognitions related with their math abilities and competencies were included in the scale. In both questions, parents were requested to score their subjective appraisals from 1 to 5. Total math-related subjective control appraisals were calculated over 10.

Students' math achievement

For measuring students' math achievement, both 7th and 8th grade students' end-of-the-year mathematics report card scores were considered to be operational definition

for students' math performance. Also, National Standardized Exam (named as "TEOG", which stands for Transition from Primary Education to Secondary Education) scores of 8th grade students were obtained.

Eight grade students were tested by a national standardized exam with two phases for transition to secondary education. Within the scope of the exam, a set of questions for each six courses (Turkish, Mathematics, Religion and Ethic, Science, History, and English) for each semester is centrally administered by Ministry of Education. Weighted scores of all grades in middle school years were calculated for every student. Based on this score, students were allowed to choose a high school. Their placement to high schools in the country is determined by depending on their scores on this test.

Parental involvement

Parents' involvement is the other salient variable of the current study. Understanding parent-child interaction from the perspective of math anxiety requires the collection of both quantitative and qualitative data. Through this objective, two questions were asked to parents. "How often are you engaged in your children's math homework?" enables us to measure the frequency of parental engagement in children's homework, which is also used in Maloney (2015)'s study. The second question "When your child asks you for help in his/her homework, what would be the sentence that you make most frequently?" provides us with information about parents' response types.

3.2 Design of the study

The present study is mainly designed based on two core phases; Part 1, where the quantitative data was analyzed and Part 2, where the interviews were analyzed. The first section includes the collection of data from both students and parents through scales which will be handled in detail in the next parts. Math anxiety levels of students and parents were determined and the relationships between students' math anxiety, parents' math anxiety and students' achievements were examined as well. In the second part, interviews with parents and children were conducted.

3.2.1 Phase I: Data collection

Three terms were often used in the study. To clarify the terms used in the present study, the term parent is defined as the primary caregiver for students. Even though mothers (62%) and fathers (26%) are predominant participants of the study, there are other people participating in the study such as elder brothers (3%) and sisters (8%). Parent does not imply to only either mother or father. In the current study, the term children and students are interchangeably used depending on the context in which they are mentioned. If it is in school-related context, then the term students is used, while the context is relevant to their families, then the term children is used by referring to their familial roles.

Participants

335 (44% male and 56% female) students and their parents were selected as the sample of the study from a public school in Istanbul. The researcher is currently working as a full-time teacher in the research school. Thus, determination of the

school is based on convenient sampling techniques. The sample of the study is composed of 7th (41%) and 8th (59%) grade students. They generally come from a socioeconomically disadvantaged region, having middle to low socioeconomic status. It is evidenced by Teacher Appointment Regulation of the Ministry of Education. Based on teacher shortage, geographic location, socioeconomic status and transportation opportunities, Turkey is divided into three service regions from 1 to 3 with increasing compelling circumstances. Also, all schools are divided into six service fields according to their difficulty of working conditions for service teachers. Schools having favorable conditions fall under group 1, while schools which have more challenging and tough circumstances are included in group 6. In group 4, 5 and 6 service fields, the teachers are required to serve as compulsory public service. Taking into account of all these, the sample school is characterized as belonging to second service region and sixth service field. That is, the school offers highly challenging conditions for teachers. Hence, the participants with low socioeconomic status constitute the sample of the study. Also, supportive descriptive data for socioeconomic states of participant will be presented in the subsequent parts.

In the present study, the term parent refers to family members who primarily and generally help students in their school work. Even though the large proportion of participant adults is composed of mothers and fathers, there might exist a minority group of students whose primary caregivers are not their mothers and fathers. Participant parents include mother, father, elder brother and sister or another person. The results showed that nearly 90% of participants are mothers (62%) and fathers (26%). About 10% is elder brother and sister while only four participants are neither of them, namely; other person. 87% of participants are married.

In the study, parents were asked for their educational status. Table 2 displays their educational levels.

Table 2. Parents' Educational Statuses

	Frequency	Percent
Primary School	146	43.8
Middle School	95	28.5
High School	64	19.2
Undergraduate	26	7.8
Graduate	2	0.6
Total	333	100

As far as the income levels of parents are concerned, the study aims to obtain information about how participants perceive themselves in terms of economic conditions instead of their exact income. It was found that 77% of participants saw themselves at the middle level and 18% of them considered themselves to be at the low level of economic conditions. It can be said that profiles of participant parents comes from middle to low socioeconomic status from their own perspectives. The total number of children in the family is important demographic information. Only 4% of the parents had a single child in the family while others have more than one child in the family.

Instruments

Mathematics anxiety scale for students (MANX for Students)

In order to measure children's math anxiety, "Math Anxiety Scale (MANX)" (Erol, 1989) was administered to students. The original version of instrument consists of 45 math-related situational items with four point Likert format; 1 (never), 2

(sometimes), 3 (very often), 4 (always). The total anxiety scores of students range from 45 (minimum) to 180 (maximum). As the scores increase children's math anxiety also increase. In the study in which MANX had been developed, alpha coefficient of .91 was found. The psychometric properties of MANX were tested (Erktin et. al., 2006). Results found to be parallel with the ones previously obtained during the development of MANX. In the study, alpha coefficient for that sample was calculated as .92. Lastly, in the current research, alpha coefficient of .92 was found.

Questionnaire for Students

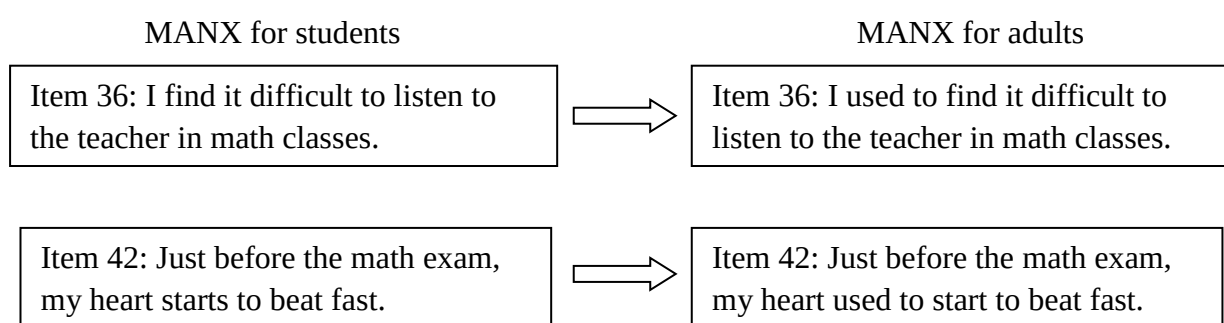
Eight items for obtaining information about children's demographics, subjective appraisals and home environments were included in the questionnaire.

The first three questions aim to get information about participant children's gender, grade levels and mathematics grades in their last report cards. These questions helped us to make comparisons among children's math anxiety levels by gender and grade level and look for correlation between their math anxiety scores and math grades. Participant students were asked how they perceived themselves in terms of self-efficacy beliefs, which corresponds to subjective control appraisals toward math. Students' subjective appraisals were determined through the two items addressing to subjective control; first one requesting them to give their perceptions about how they like math and they were expected to score from 1 to 5 and second item in which students were requested to rank their views on how they see themselves in terms of math abilities and competencies ranging from 1 to 5 in order to assess their appraisals of controllability over math. The remaining two questions

were “When needed, who generally helps your math homework in your family?” and “Do you have a separate study room that you can conveniently do your homework at home?” for obtaining information about students’ home environment.

Math Anxiety Scale for Adults (MANX for Adults)

In order to assess parents’ math anxiety, Math Anxiety Scale for Adults (MANX for adults) was used in the present study. The scale was derived from Math Anxiety Scale for Students by making modifications in each item. To clarify the justification for changes in the items, the parents were asked to respond to given math-related situational items by thinking about their own school years. The items of MANX for students are in the present tense. The items of MANX for adults referred to their school years. Therefore, it was necessary to make certain changes in the items’ tense. On the other hand, any modifications in situations or contents of the items were strictly avoided. Examples for converting items of MANX for students into adult version are presented as follows;



Since the only change was made in items’ tense, MANX for adults also has 45 math-related situational items. Hence, possible maximum and minimum scores, four point Likert type format remained as it is. High score out of the scale also refers

to high math anxiety level. In the present study, alpha coefficient for MANX for adults was found to be .93.

Questionnaire for Parents

This part is composed of the questions related with parents' demographic information, subjective control appraisals and home environments. The first seven questions pertain to information for parents' gender, closeness degree to the participant student, marital status, educational status, occupation, income status and number of children in family. In the same manner as students, identical questions were addressed to participant parents as well. Two questions pertaining to parents' self-efficacy beliefs regarding to math, referring to subjective control appraisals within the perspective of Control-Value Theory, were included in the scale. In both questions, parents were requested to score their subjective control appraisals from 1 to 5. One of the main purposes of the current study is to examine the role of parental involvement and the characteristics of parent-child contact within the scope of math anxiety. From this perspective, last two questions of demographic questionnaire, in particular, are needed to be evaluated separately. One of the questions, which is; "How often are you engaged in your children's math homework?" enables us to measure parental engagement in children's homework. The last question "When your child asks you for help in his/her homework, what would be the sentence that you make most frequently?" provides us with information about parents' response types.

Procedure

Initially, necessary legal/official permission was obtained from “Esenler District Governorship” and “Ethics Committee Approval” was received before conducting the study. Math anxiety scales for both students and parents were distributed to students in the school. Many other teachers working at the school were asked for the help for this step of the study. Scales were given to students by either the researcher or via other teachers. As soon as scales were distributed, all students were asked to write their school number on both scales so that child-parent matching could be practically achieved. Students were requested to complete “MANX (for students)” and ask their parents to fill out “MANX (for parents)”. Students were told that they were expected to help their parents in the case of any assistance about the scale.

Analysis

For investigating the research questions, descriptive and correlational statistical tools and qualitative research methods were utilized. Descriptive analyses were used to determine students’ and parents’ math anxiety levels, students’ math achievement, parental involvement, students’ and parents’ subjective control appraisals for the first research question. For looking for the mean difference between gender groups in terms of math anxiety, one-way analysis of variance was run in question 2. In order to understand parent-child contact in terms of math anxiety from quantitative perspective, in question 3, correlation analysis was employed. Similarly, with the purpose of analyzing relationship between math anxiety and its correlates, namely; math achievement, parental involvement and subjective appraisals, correlation analyses were carried out for the same research question. In order to determine the

variables accounted for the variance in students' math anxiety and math achievement, in question 4 and 5 regression analyses were utilized. Qualitative analyses were also conducted in the study. Last research question aims at revealing and comprehending parental roles on children's affect through semi-structured interviews.

3.2.2 Phase II: Collection of interview data

In the first section, parents' and children's math anxiety levels as well as their relations to children's math achievement, parents' involvement and subjective appraisals were determined. One of the aims of this study is to examine parent-child contact within the perspective of math anxiety. Related literature shows that parents might be playing an influential role in generation of their children's math anxiety through parental involvement (Maloney, 2015). Parents' own views on mathematics might be putting stress on children. In addition to the existence of interrelationships between the variables, how these relationships occur also becomes important. In order to unfold the interaction between parents' and children' math anxiety, after quantitative data collection part, parents and children were interviewed in the second section of the study. Data from the interviews were to help deeply understand the ways, models or mechanisms in which parent-child interaction takes place with respect to math anxiety.

Participants

Based on the results obtained from the data from the scales, students were ranked according to their math anxiety levels from highest to lowest. By this way, students with highest math anxiety scores were determined. Participants of the second section of the study consist of math-anxious students and their parents. Parents in the interviews were mostly the parents who filled out the scale in the previous phase of the study. During each interview, the researcher, the student and the parent were present. Interview questions were directed to both students and parents. A strict order was not followed in asking questions. 12 interviews with 7 male and 5 female students were done. Among the participant parents, there were eight mothers, three fathers and one elder brother.

Instruments

18 interview questions were developed based on both the literature and the data obtained from the interviews used in the initial step of the study. Questions were grouped based on the purposes which they intended to measure. Demographic information, anxiety, subjective value appraisals, subjective control appraisals and parental involvement were the themes of the interview questions. Interviews were planned in a semi-structured format. The themes and sources that were utilized while developing questions are presented in the Appendix.

Procedure

Before the interviews

All communication information of parents (phone numbers) was reached through the school administration. Every parent in the sample was invited to school for the interview. A suitable room was arranged in the school. The room was arranged in such a way that no interruption was allowed during the interviews.

During the interviews

Since the interviews were planned in a semi-structured format, small off-topic talk was allowed in order to create an anxiety-free environment as well as to establish rapport with the interviewees. Questions were asked in an informal manner. All interviews were recorded. For the purpose of precluding any manipulation of parents' thoughts, expressing our own opinions during the interviews was avoided. The main objective was to purely reveal parents and students' views on mathematics. Each interview lasted about 20-30 min on average.

Analysis

There are two fundamental sorts of qualitative research; participant observation and in-depth interviewing (Bogdan & Biklen, 1997). In the present study, in-depth interviewing type in which participants can flexibly express their own position on the subject through open-ended questions which are not strictly designed, was utilized as a qualitative data collection tool.

Braun & Clarke's study (2006) was followed as the reference point in analyzing qualitative data. Utilizing thematic coding, the qualitative data obtained from the interviews were analyzed. All twelve interviews were audio-recorded and then transcribed. After several reading of each interview, initial primitive notions were written down. As the next step, initial codes were assigned to the data and then first themes were generated. The coding process was repeated several times. After reviewing themes, implying that the theme-code association should be checked, a thematic map was produced for the purpose of making sense the narrative data. At this step, nine themes have emerged out of the data. Before reporting the data, the nine themes were finally refined and reduced to five main themes based on the relevance to the research questions. Eventually, final extracts which reflect the focus point of the study were selected and reported in the paper.

CHAPTER 4

RESULTS

The current study was essentially organized in two phases. The first phase involves the data collection process from 335 students and their parents. The last phase includes the interviews in which most anxious twelve students determined based on the results gained from the phase 2 where their parents were present at the same time.

In the consecutive result section divided into two main bodies; where, in chapter 4.1, the results obtained from the analysis of the data out of 335 students and their parents in Phase I were investigated; in chapter 4.2, analysis of the data obtained from the interviews with the most anxious students and their parents are presented.

4.1 Analysis of quantitative data

In this part, first, descriptive statistics on achievement, math anxiety, parental involvement and self-efficacy/subjective control appraisals are reported. Afterwards, analysis regarding to the testing of the research questions pertaining to the relationship between anxiety, achievement, parents' involvement and control appraisals are displayed.

4.1.1 Descriptive statistics for the variables

Achievement

In the present study, students' math achievement was operationally defined in three ways; math grades in students' last report cards, mean test scores in school and

standardized exam scores (only for the eighth graders). Students' were requested to give their math grades in their last report cards. The results concerning students' math grades in their last report cards showed that 75% of them had 3, 4 or 5 out of five in math. The mean score for their math test scores administrated by their teachers in the school was found to be 64.25 ($SD = 16.89$) out of 100. The mean score for the nation-wide standardized exam for eight graders was calculated to be 42.99 ($SD = 22.55$) out of 100, as indicated in Table 3 as well.

Table 3. The Mean Scores for Students' Achievement

	N	Mean	Std. Deviation
Math Grade	314	3.26	1.16
Mean Test Scores	320	64.25	16.89
Standardized Exam	180	42.99	22.55

Math anxiety

First research question, "What are the levels of middle school students' math anxiety, their parents' math anxiety, students' achievement, students' and parents' subjective control and value appraisals?" were tested through descriptive statistics.

MANX for students and MANX for parents were administered to participants. Math anxiety scores of each participant were calculated. Descriptive statistics for both students' and parents' math anxiety was conducted. Mean score for math anxiety was found to be 92.96 ($SD = 22.06$) for students and 89.27 ($SD = 21.46$) for parents, as also illustrated in Table 4.

Table 4. Students' and Parents' Math Anxiety Scores

	N	Minimum	Maximum	Mean	Std. Deviation
Students' Math Anxiety	335	49	162	92.96	22.06
Parents' Math Anxiety	335	45	169	89.27	21.46

Parents' involvement

Parents' involvement was investigated by asking both parents and students about home education environment including parent-child interaction concerning homework. Students were asked who generally helps in their homework at home. Approximately 25 % of students reported that their mothers and fathers provide assistance to their homework while about 45% stated that they ask their elder brother and sister for help for their homework. One notable result about homework help, 30% of the children stated that they request help from other sources for their math homework. This source can possibly be their neighbors, a private institutions or a tutor. Almost 85% of the students indicated that they have a suitable study environment at home.

Parents were asked how often they took care of their children's math homework. Nearly 40% of participants reported that they were never or rarely interested in their children's math homework. 40% of them stated that they sometimes get engaged in their children's homework. Only 20% of parents indicated that they often or always paid attention to their children's math homework. Participants were also asked to answer the question "How do you respond to your children when they asked you for help?" The results are shown in Table 5;

Table 5. Parents' Response Types

	Frequency	Percent
Let's do together	124	40.8
You should do by yourself	99	32.6
You should ask to more knowledgeable person	81	26.6
Total	304	100

Subjective control appraisals

Questions aiming to obtain views about children's and parents' math related affects; more specifically, self-efficacy beliefs corresponding to subjective control appraisals posited in control-value theory were very important in terms of understanding the emergence of math anxiety as well as the parental roles on development of children's math anxiety.

Participant students were asked how they perceived themselves in terms of self-efficacy/subjective control appraisals about math. Students' subjective control appraisals were determined through two items; former one requesting them to give their perceptions about how they like math and they were expected to score from 1 (very bad) to 5 (very good) and the latter question addressing to subjective control again, in which students were requested to rank their views on how they see themselves in terms of math abilities and competencies ranging from 1 to 5 in order to assess their appraisals of controllability over math. Mean values obtained from students' subjective control appraisals were presented in Table 6.

Table 6. Students' Subjective Control Appraisals

	N	Minimum	Maximum	Mean
How do you like math in general?	334	1	5	3.42
Please score your math ability level from 1 to 5	330	1	5	3.22

Additionally, percents related with students' subjective control appraisals might be more informative about the sample. As far as subjective control is concerned out of the first question, only 10% of students report low level of control (1 and 2) to math. The remaining 90% of them stated medium or high level of control concerning to math. It might mean that the participant students perceive themselves to have rather increased controllability about math. The case seems to be similar in students' perceptions about subjective control appraisals in the second question as well. Solely 17% of students evaluate themselves to have lack of abilities and competencies in math. It might be interpreted in such a way that students have medium level of control about their own capabilities concerning math.

In the same manner as students, identical questions were addressed to participant parents as well. Two questions, in which, one item pertaining to how parents' like math and the other one addressing their cognitions concerning to how much they evaluate themselves in terms of math abilities and competencies, were included in the scale. In both questions, parents were requested to score their subjective control appraisals from 1 to 5. Results are shown in Table 7.

Table 7. Parents' Subjective Appraisals

	N	Minimum	Maximum	Mean
How do you like math in general?	334	1	5	3.24
Please score your math ability level from 1 to 5	323	1	5	3.13

The percentage of parents who state low level of control toward math was revealed to be 14%, including 2 and 1 out of 5 in the first question. Assuming that holding medium level of subjective control implies a positive result, the participant parents can be thought to perceive themselves to have high level of subjective controllability toward math. However, when it is compared to children's subjective control scores, it seems that parents give rather lower subjective controllability toward math. As far as, subjective control is concerned in the second item as well, the situation appears to be the same. 22% of parents think that they appraise themselves to have lack of math abilities and competencies. The portion which believes to have lack of subjective control is larger in parents, in proportion to children. Nevertheless, 78% of parents see themselves to be medium or high level of math competent, corresponding to their subjective control appraisals according to the second question.

Total scores for both students' and parents' subjective control appraisals, calculated by the sum of each participant's score given to these two questions, are demonstrated in Table 8:

Table 8. Total Scores for Students' and Parents' Subjective Control Appraisals

	N	Mean	Std. Deviation
Students' Subjective Control	329	6.63	1.74
Parents' Subjective Control	322	6.37	1.61

4.1.2 Correlations

Students' math anxiety and gender

With the purpose of testing the second research question "Are there any gender differences in math anxiety among students?" one-way ANOVA was conducted.

No statistically significant difference was found between boys ($M = 91.56$, $SD = .23$) and girls ($M = 94.04$, $SD = .20$) in terms of math anxiety as determined by one-way ANOVA, $F(1,333) = 1.043$, $p = .30$.

In the following part, the analysis regarding the research question "Is there any relationship between students' math anxiety, parents' math anxiety, students' achievement, students' subjective appraisals and parents' appraisals?" are presented.

Students' and parents' math anxiety

Results showed that children's and parents' math anxiety levels were significantly and positively correlated, $r = .45$, $p < .01$. Students whose parents are math anxious

tend to display more math anxiety compared to the ones whose parents have rather lower math anxiety.

Math anxiety and math achievement

The research question “What is the relationship between students’ achievement and parents’ math anxiety levels?” was tested and the result obtained were presented in this part.

In this study, TEOG (a central examination for 8th grade across the country) scores and mathematics grades of students in school are taken as the operational definition of mathematics achievement. Students’ mathematics grades refer to their mean scores of math exams for both first and second semesters as well as their math grades in last school reports. Indeed, students’ school marks are available for all of them while TEOG points are present only for 8th graders. The relationships of students’ achievement scores with both parents’ and students’ math anxiety levels were analyzed.

Students’ school grade scores was found to be significantly correlated with their own math anxiety levels, $r = -.45$, $p < .01$ and their parents’ math anxiety scores, $r = -.17$, $p < .01$, in negative direction. Similarly, students’ standardized exam scores have significant negative correlation with their math anxiety levels, $r = -.49$, $p < .01$ and their parents’ math anxiety scores, $r = -.20$, $p < .01$. Highly math anxious students seemed to have lower grades in math. Students having math anxious parents rather tend to have lower math grades.

Parental involvement

Parental involvement plays a significant role in potential intergenerational transition of math anxiety from parents to students. Quantitative analysis of parent-child contact, through testing the research question “What is the relationship between parental involvement, math anxiety and math achievement?” was presented as follows;

Results indicated that parents’ involvement score was calculated to be significantly correlated with parents’ own math anxiety, $r = -.25$, $p < .01$, and students’ math anxiety, $r = -.13$, $p < .05$, in an adverse way for both. However, no correlation was found when it was correlated with students’ math achievement. Parents involving in their children’s school works less frequent are appeared to be rather more math anxious ones. Despite of significant but weak relationship between parental involvement and students’ math anxiety, it can be said that students whose parents are more frequently involved in their school works seemed to feel rather low math anxiety.

The relationship between parental anxiety and control appraisals were examined. Parents’ involvement was correlated with students’ subjective control appraisals, no relationship was found. On the other hand, significant correlation was calculated between parents’ involvement and parents’ own subjective control appraisals, $r = .28$, $p < .01$. It refers to that parents who report high level of control appraisals tend to be more frequently involved in students’ school works.

Subjective control appraisals

Self-efficacy beliefs / subjective control appraisals seemed to play crucial impacts in both emergence of math anxiety in an individual and the parent-child interaction with respect to math anxiety. For the purpose of understanding its roles, the correlation between control appraisals and other variables in the present study; namely, math anxiety, achievement and involvement was analyzed.

Students

Negative significant correlation between students' subjective control appraisals and their math anxiety score was calculated, $r = -.61$, $p < .01$. Students with high math anxiety consider themselves less competent and skilled in math-related settings, referring to controllability about math.

Students' subjective appraisals and parents' math anxiety score were correlated. There was a low but significant negative relationship between parents' math anxiety and students' subjective control, $r = -.22$, $p < .01$.

Results yielded that students' subjective control appraisals were found to be significantly correlated with both their math grades in school exams and standardized exam scores. Results showed that there exists a strong and significant correlation between subjective control appraisals and math grade, $r = .58$, $p < .01$, and standardized exam score, $r = .57$, $p < .01$. Students feeling higher level of controllability about math appeared to be more successful in the discipline.

Parents

A significant negative correlation between parents' subjective control appraisals and their own math anxiety, $r = -.36$, $p < .01$, were reported in the results. It implies that among parents, math anxiety was appeared to be instigated in the ones feeling lack of control over math.

When parents' subjective control appraisals were correlated with students' math anxiety, Small but significant negative correlation was reported in the results, $r = -.11$, $p < .05$, meaning that students' whose parents perceive themselves to be less math-skilled tend to be more math anxious.

Parents' subjective control appraisals were correlated with students' math grades and standardized exam scores. No correlation has been observed between these two variables.

Students' and parents' subjective control appraisal were correlated. A significant correlation in a positive direction was calculated, $r = .18$, $p < .01$. More specifically, parents' and students' control appraisals were calculated to be positively and more strongly associated with each other to a more significant extent. This shows that students have higher controllability about math when their parents report more subjective control. It implies that students perceiving to have higher level of controllability are rather the ones whose parents feel increased subjective control over math. Table 9 displays overall correlation between all the variables dealt with in the present study.

Table 9. Correlations between all variables

	Ach.	Students' Anxiety	Parents' Anxiety	Parents' Inv.	Students' Control	Parents' Control
Ach.	1	-.45**	-.17**	.05	.58**	.08
Students' Anxiety		1	.45**	-.13*	-.61**	-.11*
Parents' Anxiety			1	-.25**	-.22**	-.36**
Parents' Inv.				1	.10	.28**
Students' Control					1	.18**
Parents' Control						1

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

4.1.3 Regressions

In this section, the research questions 4 and 5; which are “(4) How much of the variance in students’ math achievement can be explained by math anxiety, parents’ involvement and subjective appraisals?” and “(5) How much of the variance in students’ math anxiety can be explained by the math achievement, parents’ involvement and subjective appraisals?” were answered through regression analyses. Before conducting regressions, the first step must be to check whether the assumptions are violated.

Assumptions

As the main idea in research, sample statistics are utilized to estimate the population parameters. It often seems to access the entire population in a research thus; the data collected from the sample is used for making certain estimations and inferences concerning population with an error rate as small as possible. In general, linear models are helpful in predicting a phenomenon (called “dependent or outcome variable”) based on the variables (called “independent or predictor variables”) with an error rate. The variation in data is generally fitted into a linear model in explaining a phenomenon through least square method. On the other hand, for the unbiased conclusions, certain assumptions are required to be checked. If certain prerequisites are not met in a statistical process, then the results concluded are unreliable (Field, 2013). Similarly, in regression analyses, certain assumptions are to be satisfied before conducting all analyses. In case of violation of any assumptions, the analyses conducted means that biased conclusions are drawn. Assumptions of linearity, normality, multicollinearity and homoscedasticity were checked in the present study whether there exists any violations or not.

Two regression analyses were conducted in the study. Firstly, students’ math anxiety is chosen to be the dependent variable. The independent variables or predictors are students’ and parents’ math anxiety, parents’ involvement, students’ and parents’ subjective controls. In the second regression model, students’ math anxiety was aimed to be predicted by their achievement, parents’ math anxiety, parents’ involvement, students’ and parents’ subjective controls.

Linearity

The linearity assumption implies that the predicted variable must be in a linear relationship with all of the predictor variables. In the current study, the linearity assumption can be checked via visual illustrations using scatter plots, as shown in Figure 1, 2, 3, 4 and 5.

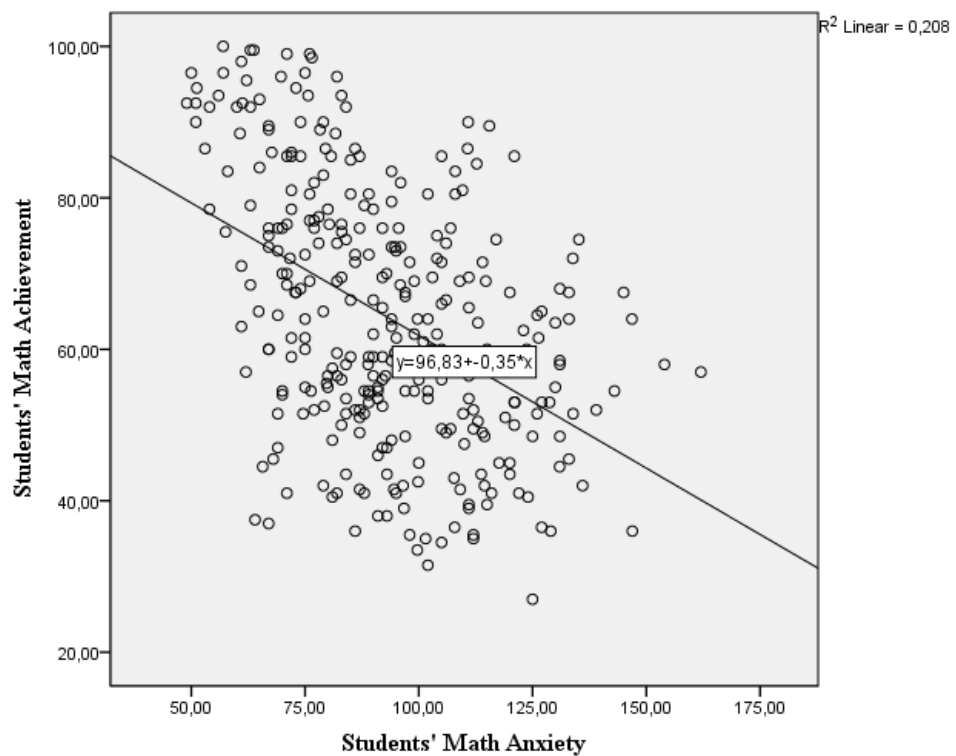


Figure 1. Scatter plot displaying achievement-students' math anxiety relationship

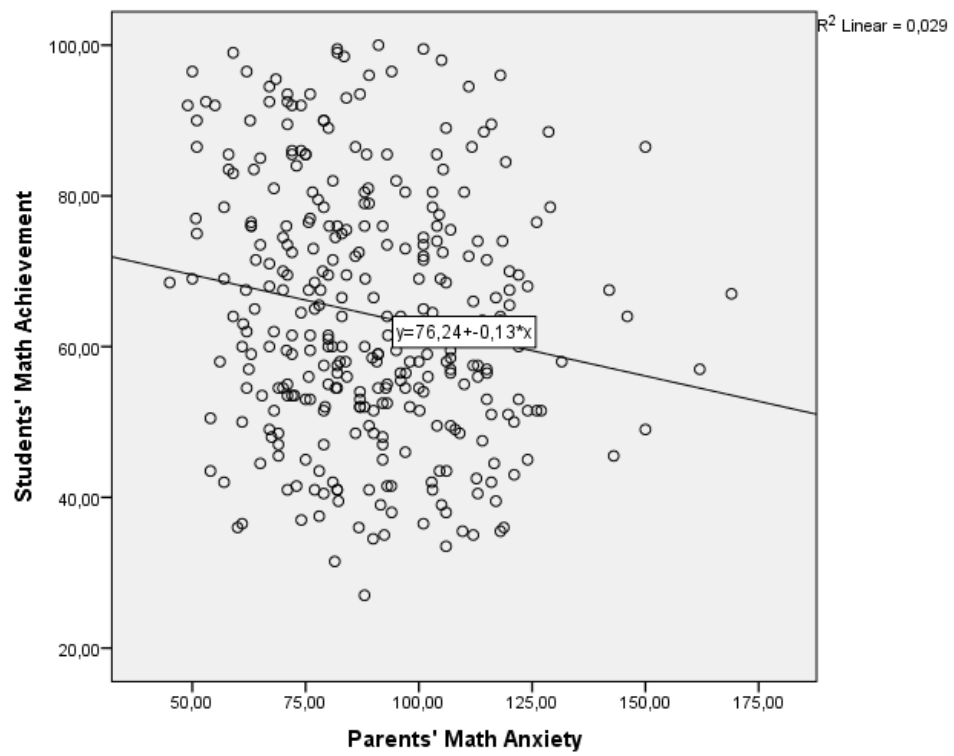


Figure 2. Scatter plot displaying achievement – parents' math anxiety relationship

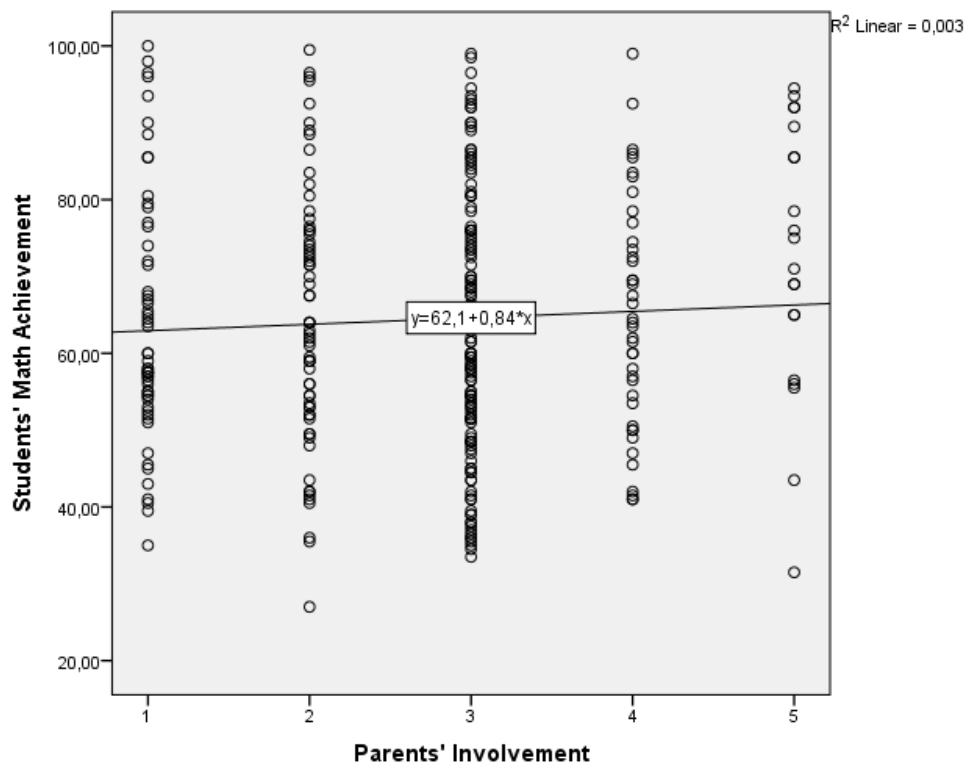


Figure 3. Scatter plot displaying achievement – involvement relationship

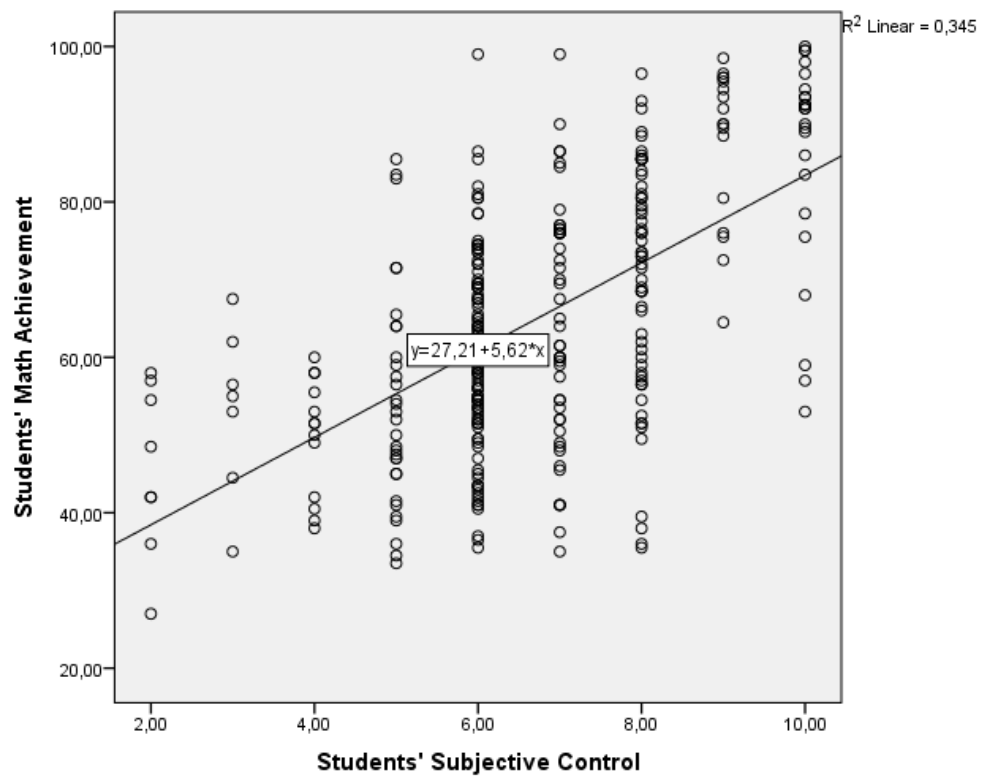


Figure 4. Scatter plot displaying achievement – students' subjective control relationship

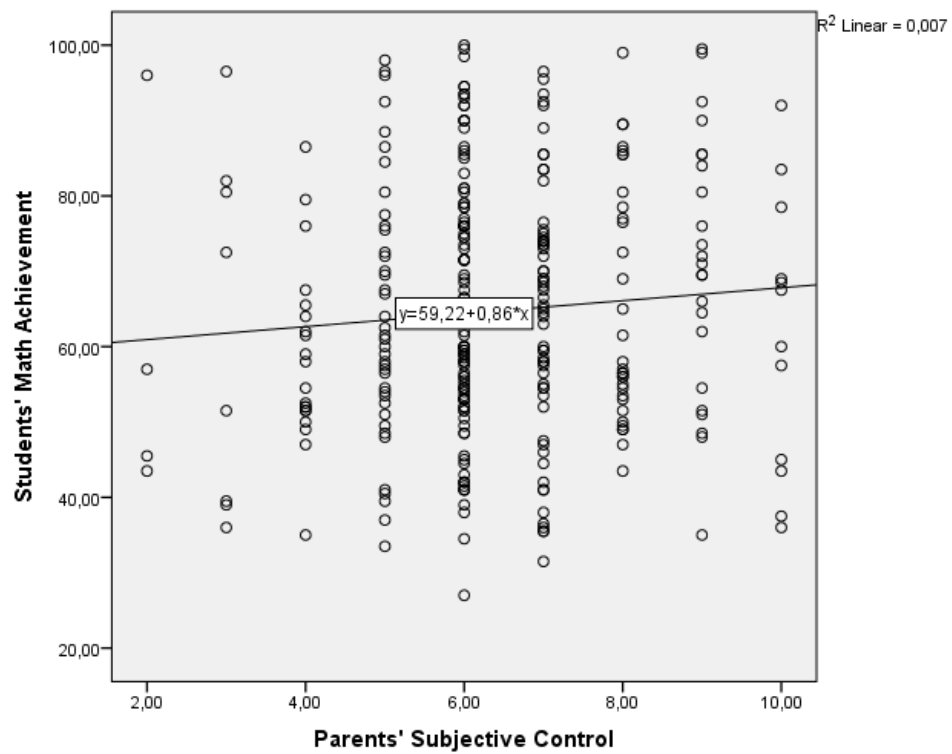


Figure 5. Scatter plot displaying achievement – parents' subjective control relationship

Scatter plots showed that the outcome variable has a linear relationship between all of the predictor variables. No case was observed concerning the violations of linearity assumption.

Normality

In contrary to the notion that the sampling data must be normally distributed in order to make unbiased conclusions out of sample statistics, Field (2013) asserts that the normality assumption might refer to different senses in different context. He advocates that the data collected from the sample does not have to distribute normally in every cases. According to the central limit theorem, population parameters will display a normal distribution if sample is large enough (Field, 2013). Parameter estimates for the entire population will approach to a normal distribution as the sample size gets larger. The estimate for population parameter is to be made out of sample statistics calculated over a sample which is big enough. As far as the sample size of the current study is concerned, it seems to be large enough for it to be normally distributed. Nevertheless, histograms related with the variables dealt with in the study are shown in order to test the assumption of normality. These are the variables; students' math achievement, students' math anxiety, parents' math anxiety, parents' involvement, students' subjective control and parents' subjective control, as indicated in Figure 6, 7, 8, 9, 10, 11.

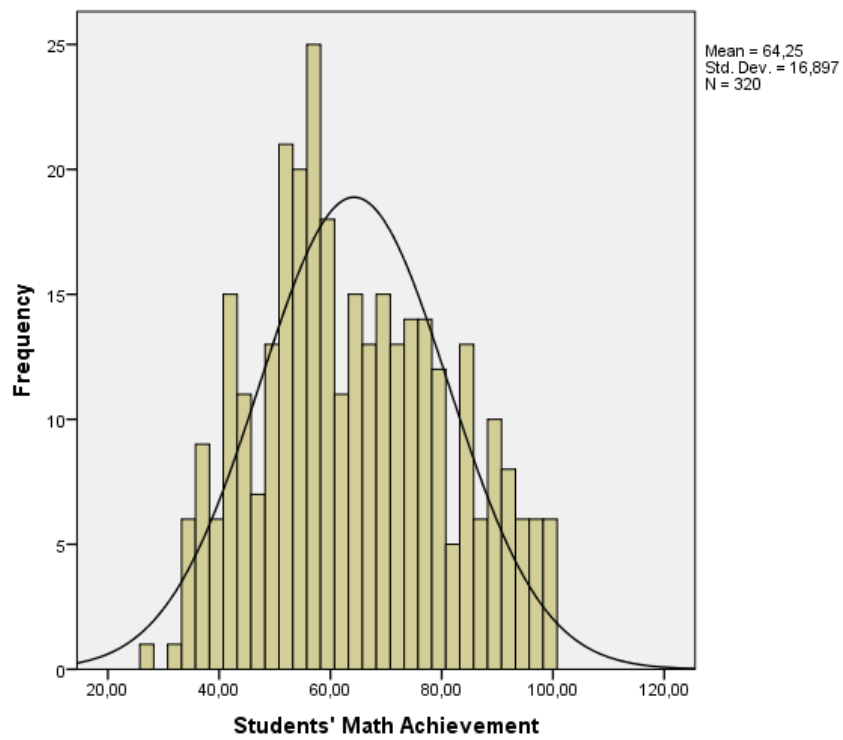


Figure 6. Distribution of students' math achievement

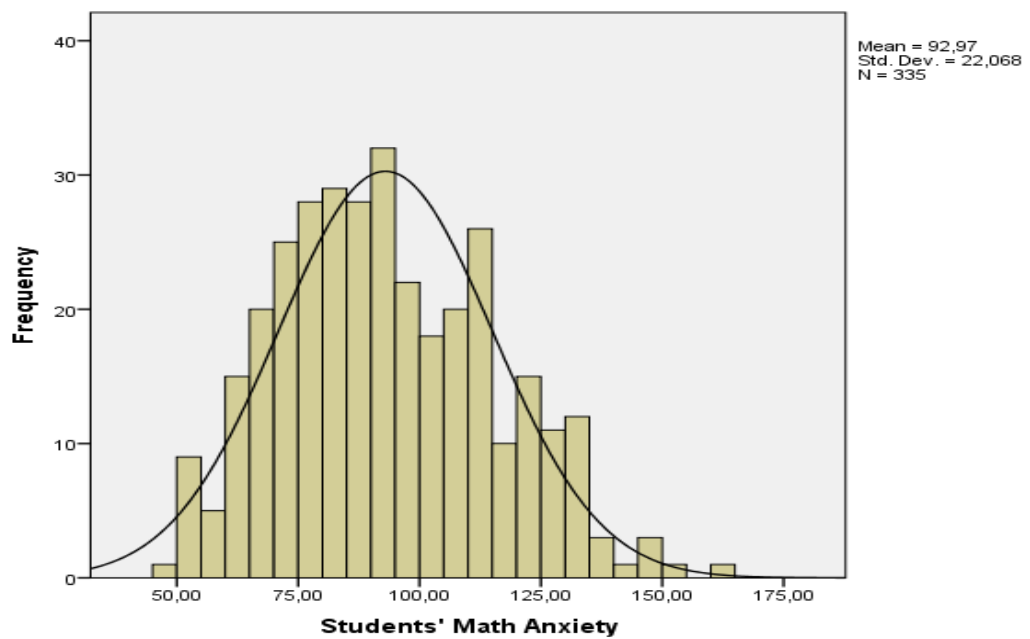


Figure 7. Distribution of students' math anxiety

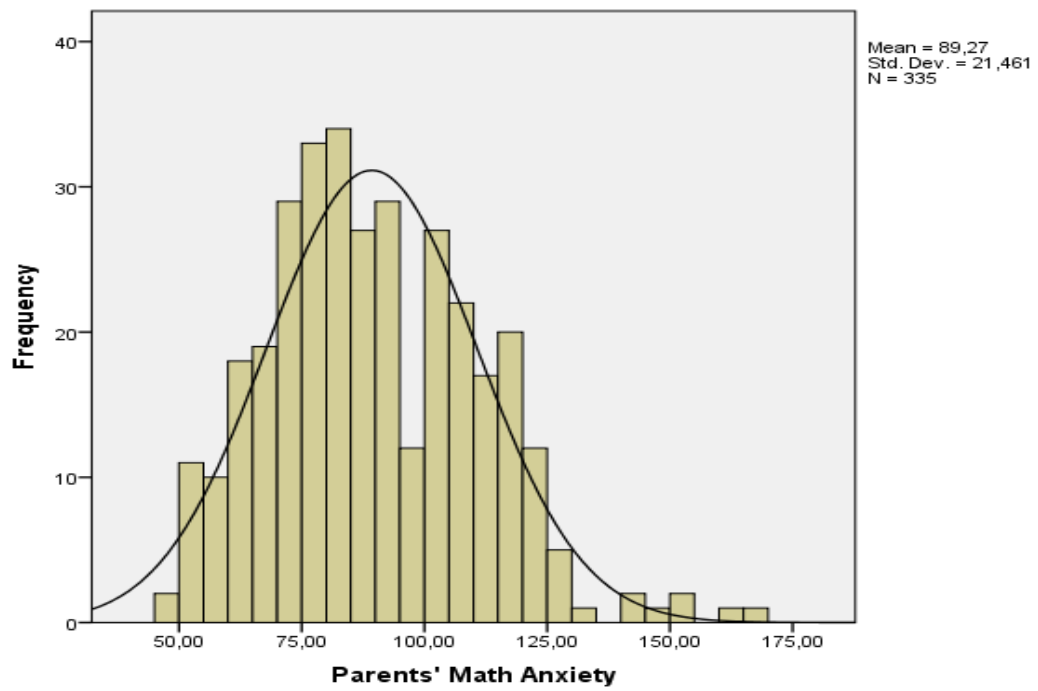


Figure 8. Distribution of parents' math anxiety

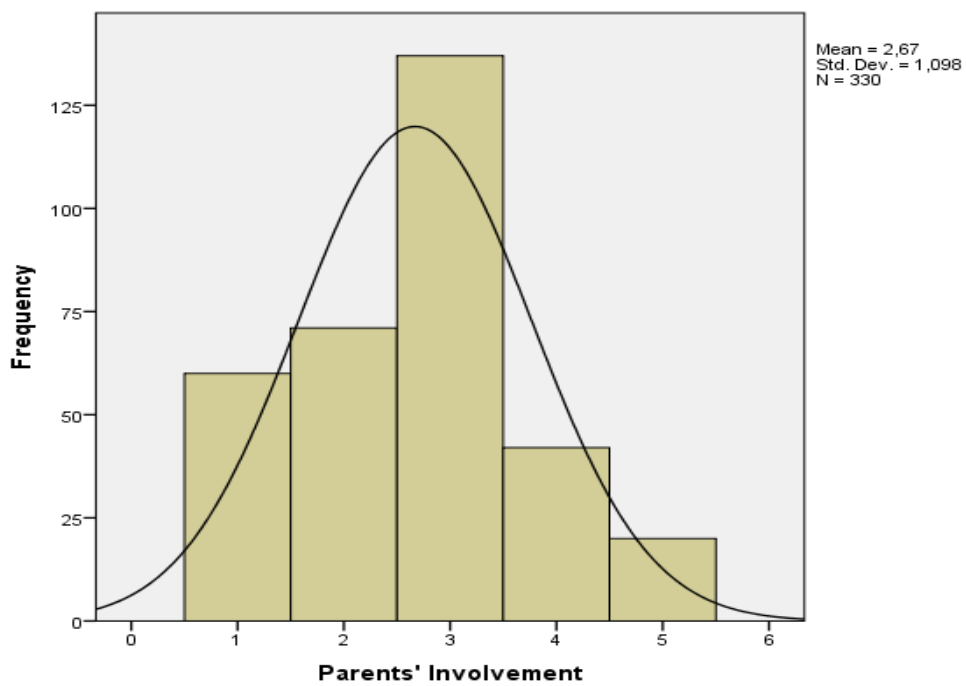


Figure 9. Distribution of parents' involvement

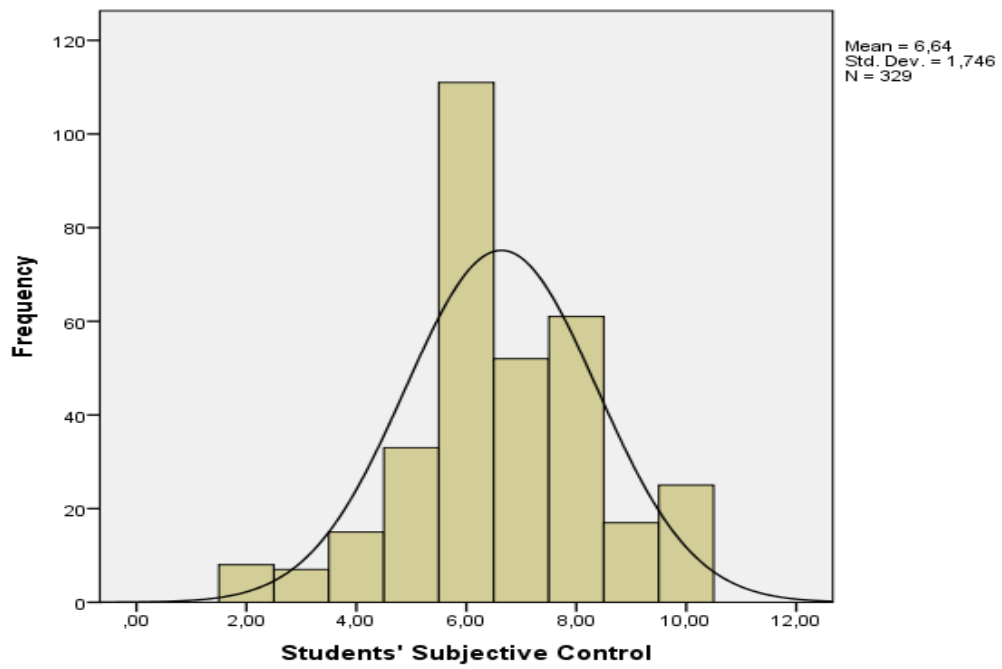


Figure 10. Distribution of students' subjective control

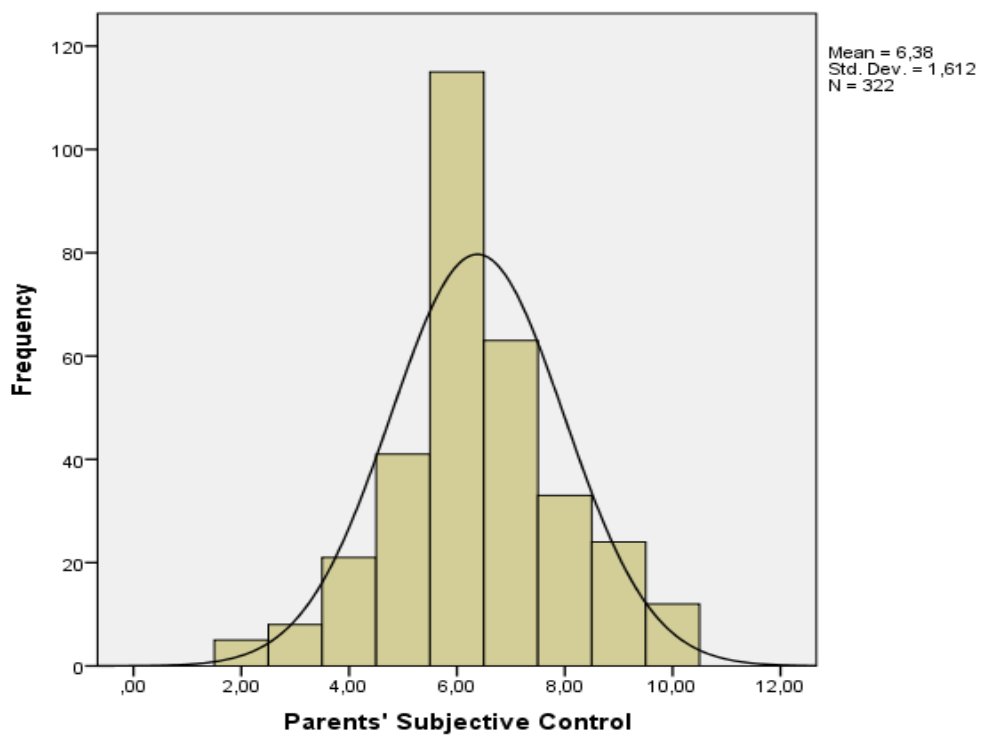


Figure 11. Distribution of parents' subjective control

As seen from the figures, sample statistics for all of the variables showed a normal distribution. Testing normality assumptions result in no violation for estimating population parameters through regression analyses even though there is

no need for normality assumption check for large enough sample in the present study (Field, 2013).

Multicollinearity

In predicting the population parameters for the dependent variable, there must be no high correlation between predictor variables (Field, 2013). In explaining the variance in the dependent variable explained by the variance in predictors, independence of predicting variables is required for the accurate estimation of parameters. In order to check any violation in multicollinearity, Variance Inflation Factors (VIF) as a tool of SPSS is utilized. In the current study, first regression analysis considers students' math anxiety, parents' math anxiety, parents' involvement, students' subjective control and parents' subjective control to be predicting variables for students' math achievement. Table 10 shows VIF values for independent variables.

Table 10. VIF values for the independent variables

Model	Collinearity Statistics	
	Tolerance	VIF
1		
Students' Anxiety	.52	1.91
Parents' Anxiety	.67	1.47
Parents' Involvement	.89	1.12
Students' Subjective Control	.62	1.61
Parents' Subjective Control	.80	1.24

a. Dependent Variable: Students' Achievement

According to the table, VIF values for testing multicollinearity assumption are regarded as the existence of no violation for conducting a regression analysis based on the evaluation; 1 means no correlation, 1 to 5 implies moderate correlation and more than 5 refers to severe level of correlation between independent variables. In other words, the independent variables are not highly correlated so that it affects confidence interval and significance testing of population parameters.

Homoscedasticity

Homoscedasticity assumption refers to the similar variance for each predictor variables in a regression model (Field, 2013). The variance of residuals in all independent variables must be similar. This assumption can be tested through visual examination of residual plot, standardized errors (residuals) by predicted value of dependent variable. Figure 12 illustrates residuals by predicted values.

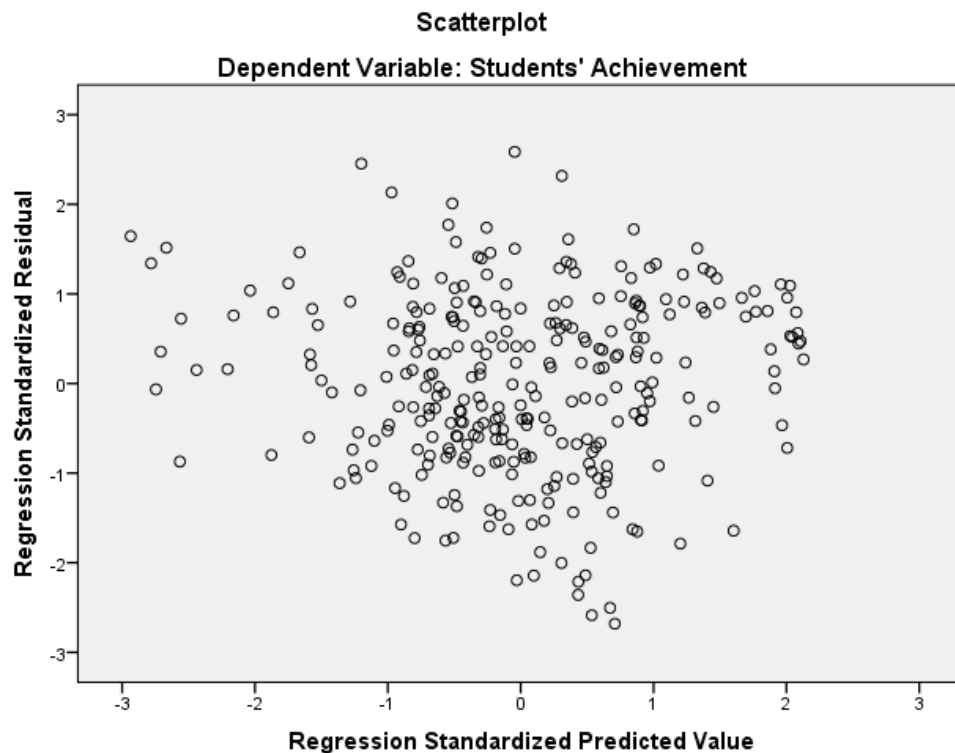


Figure 12. Scatter plot displaying the spread of residuals

As it can be seen from visual representation, scatter plot of standardized residuals by standardized predicted values showed a homoscedastic distribution, which implies no matter for conducting regression analysis (Osborne & Waters, 2002).

Analyses of all assumptions for the regression indicated that there exists no obstacle for conducting it. All prerequisites for a regression model have been met.

Achievement

Linear regression analysis was utilized to determine whether students' math achievement can be predicted by math anxiety, parental involvement and control appraisals. In this analysis, students' math grades in school exams were chosen instead of national standardized exam scores since it was available for all the participant students while standardized exam scores were present only for eighth graders. The regression results indicated that two of potential predictor variables, namely; students' math anxiety and students' subjective control appraisals explained 36.3% of the variance ($R^2 = .36$, $F(2,298) = 86.50$, $p < .001$). It was reported that subjective control appraisals significantly predicted math achievement ($B = .48$, $p < .001$) while students' math anxiety predicted achievement ($B = -.18$, $p < .01$) to a significant extent. Results obtained from regression model for prediction of students' achievement are demonstrated in Table 11 and 12;

Table 11. Model Summary for Predicting Students' Math Achievement

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.589 ^a	.34	.34	13.54
2	.606 ^b	.36	.36	13.36

a. Predictors: (Constant), Students' subjective control

b. Predictors: (Constant), Students' subjective control, Students' anxiety

Table 12. Coefficients for Predicting Students' Math Achievement

Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	27.11	3.08		8.78	.000
	Students' Subjective Control	5.67	.45	.58	12.61	.000
	(Constant)	46.40	6.99		6.63	.000
2	Students' Subjective Control	4.65	.55	.48	8.37	.000
	Students' Anxiety	-.13	.04	-.17	-3.06	.002
	(Constant)					

a. Dependent Variable: Students' achievement

Students' math anxiety

The initial result, math achievement can be significantly predicted by students' subjective control appraisals and their math anxiety, obtained from the first regression led to the investigation of predicting variables of students math anxiety.

For this purpose, in the second regression, students' math anxiety was chosen to be the dependent variable. Independent variables of the second regression were students' math achievement, parental math anxiety, parental involvement and control appraisals. It was found that, among independent variables, 48.2% of the variance in students' math anxiety can be explained by parents' anxiety, control appraisals of both and achievement ($R^2 = .48$, $F(4,296)=70.80$, $p < .001$). The results showed that students' anxiety can be predicted by parents' math anxiety ($B = .35$, $p < .001$), achievement ($B = -.14$, $p < .01$), students control ($B = -.45$, $p < .001$) and parents' control ($B = .10$, $p < .05$). Models offered and their coefficient tables were presented in Table 13 and 14;

Table 13. Model Summary for Predicting Students' Math Anxiety

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.602 ^a	.36	.36	17.54
2	.682 ^b	.46	.46	16.09
3	.692 ^c	.47	.47	15.90
4	.699 ^d	.48	.48	15.78

a. Predictors: (Constant), Students' Subjective Control

b. Predictors: (Constant), Students' Subjective Control, Parents' Anxiety

c. Predictors: (Constant), Students' Subjective Control, Parents' Anxiety, Students' Achievement

d. Predictors: (Constant), Students' Subjective Control, Parents' Anxiety, Students' Achievement, Parents' Subjective Control

Table 14. Coefficients for Predicting Students' Math Anxiety

		Coefficients ^a			t	Sig.
Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta		
1	(Constant)	143.11	3.99		35.82	.000
	Students' Subjective Control	-7.59	.58	-.60	-13.02	.000
2	(Constant)	106.56	6.06		17.56	.000
	Students' Subjective Control	-6.58	.55	-.52	-11.94	.000
	Parents' Anxiety	.33	.04	.33	7.55	.000
3	(Constant)	112.69	6.36		17.71	.000
	Students' Subjective Control	-5.49	.66	-.43	-8.28	.000
	Parents' Anxiety	.32	.04	.32	7.46	.000
	Students' Achievement	-.19	.06	-.14	-2.87	.004
4	(Constant)	100.80	8.06		12.50	.000
	Students' Subjective Control	-5.67	.66	-.45	-8.56	.000
	Parents' Anxiety	.36	.04	.35	7.88	.000
	Students' Achievement	-.18	.06	-.14	-2.75	.006
	Parents' Subjective Control	1.43	.60	.10	2.37	.018

a. Dependent Variable: Students' Anxiety

4.2 Analysis of interview data

This part consists of the analysis of the research question “How do parents’ views on mathematics and their involvement play roles in students’ views on mathematics, their math anxiety and math performance? Interviews were transcribed. The qualitative data were coded several times. Out of codes, five themes emerged; students’ math anxiety, parents’ math anxiety, students’ subjective appraisals, parents’ subjective appraisals and parental influences.

4.2.1 Theme 1 – Children’s math anxiety

Interview results showed that math anxiety is currently a prevalent phenomenon. Many children have adverse feelings toward math-related situations. These quantitative findings were supported by the qualitative results. Participant children articulated their unfavorable thoughts and feelings about math in the interviews. Children’s statements in the interviews were consistent with the self-report measures administrated in the present study. It was concluded that the targeted phenomenon was successfully measured. It seemed likely to observe various symptoms of math anxiety in the interviews. Math anxiety appears in different situations. One might experience it in the classroom.

“...Sometimes, I feel embarrassed when raising my hand for a question in class because I fear that I won’t be able to give the right answer...”

The point that differentiates math anxiety from other negative feeling in this situation is that the child avoids participating in the lesson through raising her hand only in math classes, not in others.

This negative feeling toward math might emerge before or during an exam. One of the interview questions aimed at whether children had any negative feelings peculiar to math in the standardized exam called TEOG. Children reported their feeling of tension specific to math in the exam.

“...After Turkish exam was finished, just before the math exam, I felt myself anxious about whether I would be successful or not in math. I was very comfortable in other courses’ exams but I felt discomfort before the math exam. I feel anxious before every math exam. I had twenty minutes left for seven of eight questions remaining but unfortunately due to that anxiety, I could not do it...”

Test anxiety is another phenomenon, which can be inferred from children’s expressions. Disregarding of the field, children state their own anxiety and stress before or during the exams. It is not an emotion specifically experienced about a course but it spans exams on all fields.

“...I get stressed during every exam. I feel tension about what if I fail them. Also, before the exams, I generally have a concern about what if I am late for the exam or I forget to bring my identity card...”

It seems that math anxiety and test anxiety are different phenomena. Math anxiety seems to be a field-specific emotion while test anxiety covers every exam situations.

Not only in school setting, can children’s math anxiety be observed in determination of their own future career. Most children avoid planning a future career that requires math only because of their adverse feelings toward math. Many math-related occupations are not preferred by children even though they are popular and desired professions.

“...Actually, I would like to be a pilot. However, it seems related to math, coordinates etc. I cannot do that. Thus, I gave up the idea of being a pilot because of math. Now, I think I will become a history teacher...”

One of the emerging points that came out of the interviews was the parental role on children’s articulation of their math anxiety. More specifically, children often referred to their parents’ expectations from them while mentioning their math anxiety.

“...It gets me very stressed what if I am not successful; the fear of disappointing my family, failing to meet their expectations...”

Some children state that parental thoughts and expectations concerning their school performance might be influential on their own emotions.

Interviews allow the researcher to collect data about children’s math attitude as well. Attitude is generally related with feeling of liking or disliking. Most of the participant children reported their math attitude in a negative manner. They generally do not like being engaged in math-related situations. Only a few of them stated positive attitude toward math. However, the agreement point of two groups is that all of them think that they feel concerned about math.

4.2.2 Theme 2 – Parents’ math anxiety

Out of interviews, parents appear to have anxiety about their children’s future rather than anxiety about specifically math. All of the participant parents reported a desire for their children to have good jobs and high quality living conditions. They

perceived math to be an important field in acquiring good jobs in today's world.

Thus, they maintain a rather positive attitude toward children's math learning.

"...My children grew up. One is a university student now and the other is going high school this year. We, as their parents, worry about their future careers a lot..."

Parents' affect can be examined in two distinct titles that emerged in the interviews; in daily use and school setting. In daily usage of math by parents, math does not seem to be an anxiety-evoking tool. Parents state that they feel rather comfortable when interacting with math-related cases in daily routines. Since daily use of math does not require highly complicated mathematical processes, it can be expected that parents do not feel themselves anxious about math. Daily use generally includes employment of four-operation skills. Therefore, parents can easily tackle these mathematical processes.

"...I know math enough to help me in my daily life routines, not that much complex mathematical operations in middle or high school. That is it..."

In the second title, parents confront with math in school setting apart from daily use. In terms of parents, school setting can be analyzed in two dimensions; parental math anxiety in their own student lives and parental math anxiety during engagement with their children's school work. When parents are asked how they liked math in their own student lives, they generally express positive attitude toward math. Most of them state favorable feelings about math. Only two of them seemed to be exceptions. One of them was an elder brother and had a degree in economics. He stated that he loved math a lot, which referred to a more positive attitude. The other one was a mother and a housewife. She asserted that math has not been at peace with her at all, which means that she has a strong negative attitude about math. In the

interviews, parents were asked to evaluate their anxiety state about math. In the interviews, lack of evidence for parental math anxiety was existent. More specifically, parents tended to express their positive feelings and thoughts concerning math during their student years. It appears that they do not refer to any traumatic experiences related with math. It might be explained by that participant parents mostly come from low educational status. Most of them have completed only primary school, which requires fundamental mathematical skills and low complexity of math. Anxiety stated by parents is generally related with either their children's future career or school exam.

4.2.3 Theme 3 – Children's subjective appraisals

The present study examines the roles of both children's and parents' subjective appraisals, namely; value and control appraisals, in students' math anxiety. It was thought that control-value theory may provide an explanation for the children's statements with respect to their subjective values of math. In the interviews, children tended to evaluate the valence they attached to math in two distinct settings; in daily life and school setting. In daily use, math is valuable to some extent from the children's perspectives. Except for four operations, math is perceived to be unnecessary to learn.

“...It is enough to know four operations, not much more. The rest is unnecessary...”

“...It is not useful except for four operations. It does not work in daily life. It is okay we use it for shopping but for example, square roots are not useful in this setting...”

In the school setting, math as a course is considered to be valuable by the children. In general, math is valuable because of its usefulness or instrumentality. They give value to math because it is functional and influential in their career pathways and school exams. It seems to refer to extrinsic values posited in the theory.

“...I think I am good at other courses. However, when I am faced with a math question and fail to solve it in an exam, it already causes my overall exam score to decrease. It is just because of math...”

As it can be seen from this extract, the valence given to math comes from its attainments in the exam scores, not from its own sake. Children perceive that doing math is significant not only in exams but in their vocational choices.

“...In acquisition of good jobs in the future, math is inevitably important...”

The usefulness and instrumentality of math in both children’s exams and career choices makes math valuable from children’s own views. These extracts from children’s statements correspond to the extrinsic valences attached to math included in the theory.

One contradictory case was observed in the interviews. One of the participant children stated that math in daily use is more than four operations.

“...Life is already math from the beginning to the end. We do everything with the help of math. My father told me and I witnessed that math is at the every part of the life. Every profession inevitably contains math, my father said...”

This child perceives math to be extremely valuable because of probably his parent’s influences. He often tends to reflect his father’s statements. This section is

concerned with the child's subjective valences of math but parental influences in this particular case will be discussed in the next sections.

Subjective control appraisals of children were also observed in the interviews. Children's statements can be explained through Control-Value Theory as far as their subjective control is concerned. Based on the interviews, it can be said that children, in general, feel low controllability about math. Each of the participant children, without any exception, states that they have difficulties in dealing with math, particularly in the school setting. Children can be grouped under two main titles. Some of them say that "I am not good at math but I could be, if I study", which refers to ones with high action-outcome expectancies, while the others tell that "I am not good at math and I could not be, even if I study", corresponding to the ones with low action-outcome expectancies.

"...After I experience a negative math-related situation I tell myself that I already cannot be successful in math so it is unnecessary to put more effort for success. I suddenly give up..."

The child believes that his further effort will probably have no influence on either production of positive outcome (success in math) or prevention of negative consequences (failure in math). This excerpt complies with low action-outcome expectancies of children. Similarly, another participant child states her low action-outcome expectancies at more severe level.

"...I can never be good at math. I am destined to fail in math. I got forty-five in the last exam and I was not surprised..."

On the other hand, there were some children who perceived themselves to be not good at math but specify rather high level of action-outcome expectancies in the interviews.

“...If I make an effort, I could be good at math but this effort must be very high...”

Children of this group thought that their effort would eventually have an impact on emergence of potential positive outcomes or repulsion of undesired results in math.

In the interviews, it is likely to see the example cases of causal attributions posited in the theory.

“...I feel myself happy when I get a return on my effort invested for math achievement...”

In this excerpt, it can be claimed that the child attributes a positive outcome in math, which has already occurred, to his own actions in the past. His retrospective cognitions relating to the cause-effect relations occurred between past actions and already experienced outcome refer to internal causal attributions posited in the theory.

In addition to subjective and value appraisals of children, another theme which can be observed out of the interviews would be that the common focus of children is at the failure in math rather than success. Children tend to express their own thoughts and feelings by emphasizing potential failure in math.

The theory posits that three conditions must be satisfied for the emergence of math anxiety in terms of control and value appraisals; subjective value of achievement, partial or lack of self-control about math and focus being at the failure

in math. Out of the interviews, it can be observed that math is perceived to be a valuable field, rather extrinsically, from children's perspectives. Children also see themselves to have low self-control about dealing with math-related situations in school settings. They state their feelings and thoughts toward math by emphasizing the failure, which will potentially be experienced in math. Thus, their focus is rather at the failure instead of success in math. These results obtained from the interviews comply with the explanation for the emergence of anxiety as an academic emotion, proposed by control-value theory.

4.2.4 Theme 4 – Parents' subjective appraisals

Parents, without any exception, tend to perceive math as a highly valuable field from children's views. They think that math is very important for children in every period of their lives. By stating their subjective valence to math, they refer to several justifications.

“...I think math is useful for me in terms of shopping and daily calculations. We sometimes witness that old people can be deceived due to their weaknesses about calculations...”

“...Math is important in calculating, for example, back in change. If you are not good at mathematical calculations, then you might be tricked by people...”

Parents evaluate math to be so crucial in daily life that it prevents any potential frauds in daily routines, except from its instrumentality in calculations. The message conveyed to children might be that “you can be deceived in daily life if you are not good at math”.

It can be observed in parents' statements that they generally associate math with extreme issues, such as; career pathway, success in life, problem-solving, good job, high qualitative life...etc.

"...If you are good at math then you have a prestigious and qualitative life but if not, then unfortunately the life would not be good to you..."

"...Everything in life is composed of math. Life is established based on it. Math is extremely important. If one is able to do math, she/he can solve all the problems in life. Is not it so in the exams as well? You get full score out of exam if you do only math, even if you do not do anything in other courses..."

"...I know that math is the most important tool in whichever career pathway you chose in the future. If you are not good at math it is impossible to gain admission to the departments which you desire to be..."

As seen from the excerpts above, subjective valences attached to math by parents seem to be very high. High quality lives, bright future careers, solving each daily life problems are strongly associated with math by parents.

Another example for reflecting parents' views on subjective valences given to math appeared in the interviews.

"Religion class is also important. However, Math and Turkish come in the first place..."

By force of demographic structure of the sample in the current study, religion occupies a huge place in lives of the participant people. Many of them organize their daily routines based on religious conventions. Therefore, it is considerably important for these people. However, parents perceive math to be more crucial than even

religion class. This excerpt showed the importance and value of math in the parents' eyes.

One exception was observed in parents' subjective value appraisals. One of the participant parents put stress on uselessness of math in daily life. It might refer to undervaluing of math.

"...I do not think that we use further subjects of math which we were taught in school. I suppose that no one uses, for instance, square roots in daily life. I am sure that you will not face with many math subjects in the future..."

"...Math did not work at all in daily life after graduation, except from four operations. You do not encounter with integrals or root numbers in your works. They are taught only to fill in the time or to say that students can do this as well. It might be useful for a physician but not for one working on a desk job or an officer..."

The problem with parents' statements reflecting their own subjective value to math might be potential influences of excessively given value to math. The emerging important point in parents' subjective valences to math seems to be not valuing to math but overvaluing and excessive emphasis attached to it. Potential impacts of parents' on children's affect with respect to math anxiety will be handled in the next parts.

There exist parents' expressions, which reflect their perceived subjective control over math. One notable result extracted from the interviews was that it was likely to consider parent-math contact in three setting. Parents interacted with math during their student years, confront with it in daily lives and lastly, contact with it while helping their children in school works. As far as their student years are

concerned, it seems likely that parents experienced little or no trouble in dealing with math classes.

“...Not quite. I got good scores out of each math exams. They were rather basic mathematics. I had no problem with math...”

“...I remember I could easily and quickly do four operations without using paper and pencil...”

It appears that parents have not had traumatic experiences during their student years. Participant parents mostly come from socioeconomically handicapped region. Many of them hardly graduated from primary school, being aimed to acquire fundamental mathematical skills. Thus, their perception of high subjective control concerning math might be based on this justification.

Secondly, parents are obliged to be engaged in mathematical situations in daily life. It seems that they are able to manage mathematical cases in daily practices.

“...No, I have never had difficulty in daily calculations...”

Lastly, parents confront with math intensively when their children ask them for help at home. Children generally tend to ask their parents for help about the problems that they could not solve rather than expecting them to lecture about a subject. It seems that parent-child contact within the scope of math is a complicated case. Initially, it was observed that children tend to ask their parents for frequent help in their math homework and this help-seeking behavior of children is perceived to be valuable by parents.

“...It is a pity that I cannot help my child at this level when she asks me for help in her mathematics homework. This makes me very sad...”

“...Math is so important that we face with math in every part of the life. For example simply, my daughter asks me aid for her math homework but I cannot help her...”

It is critical to understand the process occurring between parent and child after child asks the parent for help in math homework. One remarkable result emerged from the interviews was that parents did not have any trouble in helping their children at the beginning of their school years but as the grade level increases they started to feel less control about dealing with their children's school works.

“...I was able to help his math homework up to third or fourth grade. However afterwards, he has to do it by himself and I can only help him by checking it, not much more...”

“...Unfortunately, I cannot help my child with his math homework. I gave up helping at third grade. Math started to get harder at those times. I do not want to confuse him about math...”

“...Until two or three years ago, I could help my daughter in her math homework but now I cannot help her anymore...”

Within the framework of control-value theory, this situation can be explained by parents' subjective control appraisals. Parents perceive themselves to have control about children's math-related school works to some extent. As the children's grade level increases, they start to feel less control in managing their children's math homework. In other words, as mathematical subjects get harder than low subjective control in parents' perceptions seems to appear. Additionally, no change in parents' subjective valences about math was observed in the interviews. It means that parents regard math as a highly valuable field at each period of time, independent of their subjective control level over math. How do parents act after failing to provide

assistance about children's math homework? As the next step, it was observed that parents tend to seek for alternative sources of help. They try to find potential individuals or institutions, which can assist their children in math homework. Without any exception, all the participant parents try to provide the necessary assistance for the solution of questions which they failed to solve and they seek for a mathematically competent person. The ways of this guidance might vary. The prominent math figures from parents eyes emerged in the interviews were elderly brother or sister, father, a neighbor, internet connection, a close relative such as; uncle or aunt, private course or private teaching institutions, and school teachers. All these alternative ways of solution might fall into the title called parents' help-seeking behaviors.

"...I said to my child that you should ask this question to your teacher tomorrow. Tell him that we tried to solve it together with my mother but we could not..."

"...He has an uncle who graduated from high school. I generally direct my child to his uncle when I fail to solve a math question. He often helps my child..."

"...As the subjects get harder, I could not help my child and I started to guide him to ask his father for help about math questions because he graduated from high school and he is more competent than I am in math..."

"...We have no information about the subjects which she was taught in school at this grade but we have a neighbor downstairs and they have a daughter who graduated from the university. She generally helps my daughter in math homework..."

It seems that parents try to find a solution to children's homework help requests somehow. This case can be explained by control-value theory through its both subjective control and subjective value appraisals. More specifically, parents'

help-seeking behaviors might be triggered by coexistence of their perceived valences of math and perceived control over math. It seemed that math is highly valuable for the parents, which refers to high subjective valences to math. On the other hand, they fail to provide assistance to their children in their homework due to lack of control over math, corresponding to low level of subjective control. Additionally, they seemed to be concerned in potential occurrence of undesired results in children's academic lives. In other terms, their focus is apparently at the failure in math. Therefore, three basic conditions necessary for the emergence of anxiety appeared to be met. More specifically, high subjective value and low subjective control combined with the focus being at the failure might be antecedents of activating anxiety emotion in parents. This result seemed to be supported by the quantitative findings. In the quantitative part, a relatively strong relationship between children's and parents math anxiety levels was found.

4.2.5 Theme 5 – Parental influences on children's affect

The primary objective of the current study is to determine the potential undesired impacts of parents on children's affect. In accordance with this purpose, interviews with parents and children were conducted. Interview data obtained in the current study could not be enough in explaining clear effect of parents on children's affect. A more comprehensive qualitative study or a causal-comparative study is needed to see the pure impact of parents on children's emotional states about math. Nevertheless, qualitative part of the current study aims to clarify potential pathways concerning how the parents' subjective appraisals play a role on children's affect. Through this purpose, parental influences will be examined from this point of view. All the results

yielded in this part related with the parental effects are to need further research.

Several important points which might potentially have unfavorable role on children's affect were noticed in the interviews.

Parental expectations seemed to be an important mediator of children's affect. Parents set certain expectations about children's academic achievements and convey them to their students either consciously or unconsciously. It can be observed in parents' expressions as well as in practices. It means that parents might tell their expectations from children verbally or they might imply these expectations by providing support for children with, such as; private courses, private teaching institutions. All these implementations can be the reflection of parental expectations from children.

"...I bought many test books for him to solve but he has not opened it even once..."

"...We, as parents, use every means available to help him. He is enough to study..."

"...We provide all the opportunities for them but they find even opening the book difficult. This is your duty! I do not expect you anything else. I do not want you to wash the dishes or clean the house. You do not study for us; it is useful for your life.

"...We were good at math in the last year, we got eighty on the exam but this year, I suppose it was forty, was not it? Bad, very bad... On top of it, he additionally goes to the best private teaching institution in the province. Does he put effort? No! We do put effort, but he does not at all..."

It seems that it is a desired behavior from parents to support their children's academic lives. However, it appears to be problematic that they put excessive emphasis on what is being done for children and most importantly; complaining

about their faults in returning the favor or effort displayed for them. From parents' perspectives, the situation is simply considered to be like "we, as parents, always do our best but children fail to work sufficiently and give a recompense for our effort". Apparently, parents see their roles on children's academic lives to be only seeking for alternative help sources and expecting children to give return for their investments. Avoidance of parents from cooperative work with their children about their school works and directing them to other sources of help might be perceived by children as a burden or stress over themselves. The underlying reason behind parents' this behavior might be caused by different factors. In the quantitative analysis, it was found that parents' and children's math anxiety levels have some parallelism. Thus, it might be the indicator of parents' tendency to avoid possible interaction of math. It might refer to parents' own math anxiety. The explanation for the situation might also be extended to a more comprehensive dimension through parents' control and value appraisals. The theory postulates that high subjective value, low or moderate subjective control and focus at the failure exist behind anxiety emotion. Parents' expressions in the interviews seem to combine with the theory. They seek for alternative help sources for children because they perceive it valuable; feel less control over the subject and; have fear of facing failure in children's academic lives. Briefly, it can be regarded as the process of shifting responsibility from themselves to another source. Nevertheless, it needs more comprehensive research on the issue.

As mentioned in the previous theme, overvaluing attached by parents for mathematics might be another potential anxiety inducing behavior of parents from children's eyes.

“...The big exam will be held next week. I frequently warn you it will critically affect your life. You will be either a garbage man or a well-educated person...”

“...It is for sure that good jobs can only be acquired with being good at math. I do not think that she can be successful in life without math. It seems impossible to have a high quality life unless she likes math...”

“...He will maintain a family in the future. So, it is very important to have a good job. He has to lay the foundation of a good life already...”

Math is frequently associated with extreme issues; such as, a high quality life, a good job, for their children by their parents. High level of parents' subjective values might be influential in children's own appraisals. It might lead children to question their own subjective control over math, which is such a valuable field. Children's feeling of low control over math, combined with the focus at potential failure, might be held accountable for the activation of math anxiety in children. Uncertainty appraised by children toward math appeared to be a significant determinant in emergence of math anxiety.

Parents' expressions about the nature of math as well as their children's capabilities and skills might be held to be responsible for activation of math anxiety in children. In the interviews, it was observed that parents stated their views on both mathematics and its learning based on their experiences and observations.

“...Math is a very difficult course. Not every child can succeed in it. If a child is not able to do math she/he is unlikely to be successful even if you put effort on its teaching...”

“...If you have natural math ability inborn then you can be good at math. Otherwise, it is impossible to succeed in math even if you hire a tutor from Boğaziçi University. It is a matter of talent...”

“...If her inherent capacity is fifty I can hardly increase it to sixty, not to seventy. I mean the capacity is too important...”

“...I noticed that she has predominantly verbal intelligence, not mathematical intelligence. It could not be enough only to like math, furthermore, it needs some intelligence from birth...”

“...Being good at math is mostly up to your capacity. It heavily depends on how much you were gifted for...”

“...Math exceeds her head. It is already impossible that everyone can be a mathematician...”

“...She is impossible to be a chemist or physician. Her verbal intelligence is predominant. She can be a teacher or district governor. She is prone to verbal fields. She says she will be a policewoman but both of us already know that she will not...”

CHAPTER 5

DISCUSSION AND CONCLUSIONS

5.1 The prevalence of math anxiety

As a result of the quantitative analyses of the study, it was found that most of children suffer from math-related situations in their daily routines and school settings as it was in the past. Prevalence of children's math anxiety was evidenced by data obtained through the measuring instruments in the current study. The results of the present study were found to be parallel with earlier studies (Erktin et. al., 2006). Math anxiety still remains a significant and prevalent phenomenon to be examined in mathematics education. From the beginning of 70's, math anxiety had been a significant phenomenon for math educators. Over the years, many studies had been conducted to understand math anxiety and its correlates (Erktin et. al., 2006; Hendel & Davis, 1978; Lefevre et. al., 1992; Richardson & Suinn, 1972; Wigfield & Meece, 1988). It seems to be still a prominent and current issue in today's studies (Cargnelutti et. al., 2017; Soni & Kumari, 2017). Math anxiety currently appears a prevalent and prominent detrimental variable among individuals (Johnston-Wilder et al. 2014). It has been examined in Turkish context (Baloglu & Balgalmis, 2010; Bekdemir, 2010).

It was likely to observe math anxiety of both students and parents in the interviews. Out of students' and parents' reactions to the interview questions about math-related situations, physiological reactions (crying), avoidance of even talking about math, rejecting a math-related career pathway, or from parents' perspectives, avoidance of involvement in math-related situations in daily life as well as their

children's math homework, talking about math-related past traumatic experiences were considered to be the indicators for the existence of math anxiety.

5.2 Math anxiety from past to present

The present study has an additional aspect, in particular. Participant students of Erol (1989)'s study have grown to become participant parents of the current study. In both periods, math anxiety among participants was diagnosed after several decades. It allows comparing math anxiety levels of two independent groups in two different time periods, measured through the same scale. When compared with the results of Erol (1989)'s study, the present study reported higher mean scores for students in terms of math anxiety by almost 6 points. On the other hand, in order to evaluate whether the difference found is trivial or not, Cohen's d was calculated to determine the effect size between two groups. The results indicated that no significant difference between two groups has been noticed. The change in mean scores for math anxiety appeared to be not significant. This shows that math anxiety is maintained through almost three decades among the students. Math anxiety remains a prevalent phenomenon among learners.

Assuming math anxiety scores would show a normal distribution, based on the rough calculation, math anxiety scores of students can be classified into 4 groups; low anxious (89 to 112), moderately anxious (113 to 135), highly math anxious (136 to 158) and very highly anxious (159 to 180) (Erol, 1989). According to this grouping, 18% of the students are placed at moderately or highly anxious groups, unlike to the previous findings which were found to be 10% of them.

5.3 The role of math anxiety on math achievement

The ultimate outcome of the education is to enhance learning and increase achievement. The underlying justification for examining math anxiety is due to its potential negative influence over math achievement. Math anxiety is studied because it is found to be an emotional barrier for the increased achievement. In the present study, a negative significant relationship between these two variables was evidenced by both quantitative and qualitative analyses. The results were appeared to be consistent with many past studies. Negative strong relationship between math anxiety and math performance has been observed in several studies from past to recent (Hembree, 1990; Erktin et al, 2006; Devine et. al, 2012; Radišić et. al., 2015; Cargnelutti et al., 2017). In Ma's meta-analysis (1999), 26 studies dealing with anxiety-achievement association were examined and $-.27$ was estimated to be the predicted coefficient for this relationship for the entire population. The identical result concerning to anxiety-achievement interaction were evidenced for several cultural contexts (Ho et al., 2000). This negative relationship can be explained by several ways. One might be that students might be allocating their cognitive resources not only for the success but some irrational thoughts or worries concerning to potential outcomes. Impediments to functioning of working memory might be accountable for the decreased math achievement. For instance, students focusing on their parents reactions to potential failure in math exams instead of necessary cognitive processes to solve the problems are more likely to get low grades out of the exam. Additionally, math anxiety is defined as one of the prospective achievement emotions. Antecedents cognitions related with the outcome might be triggering the emergence of math anxiety. Negative thoughts concerning to activity or outcome might be preventing students to perform properly in math classes or exams. Control –

value theory of achievement emotions defines the emergence process of math anxiety as high level of subjective value, low level of control appraisals and focus at the failure. From qualitative analysis, it was observed that math is seen as a highly valuable field by both students and parents. On the other hand, students were noticed to feel lower controllability about math. This case causes to increased math anxiety in students. Thus, this emotional barrier for students is seen to be responsible for low success in math. Results inferred from both quantitative and qualitative data appear to support each other.

In the first regression analysis, students' subjective control was found to be the predominant contributor in the explanation for the variance in math achievement. In other words, low subjective control of students can be accounted for the decreased math achievement. This result can be combined with the high negative correlation found between students' subjective control and students' math anxiety. The pathway between subjective control and achievement seem to be through students' math anxiety. It can be interpreted in such a way that students feeling highly controllable about math, i.e. believing their own math abilities and capabilities, tend to have less anxiety. Afterwards, less anxious individuals are mostly the ones having increased math achievement. Consistently, the regression analysis showed that students' math anxiety has a small contribution to math achievement when students' subjective control is similar for participant students. It means that math anxiety seems to be less important when it is compared to subjective control appraisals of students.

5.4 Gender differences in math anxiety

In the present study, no gender difference in terms of math anxiety was observed.

This result might be explained by the change in the paradigm in gender-related issues throughout the last few decades. In other words, perspectives towards females might have shifted to a different point. Similar to recent studies on math anxiety, gender differences attracted attention in the past. Gender difference was firstly interpreted as one of the few influential variables accountable for the variance in math anxiety.

This notion has evolved to that the variability in math anxiety can be accounted by other extrinsic affective factors; such as, familial thoughts or teachers' dispositions.

No significant difference was observed between males and females with respect to math anxiety (Haynes et al., 2004). The variables accounted for the variation in math anxiety were noticed to be other factors than gender. In the same study, two differentiated model was proposed for males and females. In the analysis of participant girls' responses, perceived math ability was found to be most impactful variable in females' math anxiety. It means that decreased perceived math ability, corresponding to subjective control appraisals in this study, result in higher math anxiety. In the present study, a significant negative relationship between control appraisals and math anxiety was found independently of gender. Thus, the gap observed in the past studies between males and females about gender difference in math anxiety seemed to disappear due to the change in the focus from gender issues to rather social factors.

Even though teachers' math anxiety were not included in the study, it had been evidenced that particularly female teachers' math anxiety were influential in math achievement of female students via their traditional stereotyped gender beliefs about math (Beilock et al., 2010). In the current study, quantitative analysis showed

no significant difference between females and males. It might be resulting from the decrease in the emphasis on the stereotyped gender beliefs triggered by the social environment. More specifically, it might be interpreted as parents tend to ignore the notion of “math as a male domain” in particularly current study. Parents’ deemphasizing gender beliefs about math might be preventing female students’ control from decreasing which, in turn, leads to increased math achievement.

Similar to findings from quantitative analysis, qualitative data supported the idea that no socially constructed gender roles induced by parents exist. It was observed that parents approach math as a gender-independent issue. No data related with the stereotyped notion that “males are good at math while girls are good verbal fields” was noticed. This shows that gender related differences in math anxiety gradually disappeared. Considering the change in the gender roles in last decades in Turkish context, it might be resulting from the shift in the perspectives toward females’ roles. As stereotyped roles, female had been seen to be responsible for domestic affairs while males had been provided with a role of maintaining the home. Today, social expectations from females and males in educational setting do not differ. Nevertheless, gender-related issues were dealt with as an additional aspect in the present study. Further research merely focusing on gender issues might be conducted in the future.

5.5 The role of parental involvement

Before examining parental involvement, it can be useful to explain the justifications for why involvement is handled as an important variable in the present study. The study takes involvement into consideration because parents were found to be math

anxious and it was suspected that they transmit their own anxiety to children through involvement. Examination of involvement is important in terms of potential influence over students' math anxiety. By this reason, it would be reasonable to firstly present the results concerning to parents and children's math anxiety.

A notable result from the analyses revealed the significant relationship between children's and parents' math anxiety levels. Data showed that there exists a positive correlation between children's and parents' math anxiety. This indicates that parental roles in terms of math anxiety are crucial concerns to be regarded in examination of children's math anxiety. Not only students but also adults seem to suffer from the fear of interaction with math-containing cases. Parents' own views on mathematics might have an influential role on upcoming generations that are potentially exposed to parents' emotional reactions to math-related situations.

Not only students but also adults seem to suffer from the fear of interaction with mathematical issue. Parents' own views on mathematics might have an influential role on upcoming generations that are potentially exposed to parents' emotional reactions to math-related situations. Adults are often considered to be significant figures for children. Their reactions to math-related tasks might be influencing children's views toward math and partially accountable for increased math anxiety in children. The underlying construct of these notions and feelings might be adults' math anxiety. Parents' own level of math anxiety might play an influential role on students' math anxiety. In their study, Maloney et al. (2015) found that parents' math anxiety might be conveyed to their children through particularly during homework assistance. Regardless of grade level, parents are likely to act in such a way that they consider their interaction with children to be an opportunity to

transmit their own views on math to children. Contrary to intuition that parental involvement has generally positive influences on children, Maloney et al. (2015) showed that when parents are math anxious parental involvement could backfire.

Parental involvement in students' affect and academic performance seemed to be an ambiguous issue in the literature. Parents' involvement, when it is defined as parental home support and parental expectations for mathematics from children, exerts buffering effect over children's math anxiety, which in turn leads to increased math performance at school settings, especially in word problems and algebraic reasoning rather than whole number arithmetic (Vukovic et al., 2013). The mentioned study advocates the existence of protective role of parental involvement upon ethnic minority group in urban regions due to their vulnerability to negative influences of mathematical outcomes. It asserts that parental involvement compensates the damage occurred in children's math performance through reducing their math anxiety levels with the help appropriately created home support and established higher expectations from children about math.

The results showed that parents involving in their children's school works less frequent are appeared to be rather more math anxious ones. This result can be interpreted as the avoidance behavior of parents from math. Parents' own level of math anxiety seemed to be an obstacle for their involvement in children's school works. Parents' prospective feelings and thoughts relating to the case of interaction with math during help for children seemed to be the main reason for their noninvolvement decision. In such case, parents are not expected to exclude themselves from children's learning processes. Conversely, they have some responsibilities and important roles in children's academic development. The

problem at this point is not placed at being involved but the existence of parents' math anxiety. Furthermore, they might be considering parent-child contact to be a channel in which they can easily express their negative opinions and emotions about math. In place of being accountable for instigation of math anxiety in children, parents can be supportive toward children via providing effective feedbacks, motivation to learn, creating efficient learning environment at home, and effective monitoring of children's learning process. Additionally, encouraging statements targeting to increase children's academic self-concept are very crucial in reducing children's math anxiety and enhancing their achievement.

5.6 Parental involvement and control – value theory

Parental involvement is seen to be crucial for understanding parent-child interaction with respect to math anxiety. Since parent-child relationship might be responsible for the intergenerational transition of adverse feelings about mathematics, how this relationship might be taking place and what parents' behavior might be anxiety-inducing while engaging with their children's school works are likely to be important. The role of parents' affect on children's math anxiety and performance is placed at the focus of the current study. In the present study, control-value theory of achievement emotions was considered in order to explain parental roles on students' anxiety and achievement. Control and value appraisals of parents and students are helpful in comprehension of both emergence of math anxiety and parental influences over students' affect and performance. In this part, parental involvement will be extended to a broader sense.

Parents' involvement was found to be significantly correlated with both of parents' subjective appraisals. Parents valuing math and feeling more math-skilled were seemed to be involved more in students' school works. This result appears to be consistent with the theory of parental involvement process (Hoover-Dempsey & Sandler, 1997). As the initial step of the involvement process, parents' make decision of involvement in students' school affairs based on their own abilities and competencies, referring to their self-efficacy beliefs or appraisals of subjective control in the current study. The parents having higher level of controllability about math tend to be the ones involving more in students' school works.

Two important results; which are; control-anxiety relationship and control-achievement relationship were noticed. A strong negative correlation between students' subjective control appraisals and anxiety was revealed. Students' beliefs concerning their math abilities and skills were found to be one of the determinant antecedents for instigation of math anxiety. The higher students' control appraisals about math are, the lower their math anxiety levels would be. In order to eliminate the barrier math anxiety for students, Interventions should be developed in such a way that students' control appraisals are enhanced so that they feel less anxious about math. From the interview data, it was inferred that students attaching excessive value to math tend to feel more anxious. It can be interpreted as highly valued math might be causing prospective cognitions, which lead them to question their own abilities and skills about the field. As the gap between value and control appraisals expands the possibility of appearance of math anxiety increases according to control-value theory. The positive correlation between students' control appraisals and achievement can be discussed. Successful students seemed to be the ones whose

control appraisals were high. In reducing the impact of math anxiety on achievement, students' control appraisals could be targeted.

In the second regression analysis, where students' math anxiety was chosen to be the dependent variable, it was found that the variance in students' math anxiety can be explained prominently by students' subjective control and parents' math anxiety, with 10% individual contribution of parents' anxiety. This implies that, apart from students' subjective control, parents' anxiety is appeared to be a prominent and valuable factor to be considered. It can be discussed that parents' anxiety seems to be influential in students' math anxiety to a significant extent, as supported by Maloney et. al. (2015) as well. This case can be interpreted as the transmission of parental math anxiety to students. When parent' involvement in students' school works is also taken into consideration, it might be concluded that parents see their interaction with their children concerning math as a discharge session of their own negative feelings and thoughts toward the field. Control – value theory supports the current study in terms of providing a model for the occurrence of the interaction responsible for the transmission of anxiety via subjective control and value appraisals.

CONCLUSION

As a result of the present study, it was evidenced that parents' feelings and thoughts toward math play a significant roles in students' math anxiety. Another important finding was that anxiety and achievement relationship in a negative direction was supported by data. Thus, parents' anxiety seems to be a barrier in students' enhanced learning. Intervention programs aiming to reduce anxiety levels of parents can be developed. Subjective control appraisals are valuable tools for this purpose. Through

focusing on enhancing parents' self-efficacy beliefs/control appraisals, it might be likely to make them less anxious individuals.

In the study, parental involvement appeared to be a crucial issue in parent-child interaction within the scope of math anxiety. Certain statements of parents about math might be anxiety-inducing for students. Parental homework help should be carefully examined. Programs for creating awareness for parents about effective involvement in students' schoolwork can be developed. In the present study, it was observed that parents are influential over students' math anxiety through parental involvement via unconscious targeting their subjective control and value appraisals. Parents might be counted accountable in students' overvaluing of math and low level of controllability, which leads to increased math anxiety levels according to control-value theory. Additionally, in the interviews, it was observed that parents tend to focus on failure rather than the success of students. Therefore, informative programs for teaching parents about children's subjective appraisals can be improved.

In the study, students' subjective control appraisals have been emerged to be a prominent variable in explaining both students' math anxiety and achievement. It can be concluded that students having high level of control about math tend to be more successful in math. Students' subjective appraisals, in particular, can be considered as a pathway in decreasing math anxiety and enhancing math achievement. At this step, certain crucial roles fall on teachers. Firstly, teachers can be informed about subjective control appraisal so that they can develop lesson plans and create class atmosphere encouraging students to be more confident about activities. Secondly, teachers are the intermediary to accessing parents through parents-teacher meetings or one to one sessions. Informative programs aiming to

teach teachers about effective communication concerning their involvement can be developed. These sessions should be related with appraisals rather than anxiety itself. For example, parents can be informed about their ways of involvement, in particular, homework help via teachers. The statements parents should avoid or emphasize can be clarified based on the control appraisals perspectives.

For further research, comprehensive quantitative measurement concerning subjective appraisals, namely; control and value, can be conducted in order to develop a model dealing with appraisals, anxiety and achievement relationship.

Teacher is another aspect concerning affective states of students toward math. In the further studies, teachers' anxiety and appraisals can be taken into consideration for a more comprehensive understanding of students' math anxiety.

APPENDIX

INTERVIEW QUESTIONS

Questions	Theme	Source
1. Could you please briefly introduce yourself? Your occupation, educational status...	Demographic information	
2. How do you like mathematics in general?	Subjective values	Literature (McLeod, 1992)
3. Does it discomfort you to confront with math-related situations in your daily life?	Math anxiety	Literature (Richardson & Suinn, 1972)
4. If exists, score your math anxiety level ranging from 0 to 10.	Math anxiety	Literature (Ashcraft, 2002)
5. How would you evaluate yourself? An anxious person in general or situation-dependent anxious person?	General anxiety	Literature State-trait Anxiety (Spielberger, 1966)
6. In your school years, do you remember a math-related situation in which you got extremely anxious?	Math anxiety	Scale (Math-related situations)
7. In your school years, do you remember a math-related situation in which you did not get anxious at all?	Math anxiety	Scale (Math-related situations)

Questions	Theme	Source
8. Do you think it is necessary and useful to know mathematics? - Is it useful for us in our daily lives?	Subjective value appraisals	Literature (Erol, 1989; McLeod, 1992)
9. When a supplementary material is needed for math classes, do you provide it immediately?	Subjective value appraisals	Literature (Erol, 1989; McLeod, 1992)
10. Do you think math is a field which requires ability?	Subjective control	(Erol, 1989)
11. Do you consider yourself that you are able to do math?	Subjective control	Literature (Bandura, 1977)
12. Does feeling of failure discomfort you while engaging with math?	Math anxiety	Literature (Erol, 1989; Richardson & Suinn, 1972)
13. Do you provide assistance to your child in mathematics?	Parental involvement	Literature (Maloney et al. ,2015)
14. How would you react to your child, when he/she asks you a math question?	Parental involvement	Literature (Maloney et al. ,2015)
15. Suppose that your child will take a math exam soon and he/she seems to be quite anxious. How would you treat him/her?	Parental involvement	Literature (Maloney et al. ,2015)
16. Do you discuss about the importance of math with your child?	Parental involvement	Literature (see. PISA 2012 report Volume III, students' engagement, drive and self-beliefs, p. 98)

Questions	Theme	Source
17. Would you like your child to have a math-related profession in the future?	Math anxiety	Literature (Hendel & Davis, 1978; Lefevre, Kulak & Heymans, 1992)
18. Do you think it plays an important role in acquisition of good occupations in the future to have good mathematical knowledge and skills?	Subjective value appraisals	Literature (Erol, 1989; McLeod, 1992)

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