ANALYZING THE EFFECTS OF MOTIVATION, EXPECTATIONS AND SELF-CONCEPT ON EIGHTH-GRADE STUDENTS' MATHEMATICS ACHIEVEMENT

By

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<tr>
<td>IEA</td>
<td>International Association for the Evaluation of Educational Assessment</td>
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<td>MEB</td>
<td>Milli Egitim Bakanligi [Ministry of National Education of Turkey]</td>
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<tr>
<td>NCTM</td>
<td>National Council of Teachers of Mathematics</td>
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<td>NELSS88</td>
<td>National Education Longitudinal Study of 1988</td>
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<tr>
<td>OECD</td>
<td>Organisation for Economic Co-operation and Development</td>
</tr>
<tr>
<td>PISA</td>
<td>The Programme for International Student Assessment</td>
</tr>
<tr>
<td>SMIRC</td>
<td>Science and Mathematics Review Committee</td>
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<td>TIMSS</td>
<td>The Trends in International Mathematics and Science Study</td>
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Improving students’ mathematics achievement has long been a major concern for educators, policy makers and researchers. In order to contribute to theoretical developments on this issue, understanding the underlying factors that influence student mathematics achievement from a wider and more comprehensive perspective is the purpose of this study. Interactive effects of intrinsic motivation, extrinsic motivation, teacher expectation, parent expectation, mathematics self-concept and eighth-grade students’ mathematics achievement scores were investigated using the Trends in International Mathematics and Science Study (TIMSS) 2015 dataset. Additionally, congruence-dissonance between teacher expectation and parent expectation and its effect on eighth-grade student mathematics achievement was studied. Besides, the mediation effect of SES and gender on the constructs of interest were tested. The sample of interest is Turkish eighth-grade students. Therefore, Turkey portion of TIMSS 2015 was used. Data analyses were performed using multiple regression, mediation analysis, and structural equation modeling methods. Apart from relationships among the constructs of interest, unique findings were revealed with respect to intrinsic and extrinsic motivation and their interactions with mathematics self-concept. Moreover, this study provided evidences for
congruence-dissonance between teacher expectation and parent expectation and its effect on eighth-grade student mathematics achievement. The effect of cultural and educational context on the literature and the findings of this study are discussed. The implications of the findings and associated future recommendations concerning educational research and Turkish educational system are shared.
CHAPTER 1
INTRODUCTION

1.1 Statement of the Problem

Students’ academic achievement in mathematics has long been one of primary concerns for educators, policy makers and researchers due to its significant and distinguishing effect on educating skilled labor force (Hanushek & Kimko, 2000). Education, and more specifically mathematics education, has an undeniable role as a considerable determinant of the long-term economic growth and development of countries (Barro, 2001; Ramirez, Luo, Schofer, & Meyer, 2006), and consequently, the welfare of its citizens since mathematics is the basis of many skilled jobs in engineering, biotechnology, computer science, business and finance related occupations. While education is considered to be the most outstanding investment in human capital (Becker, 1994), students’ mathematical skills (and science skills) constitute a specific type of human capital that dynamically changes the quality of the labor force and the degree of economic growth (Hanushek & Kimko, 2000). In this regard, educating students who will be skilled in mathematics has a significant importance for many countries (Barro, 2001; Ramirez, Luo, Schofer, & Meyer, 2006; Zhao & Akiba, 2009) including Turkey. National and international research has indicated that Turkish students have considerable difficulties in mathematics (Basturk, 2011; Basturk & Dogan, 2010; Mullis, Martin, Foy & Arora, 2012; OECD, 2010; OSYM, 2017). As acknowledged by prolific research and the Ministry of National Education, low mathematics achievement is one of the central issues in Turkey (Kalaycioglu, 2015; Yuksel, 2014).

A prominent issue related to this point is to measure and evaluate the level and quality of mathematics achievement both within and between countries in order to have a reference point. Also, it is crucial to regulate future implementations in educational reforms for improving
students’ mathematics achievement based on generalizable empirical studies in the field of mathematics education. International examinations such as Trends in International Mathematics and Science Study (TIMSS) and The Programme for International Student Assessment (PISA) provide such an opportunity. In this study, the Turkish portion of the TIMSS data will be investigated.

1.2 A Concise Overview of Turkish Educational System

The most recent census statistics show that Turkey’s population was over 80 million in 2017 (Turkish Statistical Institute, 2018). Percentages of male and female were almost equal and 23% of the population was 0-14 years old. In 1997, compulsory education was increased from 5 years to 8 years (consisting of primary and middle schools). In the 2012/2013 school year, Milli Egitim Bakanligi (MEB, Ministry of National Education) increased the compulsory education to 12 years (primary, junior high, and secondary education), with each stage consisting of four years. According to MEB (2017), in primary schools, there were 4.97 million students; in junior high schools, there were 5.55 million students; and in high schools, there were 3.14 million students in general high schools and 2.17 million students in vocational and technical high schools. In junior high schools, students take year-end examinations for each year. Students are placed in high schools based on weighted average of their year-end examination scores and GPA. Moreover, high school students are required to take university entrance exams in their last year for college education. Pertaining to the cost of education, compulsory education at public schools is free for all students, while private schools are also available. During the last decade, MEB has made significant changes in educational system in order to improve educational outputs locally and internationally. Optimizing the quality and quantity of educational and human resources is the main goal of MEB.
1.3 TIMSS and Turkish Students’ Mathematics Achievement Trend

TIMSS is an international examination that has been conducted every four years since 1995. It is administered by the International Association for the Evaluation of Educational Achievement. While the first TIMSS study included only fourth-graders, eighth-graders have been included in survey sample since 1999. The purpose of the test is to evaluate fourth- and eighth-grade students’ mathematics and science knowledge as well as the contextual information (e.g., school, teacher characteristics) that may be associated with student achievement (Provasnik et al., 2016). TIMSS data not only allows evaluation of educational applications and policies within countries, but also comparison of students' performances in particular parts of the mathematics curricula among participating countries (EARGED, 2003). The content domains in TIMSS assessments for eighth-graders include knowledge and skills in number, algebra, geometry, and data and chance. Ability to apply these knowledge and skills to problem solving situations is another main goal of the assessment (Provasnik et al., 2016). Therefore, TIMSS assessment data is a viable and reasonable dataset for understanding the factors influencing students’ mathematics achievement. It can help measure students’ academic skills and processes in aforementioned content domains and its results can fairly represent students’ mathematics achievement in schools because TIMSS items are more closely related to school curriculum in comparison with PISA (Gür, Celik, Özoğlu, 2012) which measures the degree to which students apply their mathematical proficiency to everyday life situations (Akben-Selcuk, 2017; Wu, 2010). These arguments support the idea that using TIMSS dataset is suitable for understanding the factors associated with mathematics achievement patterns.

Historically, TIMSS results have influenced curricular reform movements in Turkey (Gur, Celik & Ozoglu, 2012). Accordingly, recent results in TIMSS show that the reform efforts have served the purpose. Turkey participated in TIMSS examination in 1999, 2007, 2011 and
2015. Although Turkish students’ TIMSS scores are below average of participating countries, since Turkey’s first participation in 1999, the trend in TIMSS mathematics scores has continuously increased for both fourth- and eighth-grade students (Figure 1-1).

![Figure 1-1. Turkey's eighth-grade mathematics achievement trend in TIMSS](image)

Average TIMSS scores for eighth-grade students were 429 in 1999, 432 in 2007, 452 in 2011 and 458 in 2015 (Yildirim, Ozgurluk, Parlak, Gonen, & Polat, 2016). This trend is promising, yet the crucial fact remains: Turkish students’ average mathematics achievement scores in TIMSS is below the average of participating countries. As McInerney (2007) posits, students’ learning and classroom behaviors might substantially differ across different cultures, educational settings or social settings (e.g., see Areepattamannil, 2011, 2014). Concordantly, tenets of educational theories might function differently within the context of Turkish educational system. Therefore, exploration of some of the characteristics of the factors associated with high or low mathematics achievement within this context, finding causal links between these factors and their relationship with mathematics achievement, and informing educators, policy makers and researchers about reliable, valid and applicable findings that can yield clues
for effective interventions play a crucial role in improving Turkish students’ mathematics achievement in international examinations.

In this study, there are several reasons for placing emphasis on eight-grade student as the population of interest. The most outstanding reasons are related to students’ developmental transition during adolescence. During the middle school, students start experiencing puberty, which has a tremendous effect on their biological development (Wigfield & Wagner, 2005). Additionally, adolescent students’ struggle for adaptation to these biological changes influence their thinking and behaviors along with the process (Arnett, 1999). Changes in thinking reveal themselves concurrently. Primary cognitive changes—which are closely related to students’ learning mathematics, mathematics achievement, motivation, competence beliefs, and identity development—are “the increasing propensity to think abstractly, to consider the hypothetical, as well as the real, to engage in more sophisticated and elaborate information-processing strategies, to consider multiple dimensions of a problem at once, and to reflect on oneself and on complicated problems” (Wigfield & Wagner, 2005, p. 223). Similarly, adolescent students commence regulating and controlling their behaviors in daily life (Zimmerman, 2000).

Supporting the importance of these changes, researchers have consistently addressed the decline in students’ intrinsic motivation, self-concept, and academic interest as they advance through elementary school to secondary school (e.g., Frenzel, Goetz, Pekrun, & Watt, 2010; Gottfried, Marcoulides, Gottfried, Oliver, & Guerin, 2007; Lee & Kim, 2014; Shi et al., 2001). Additionally, although expectations for students have been researched relatively extensively, there are scarce research with respect to middle school students (Rubie-Davis, Peterson, Irving, Widdowson, & Dixon, 2010). In summary, biological changes followed by changes in thinking, reasoning, motivational profiles, identity and other developmental factors, and lack of research in
expectations for middle school students justify the necessity of focusing on middle school students. In the TIMSS 2015 dataset, only fourth- and eighth-grade students data are available, therefore, eighth-grade students’ data will be used for answering the research questions that seek to understand the associations between intrinsic motivation, extrinsic motivation, mathematics self-concept, teacher expectation and parent expectation, and their association with eighth-grade student mathematics achievement.

1.4 A Glance at the Past: Development of Theories on Mathematics Achievement

Research in mathematics education has gone through complementary developments of various perspectives, methodologies, and theories. Historically, the early research about mathematics achievement mostly focused on student characteristics to explain the differential achievements and was gradually expanded toward more complex and comprehensive context. This trend can be observed in National Council of Teachers of Mathematics’ (NCTM) yearbooks. Although this trend is not straightforward or linear, the gradual change is obvious. For example, in the NCTM yearbooks, the following perspectives are covered with a chronological fashion: group intelligence tests, ability grouping and the promotion of segregation (Reeve, 1940), consideration of individual differences (Fehr, 1953), connection of mathematics/geometry to real-life examples and ethnomathematics (Sharron & Reys, 1979), taking cognitive factors into account and consideration of gender differences (Silvey & Smart, 1982), stress on social factors (Cooney & Hirsch, 1990), and in Trantacosta and Kenney (1997), significant amount of utilization of sociocultural theory, social cognitive theory, and social learning theories. As a consequence, to accomplish the desired educational goals, previously mentioned approaches gradually expanded to include not only students’ ability and cognition, but also the influence of instruction, teachers, classrooms, schools, and more recently, social structure and institutional factors as essential, intersected and interwoven dimensions as the
cause of differential achievements. Accordingly, more holistic and multidimensional perspectives and interventions are warranted to probe differential student achievements and to obtain the desired educational outcomes. Therefore, as a general perspective, this study will adopt a social cognitive perspective, which asserts reciprocal associations between personal factors, environmental factors and individual behavior (Bandura, 1989).

1.5 Terminology: Basic Concepts

The term ‘construct’ refers to ‘a phenomenon of theoretical interest’ (Edwards & Bagozzi, 2000). It can be used synonymously as the concept (Carmines & Zeller, 1979). Some of the constructs that will be part of this study are intrinsic motivation, extrinsic motivation, teacher expectations, parent expectations, and students’ mathematics self-concept.

These constructs can be categorized as observed variables and latent variables. Teacher expectation and parent expectation variables can be defined as observed (or manifest) variables since their scores are directly entered into the data file. Latent variables correspond to “hypothetical constructs or factors, which are explanatory variables presumed to reflect a continuum that is not directly observable” (Kline, 2011). In this study, intrinsic motivation, extrinsic motivation and mathematics self-concept are latent variables (or latent constructs) because they are comprised of multiple survey items to be defined and measured.

Merriam-Webster dictionary define expectation as “a belief that something will happen or is likely to happen” and “a feeling or belief about how successful, good, etc., someone or something will be”. Thus, in this context, ‘expectations’ will refer to beliefs about students’ future mathematics achievement (Burrus & Moore, 2016).

Conceptually, motivation can be described as the processes of energized, guided, and perpetuated activities for achieving a goal (Schunk, Pintrinch, & Meece, 2008). In this study,
motivation refers to student academic motivation and when used alone, it represents both intrinsic and extrinsic motivation.

Mathematical self-concept refers to the confidence in student feelings of solving a mathematical problem and performing well on a test (Schukajlow, Rakoczy, & Pekrun, 2017).

1.6 The Role of Motivation and Expectations on Students’ Mathematics Achievement

Fields of educational research have spent extensive effort to explain the complex nature of student behavior, which is mathematics achievement in the context of this study. Some of the major concepts associated with mathematics achievement within these fields are: motivation, expectations, mathematics self-concept, math anxiety, and cognitive factors within the field of educational psychology (e.g., Froiland & Davison, 2016; Jussim & Eccles, 1992; Stevens, Olivarez, & Hamman, 2006); gender differences, socioeconomic factors, social capital, and cultural differences within the field of educational sociology (e.g., Carolan, 2012; Walker, & Berthelsen, 2017; Yan, & Lin, 2005); computer assisted instruction, graphing calculators, and game-based learning within educational technology (e.g., Barkatsas, Kasimatis, & Gialamas, 2009; Carr, 2012; House, 2011); and other related fields. This study will be constrained by the fields of educational psychology and educational sociology for two reasons. The first reason is related to the purpose of centering on the concepts that are assumed to have strong ties—based on conducted studies and research evidences—with mathematics achievement. The second reason is the availability of data in TIMSS 2015 from which intended constructs can be derived.

In this study, focusing on eighth-grade student mathematics achievement comes from the fact that mathematics achievement in high school is positively associated with college level mathematics achievement, mathematics-related career intentions, and postsecondary degree earned (Adelman, 2003; Lazarides & Watt, 2015). Research indicates that the most predictive indicators of mathematics achievement in high school are prior achievement and highest-level
mathematics course taken (Froiland & Davison, 2016). Prior achievement points to middle school student mathematics achievement. Moreover, motivation, expectations of significant others (i.e., teacher and parent expectations), and student mathematical self-concept have been found to be significant predictors of mathematics achievement, student prior achievement, and students’ highest-level mathematics course taken (e.g., Areepattamannil, 2014; Froiland & Davison, 2016; Murayama, Pekrun, Lichtenfeld, & Hofe, 2013; Parsons, Adler, & Kaczala, 1982; Smith Jussim, & Eccles, 1999). For these reasons, student motivation, expectations of significant others and mathematics self-concept additively play important roles in student middle school (including eighth-grade) mathematics achievement as well as their mathematics achievements in high school and future career.

1.7 Research Gaps and Significance of the Study

Related to motivation, expectations of significant others and mathematics self-concept, and their effect on eighth-grade students’ mathematics achievement, there are substantial gaps that are indicated in the literature that have to be addressed. First of all, most studies that are conducted about motivation focus on one-directional relations between types of motivation and mathematics achievement. Murayama, Pekrun, Lichtenfeld and Hofe (2013) indicated the need to examine reciprocal associations between intrinsic motivation, extrinsic motivation and mathematics achievement. Thus, the first research question will address this gap. Second, there is lack of evidence about causal relationship between types of motivation (i.e., intrinsic and extrinsic motivation) and academic achievement (Akben-Selcuk, 2017; Wang, Deng, & Yang, 2016). Moreover, Wooley, Strutchens, Gilbert and Martin (2010), similarly, stressed on the necessity of empirical research about causal directions about the effect of teacher expectations and student motivation on mathematics achievement. These gaps will be addressed by employing a statistical method that yield evidences for causal inference (i.e., structural equation modeling).
Research findings on dual relationship between mathematics achievement and expectations of significant others (i.e., teacher expectation and parent expectation) generally have shown mixed results (Chapter 2 for more details). The following reasons can be attributed to this confusion: earlier research about expectations has mostly utilized unidimensional analysis and reckoned without reciprocal relationships; small number of constructs and their relationships have been examined in studies; and most studies consist of small samples. Additionally, mixed results might be related to different social contexts in which research studies took place. Because of these reasons, contradictory findings emerge which hinder having a consensus among researchers to attain generalizable results. Additionally, related to this issue, Benner and Mistry (2007) stated that more studies are needed to examine congruence-dissonance of adult expectations in more detail as well as how adult’s expectations independently and conjointly influence student academic achievement. Moreover, Rubie-Davies, Peterson, Irving, Widdowson and Dixon (2010) pointed out that student, teacher, and parent expectations should be explored with large-scale datasets. The second research question will address these gaps by i) finding a correlation between teacher and parent expectations; ii) examining how congruence-dissonance of teacher and parent expectations influence mathematics achievement; and iii) using a large-scale dataset (i.e., TIMSS 2015).

A considerable amount of research exists about teacher expectations, parent expectations and student expectations and their effects on mathematics achievement. However, there is lack of theoretical perspectives with respect to ‘expectations’. Self-fulfilling prophecy (Merton, 1948) is a theory that explain the mechanism of expectations. Apart from this theory, expectancy-value theory, which is a theory of motivation, explains the effect of personal expectations and value on motivation. Froiland and Davison (2016) criticized the expectancy-value theory. According to
this theoretical perspective, student intrinsic motivation and student expectation must have stronger effects on mathematics achievement than teacher and parent expectations. However, their findings indicated that parents’ expectations have a larger influence on students’ mathematics achievement than the effect of student expectation on mathematics achievement. They recommend the necessity of more research about the effect of parent expectations on student intrinsic motivation. Therefore, to answer the third research question, this study will address these gaps by comparing the effects of parent expectations and student expectation on mathematics achievement.

In addition to these constructs (i.e., motivations, expectations and mathematics self-concept), research studies extensively investigated how gender and socioeconomic status are associated with students’ mathematics achievement (e.g., McGraw, Lubienski, & Strutchens, 2006; Tate, 1997). However, the literature lacks enough evidences for their effects as mediators. Therefore, the fourth research question will address another goal of the current study by investigating if gender and socioeconomic status mediate the effect of each construct on mathematics achievement.

Besides aforementioned reasons, more research is needed with respect to reciprocal relationships between student motivation and parental expectations (Simpkins, Fredricks, & Eccles, 2012), unification of a framework (Lee & Stankov, 2013), and different research methods pertaining to motivation, expectations and mathematics achievement (Cao, Bishop, & Forgasz, 2007; Wang, Deng, & Yang, 2016). Taking all reasons into account, the fifth research question will address these research gaps and analyze relationships between types of motivation, expectations of significant others and mathematics self-concept by employing structural equation modeling technique.
In addition to these research gaps and recommendations, a scarcity of research studies related to the context of Turkey constitutes a major rationale for conducting the current study. A review of literature in major databases (i.e., JSTOR and EBSCOHOST Academic Search Premier) demonstrates that few research studies have examined the effect of intrinsic motivation on student mathematics achievement in Turkey. However, there is only a single study with respect to the effect of extrinsic motivation on mathematics achievement (Keklik & Keklik, 2013), which included Turkish high school students in the sample. Furthermore, no research study was found related to the effect of mathematics self-concept on Turkish students’ mathematics achievement. In other words, there exists no research study with respect to the effect of extrinsic motivation and mathematics self-concept on eighth-grade students’ mathematics achievement in Turkey. Besides, the review of literature revealed no research study that examined the effect of parent and teacher expectations on eighth-grade student mathematics achievement in Turkey. In summary, this study will not only contribute to the research by addressing aforementioned gaps stated in educational research literature, but also investigate unresearched factors that influence eight-grade students’ mathematics achievement in Turkey.

To address aforementioned gaps, the Turkish portion of TIMSS 2015 dataset will be used to investigate eighth-grade student mathematics achievement with respect to intrinsic motivation, extrinsic motivation, expectations of significant others and mathematics self-concept. Furthermore, validity and reliability evidences of findings will be discussed and recommendations for educators, policymakers and researchers will be provided. The following research questions are of prime importance:

**Research Question 1:** Do intrinsic and extrinsic motivation predict eighth-grade student mathematics achievement or are they predicted by mathematics achievement?
**Research Question 2:** Does congruence-dissonance of teacher and parent expectations influence eighth-grade students’ mathematics achievement?

**Research Question 3:** Is the effect of parent expectation on eighth-grade student mathematics achievement is larger than the effect of eighth-grade student expectation on eighth-grade student mathematics achievement?

**Research Question 4:** Do gender and socioeconomic status mediate the relationship between ‘constructs of interest’ (i.e., intrinsic and extrinsic motivation, expectations of significant others, and mathematics self-concept) and eighth-grade student mathematics achievement?

**Research Question 5:** What is the association between expectation of significant others (i.e., parent and teacher expectations), motivation (i.e., intrinsic motivation and extrinsic motivation), and mathematics self-concept on Turkish eighth-grade students’ mathematics achievement?

### 1.8 Organization of the Dissertation

This chapter has provided background regarding the problem of low mathematics achievement of Turkish students. A concise overview of Turkish Educational System is provided. Then, general characteristics of TIMSS surveys are discussed and Turkish students’ mathematics achievement trend—in comparison to countries that participated in TIMSS 2015 survey—was explained. Following theoretical developments on mathematics achievement, non-cognitive factors (intrinsic motivation, extrinsic motivation, expectations of significant others, and mathematics self-concept) that influence mathematics achievement are discussed. Related to these factors, research gaps and the significance of this study is offered.

In chapter two, a brief history of major theories of motivation will be addressed. Subsequently, findings of relatively recent research studies about types of motivation and their
association with mathematics achievement will be evaluated and discussed. Theoretical developments and research studies pertaining to expectations will be addressed in a similar order. Afterwards, some other factors related to mathematics achievement will be explained (i.e., mathematics self-concept, gender, socioeconomic status). The literature review will be concluded with a model that summarizes research evidences. The chapter will end with the research questions and hypotheses.

The third chapter will cover methodology. The chapter will start with the purpose of the study. Then, the developmental procedure of data source (i.e., TIMSS 2015), the sample of interest, description and operationalization of the variables, and a discussion of validity and reliability of the items will be provided. Methodology chapter will end with the description of the data management and analysis procedures.

In chapter four, results of data analyses will be reported by addressing each research question and evaluating the hypotheses. Tables and figures related to data analyses will be included.

In the fifth chapter, results will be interpreted with respect to research questions. By matching hypotheses with the results, possible explanations will be provided for expected and unexpected results. The implications of the findings of the study will be discussed. After describing the limitations of the study, the directions for future studies will be given. The chapter will end with a general conclusion.
CHAPTER 2
THEORETICAL FRAMEWORK

In contrast to reductionist approaches which focuses on a single factor to explain psychological or behavioral constructs (such as mathematics achievement), social cognitive theory acknowledges the complex nature of behaviors and describes learning as the product and processes of triadic reciprocal relationships between human agency, the environment and the behavior (Bandura, 1989). This reciprocity comes from the fact that individuals are rooted and function within sociocultural influences and they are both producers and products of their environments (Pajares, 1996). In this study, social cognitive perspective will be employed, and within this framework, personal factors (e.g., self-concept, motivation, and expectation) associated with environmental factors (i.e., expectations of significant others such as teachers, parents) will be utilized in order to explain student behavior (i.e., mathematics achievement) by taking confounding factors into account. Prolific research evidences for the effect of these factors on both students’ mathematics achievement and other constructs of interest will be provided. As a result, a network of factors that are influencing mathematics achievement will be integrated into a condensed theoretical framework.

2.1. Motivation

Motivation can be described as the processes of energized, guided, and perpetuated activities for achieving a goal (Schunk, Pintrinch, & Meece, 2008). Among the types of motivation (e.g., achievement motivation, goal theory, attribution theory etc.), in this study, achievement motivation, namely, students’ motivation for mathematics achievement will be examined. Nevertheless, major theoretical developments of research in motivation will be discussed in the following section. Afterwards, a synopsis of research findings about motivation pertaining to mathematics achievement will be provided.
2.1.1 Overview of Theories of Motivation

Theoretically, the complex nature of the construct of motivation have evolved since motivation began to be studied as a discipline in 1930s. The early contributors of research in motivation were Kurt Lewin, Henry Murray, Clark Hull and Gordon Alpert (Maehr & Meyer, 1997). Initial explanations of motivation centered on the factors which stimulated behavior (Zhu & Leung, 2011). For example, Hull proposed a drive theory which asserted that hunger, thirst, sex, and the avoidance of pain are four main drives that gives impetus to human action (as cited in Deci & Ryan, 1985). Besides, initial explanations of motivation were guided by ‘machine metaphor of motivation’ (Weiner, 1990; e.g., Spence, 1958). Deci & Ryan (1985) states that psychoanalytic theory of motivation focuses on unconscious urges and their relationship to objects while behavioral theory of motivation emphasizes ‘stimulus-response associations that developed through reinforcement (i.e., drive-reduction) processes’. They categorize both theoretical domains as ‘mechanistic’ because these theories give choices and intentions a secondary role (or not at all). Hull’s conceptualization of motivation as a hydraulic machine that explain how basic drives guide, inhibit or reinforce behavior (as cited in Maehr & Meyer, 1997) is such an example. Furthermore, need and activity level, incentives, equilibrium and homeostasis were some of the contents of the chapters on motivation in the Encyclopedia of Educational Research in 1941 and 1950 (Weiner, 1990). Moreover, related to educational applications, during this timeframe, researchers focused on praise and reproof, success and failure, reward and punishment, and cooperation and competition. These early attempts indicate a dominant behaviorist perspective in motivational research. Therefore, failing to account for the complexity and richness of human motives is apparent in early research (Maehr & Meyer, 1997).

Emergence of cognitive science in 1950s shifted the orientation of theory and research in motivation, and by the beginning of 1960s, the concept of goals replaced the concept of needs
Instead of stimulus-response associations, choice and decision making were used to explain the direction of behavior (Deci & Ryan, 1985). A prominent and pioneering cognitive motivation theory is expectancy-value theory (Zhu & Leung, 2011) which views motivation as a product of perceived probability of success and the intrinsic value of success (Atkinson, 1957; Eccles, Midgely, & Adler, 1984; Elliot & Dweck, 2005; Schunk, 1991; Wigfield, 1994; Wigfield & Eccles (2000). Atkinson’s (1957) conceptualization of motivation which was based on expectancy-value framework that is centered on risk-taking behavior has been extended to include the whole range of behaviors. Moreover, individual’s perceived competency in mastering a task by their abilities (i.e., self-efficacy) has been accepted as an essential component of expectancy-value theory (Dalton, 2010; Martin & Dawson, 2009). Eccles and colleagues operationalized subjective task value and divided it into four components: attainment value, intrinsic value, utility value, and perceived cost (Simzar, Martinez, Rutherford, Domina, & Conley, 2015; Wigfield, 1994; Wigfields & Eccles, 2000). Wigfield (1994) explained these components as following: attainment value is the importance of doing well on a task; intrinsic value is similar to intrinsic motivation, which shows the enjoyment one gains from doing a task; utility value is the degree to which success on a task aligns with the individual’s future plans; and cost indicates what one has to give up succeeding on a task or the anticipated effort.

In educational context, two sets of beliefs (i.e., expectations of success and subjective task value) jointly indicate student motivation and impact student engagement in a subject, their educational choices, and their achievement (Schukajlow, Rakoczy & Pekrun (2017). In a nutshell, individuals are motivated to act for success when they perceive the success on a task as attainable and if the task has a value for the individual (Schunk, 1991). In a similar vein,
motivation to avoid failure can be formulated similarly. Individuals avoid taking action when they perceive likelihood of failure and have a negative incentive value of failure (Martin & Dawson, 2009). Additionally, Wigfield and Tonks (2002) extended the framework to include the influence of social factors on motivation. They assert that significant others (e.g., peers, parents and other ‘significant others’) impact students’ expectancies and values. Thus, individual’s motivation is largely influenced by the perceived probability of success, perceived value of the task, and the degree of social support one receives from significant others.

In 1970s, the concept of voluntarism started to become widespread in research in motivation (Zhu & Leung, 2011). This movement extensively stresses on the self as a major component of motivation. In accordance with this movement, self-determination theory (Deci & Ryan, 1985, 1991, 2000) was developed. Self-determination theory proposes that motivation is multidimensional and can be categorized in three dimensions, i.e., intrinsic motivation, extrinsic motivation, and amotivation (Areepattamannil, 2014; Deci & Ryan, 1985, 2000, 2008). Intrinsic motivation is the inner energy source that activate the organism to engage with a task (Deci & Ryan, 1985), which promotes psychological growth (Deci & Ryan, 2000). In other words, motivation engages persons in a task and shaped by inherent pleasure attained by engaging in a task (Murayama, Pekrun, Lichtenfeld & Hofe, 2013). For example, a student is said to be intrinsically motivated if s/he learns mathematics for the desire to learn, finding it interesting or the enjoyment obtained from learning.

Intrinsic motivation is separated from earlier drive theories in which energy is assumed to be intrinsic to the nature of the organism. Although intrinsic motivation has a similar conceptualization of intrinsic value in expectancy-value theory (Wigfield & Eccles, 2000), they differentiate in terms of value hierarchy. Particularly, in self-determination theory, intrinsic
motivation is the highest form of motivation, i.e., intrinsic motivation has a larger influence on learning than extrinsic motivation. However, expectancy-value theory considers intrinsic value or utility value to create a similar advantage on learning (Froiland & Davison, 2016). As a final point, although a majority of researchers use intrinsic motivation as a single construct, Vallerand and Ratelle (2002) proposed a taxonomy of intrinsic motivation, which includes intrinsic motivation to learn, intrinsic motivation to accomplish things, and intrinsic motivation to experience stimulation.

Another dimension of self-determination theory is extrinsic motivation, which is a form of motivation that activates the organism for attaining contingent/extrinsic outcomes (Deci & Ryan, 1985). In some research articles, it is rephrased as instrumental motivation. For example, a student is said to be extrinsically motivated if he learns mathematics for the sake of obtaining a reward or for avoiding punishment. Deci and Ryan (1985) classified extrinsic motivation into four types and ordered them to reflect varying degrees of self-determination and autonomy. From the least intrinsic form of extrinsic motivation to a more autonomous one, these types of extrinsic motivation are suggested: external regulation, introjected regulation, identified regulation, and integrated regulation. Each of these steps represents a progress toward internalization. Externally regulated behaviors are performed solely for external rewards that satisfy the person. Introjected regulation defines a state where students perform an action with the purpose of avoiding shame and guilt and maintain self-esteem. Identified regulation is a more autonomous state where the person embraces the new behavior, matches the behavior to his/her personality by attaching personal importance. The most autonomous form of extrinsic motivation is integrated regulation, in which one completely assimilates new regulations and adapt them to other personal values and needs. Although these types of extrinsic motivation change from the least autonomous regulation
toward self-controlled decision making and choice, they differ from intrinsic motivation based on the fact that engagement with the task or behavior are initiated for external rewards and outcomes. Nonetheless, “the more fully it [extrinsic motivation] is internalized and integrated the more positive are its consequences” (Deci & Ryan, 2000, p. 260).

Covington and Mueller (2001) argues that although intrinsic and extrinsic motivation are not equally valued, they are compatible and coexist in varying degrees and conditions. Research has shown mixed results about mutual relationship between intrinsic and extrinsic motivation and their effect on academic achievement. In other words, in some cultural contexts intrinsic and extrinsic motivation have positive associations with academic achievement. Yet, many studies indicate that extrinsic motivation shows a negative association with learning. For example, Zhu and Leung (2011) used TIMSS 2003 eight-grade mathematics data of East Asian countries (i.e., Hong Kong SAR, Japan, Republic of Korea, Singapore, and Chinese Taipei) and four Western countries (i.e., Australia, England, The Netherlands, and the USA). They found that both intrinsic and extrinsic motivation benefited East Asian students’ mathematics achievement. For Western countries, intrinsic motivation had positive association with mathematics achievement while extrinsic motivation had a negative association with mathematics achievement. This example shows not only distinct effects of intrinsic motivation and extrinsic motivation on mathematics achievement, but also the mediating role of culture and educational setting on those effects. A more comprehensive review of literature on this relationship will be provided in the following sections.

Although the concepts of intrinsic and extrinsic motivation are not peculiar to self-determination theory, they are highly emphasized in this theory. Relatedness, competence, and autonomy (Zhu & Leung, 2011), which are basic human needs for psychological growth and
development, are distinctive characteristics of self-determination theory, which differentiate it from other theories of motivation that partly include some aspects of intrinsic and/or extrinsic motivation. Self-determination theory claims that when these needs (i.e., relatedness, competence, and autonomy) are met by significant others (e.g., peers, parents, and other adults), individuals’ intrinsic motivation can be maintained or enhanced (Deci, 1971; Froiland & Worrell, 2017; Ryan & Deci, 2000). Relatedness refer to connections with others and sense of belonging in a social context from which individual benefits warmth, support and nurturance (Martin & Dawson, 2009). Furrer and Skinner (2003) states the prominence role of relatedness as:

Feelings of relatedness tapped by measures of school climate and quality of teacher–student relationships, as well as feelings of belonging, inclusion, acceptance, importance, and interpersonal support, have been linked to important academic outcomes, including self-efficacy, success expectations, achievement values, positive affect, effort, engagement, interest in school, task goal orientation, and school marks. (p. 149)

These constructs, which are individual’s basic psychological needs, do not work independently. Feeling of relatedness, competence and autonomy, more or less, must be satisfied in concert. Ryan & Deci (2000) present factors that might facilitate or undermine intrinsic motivation in certain conditions. For example, based on cognitive evaluation theory—which is presented by them, they claim that intrinsic motivation and learning can be facilitated if feeling of competence is accompanied by feeling of autonomy. In addition, they claim that when the balance between autonomy versus control shifts toward more control, namely, from ‘a more internal to external perceived locus of causality’, may undermine intrinsic motivation. In conclusion, according to self-determination theory, individual’s enhanced intrinsic and extrinsic motivation must be accompanied by fairly synergistic combination of feeling of relatedness, competence, and autonomy.
A third concept of motivation in self-determination theory is amotivation (Ryan & Deci, 2000). Prior to the development of self-determination theory, research in motivation had considered two distinction: motivation and amotivation. Amotivation refers to the state of lacking motivation to perform an activity. This situation may be associated with not valuing the activity (Ryan, 1995), frustration of basic needs (Deci & Ryan, 2000), or avoidance of activity due to lack of self-competence (Deci, 1975).

Expectancy-value theory and self-determination theory are commonly utilized two prominent theories of motivation in the context of mathematics education (Schukajlow et al., 2017). However, other commonly known theories of motivation have been developed and utilized by researchers are attribution theory (Weiner, 1985) and goal theory (Dweck, 1992; Martin & Dawson, 2009; Pintrich, 2000). Attribution theory of motivation and emotions addresses the causes of success and failure that individuals attribute to the events and explains how these attributions cognitively, affectively, and behaviorally impact individual’s future behaviors (Martin & Dawson, 2009). This theory proposes three dimensions of causal thinking: locus, stability, and controllability. These causal dimensions have psychological consequences on cognition and affect. For example, Weiner (1985) perceived that locus of causality impacts pride and self-esteem; perceived stability impacts expectancy of success (cognitive) and hopelessness/hopefulness (affect); and perceived controllability of causes impacts shame, guilt, anger, gratitude, and pity. These constructs later result in behavioral consequences such as achievement or persistence.

Goal theory explains the meanings students attribute to the achievement and their purpose for taking action. Two general goals are indicated in the literature: mastery orientation goals and performance orientation goals. The former refers to the desire to claim competence and the latter
refers to the desire to corroborate superiority. According to Pintrinch (2000), these explanations can be categorized as approach versions of mastery and performance goals. Similarly, these dimensions can be explained from an avoidance perspective. Mastery orientation goals can be described as the desire to avoid misunderstanding or avoiding not mastering a task. Performance orientation goals, also, can be described as the desire to avoid looking inferior or avoiding disapproval. Martin and Dawson (2009) assert that teachers, parents or peers may have distinct impact on individual’s various goals.

2.1.2 Recent Research on Motivation and Mathematics Achievement: Mixed Findings and Mutual Relationship

A review of research indicates ample evidence about positive association between motivation and mathematics achievement, albeit the existence of contrary arguments and findings that will also be discussed. In educational research, mostly agreed and researched types of motivation are intrinsic and extrinsic motivation. In this section, connection between mathematics achievement and both intrinsic and extrinsic motivation will be discussed.

2.1.2.1 Intrinsic motivation and mathematics achievement

Pioneering studies about intrinsic motivation date back to the early 1970s when behaviorist theories still had relatively strong influence on empirical psychology (Deci & Ryan, 2000). Deci (1971)’s study found negative effect of tangible reinforcement (i.e., monetary rewards) on intrinsic motivation. This finding highlighted the importance of understanding motivational processes and challenged then-existing consensus of ‘positive effect of reinforcement on intrinsic motivation’ (Deci & Ryan, 2000). Since then, literature substantially provide evidences for significant association between intrinsic motivation and mathematics achievement.
Students with higher intrinsic motivation, in general, demonstrate higher mathematics achievement compared to students with lower intrinsic motivation (e.g., Akben-Selcuk, 2017; Areepattamannil, 2014; Areepattamannil, Freeman, & Klinger, 2011; Froiland & Davison, 2016; Murayama, Pekrun, Lichtenfeld, & Hofe, 2013; Zhu & Leung, 2011). Both cross-sectional and longitudinal studies support this connection. Intrinsic motivation influence mathematics achievement both directly and indirectly. For example, Froiland and Davison (2016) found that intrinsic motivation predicts mathematics achievement directly. Additionally, they found that intrinsic motivation predicts mathematics achievement indirectly: via highest level of mathematics course taken by 11th graders and ninth-grade achievement, which both predicted mathematics achievement. While there is a consensus about the positive relationship between intrinsic motivation and mathematics achievement, in the literature, some contrary findings exist. For example, a study conducted by Areepattamannil (2014) did not found a significant and positive relationship between academic motivation (intrinsic motivation and extrinsic motivation) and mathematics achievement among Indian adolescents in India while a positive association is found among immigrant Indian adolescents in Canada. However, research findings provide evidences for the conclusion that intrinsic motivation improves students’ mathematics achievement in general.

This strong predictive power of intrinsic motivation on students’ mathematics achievement direct one’s attention to the importance of factors that improve students’ intrinsic motivation. One factor to consider is cultural/national differences. Areepattamannil, Freeman and Klinger (2011) conducted a study on Indian adolescents in India and immigrant Indian adolescents in Canada. They found that Indian immigrant adolescents in Canada were more intrinsically motivated than their counterparts in India. Their findings suggest that individuals
within distinct cultural contexts may have dissimilar level of motivation, albeit being from the same nation. Moreover, they underlined the fact that various cultural contexts (e.g., collectivist vs. individualist) may have different effects on mathematics achievement. McInerney (2007) claims that transporting motivational theories to new cultural or social settings may cause unexpected consequences when individual or group behaviors don’t match. One example is Asian students’ high achievement but relatively low intrinsic motivation (Schunk, Pintrinch, & Meece, 2008). Therefore, social and cultural context needs to be taken into account when the goal is to research the effect of intrinsic motivation on mathematics achievement or to improve students’ intrinsic motivation.

Another factor that has an effect on intrinsic motivation is parents’ involvement and educational aspiration for their children. There is fairly strong evidence that parents’ educational aspirations (Fan & Williams, 2010) and parental involvement in school activities (Grolnik & Slowiaczek, 1994) improve students’ intrinsic motivation. However, Gottfried, Marcoulides, Gottfried, Oliver and Guerrin (2007) found that parents’ effect on students’ motivation gradually decreases over time as students get older. Furthermore, Froiland and Davison (2016) found that highest level of math course taken and peer interest in mathematics predicted students’ intrinsic motivation. Bissell-Havran and Loken (2009) also found the same conclusion, that is, peer interest in mathematics had students have higher intrinsic motivation. Additionally, from a developmental perspective, intrinsic motivation in mathematics is found to decrease during middle school and high school years (Lee & Kim, 2014).
2.1.2.2 Intrinsic motivation and extrinsic motivation

Atkinson (1957) formulized motivation as a function of motive, expectancy and incentive. He applied pure algebraic logic to ‘motivation to approach and avoidance’ and claimed that when motivation to approach and avoidance are simultaneously aroused, aftereffect is the sum of approach and avoidance. Here, ‘motivation to approach’ occurs when one performs a particular behavior for positive consequences and ‘motivation to avoid’ occurs when avoiding a behavior that results in negative consequences. According to this logic, when the effects of approach and avoidance are equal, their summation is zero. Since the ultimate goal of educational research is to improve student achievement and its associated factors (e.g., motivation), this problem necessitated a form of motivation apart from intrinsic motivation. What makes extrinsic motivation a complementary theoretical concept relies on the fact that all tasks in teaching and learning are not ‘inherently enjoyable or interesting’ to students (Ryan & Deci, 2000). In other words, solely improving intrinsic motivation may not produce desired outcomes. In addition to improving intrinsic motivation, educators need to extrinsically motivate passive students to actively join tasks.

Past research has considered tangible and intangible incentive mechanisms (Covington, 2000) for explaining students’ motivation for learning and achievement. Intangible incentives like pride, self-esteem, enjoyment, satisfaction of personal curiosity may either be intrinsic or extrinsic based on the cause of the action and reward. Tangible incentives, on the other hand, are extrinsic rewards, include physical rewards and socio-psychological rewards like social acceptance, gold stars or grades. Research in motivation for mathematics achievement has examined extrinsic motivation, in addition to intrinsic motivation, about the effects of tangible and intangible incentives on student mathematics achievement. Although existing research provide evidences for positive and mostly significant effect of intrinsic motivation on
mathematics achievement, research findings on the effect of extrinsic motivation on mathematics achievement depicts a mixed picture. Nevertheless, student intrinsic and extrinsic motivation can be manipulated with differing degrees—depending on situation such as task, subject-matter, student interest—to enhance student achievement (Skinner & Belmont, 1993).

The early literature mostly shows negative effect of extrinsic motivation on intrinsic motivation (Deci, 1975; Deci & Ryan, 1985; Greene & Lepper, 1974; Lepper & Greene, 1975; Lepper, Greene, & Nisbett, 1973; McCullers, Fabes, & Moran, 1987), especially, when the extrinsic motivator is controlling rather than autonomous (Deci & Ryan, 1985). Namely, students with high level of intrinsic motivation for a subject or a task show lower level of extrinsic motivation, and vice versa. Moreover, the detrimental effect of extrinsic motivation on intrinsic motivation show itself in the form of dependence on incentives. Students who are motivated by external incentive show lower intrinsic motivation in the absence of incentive. A meta-analysis conducted by Rummel and Feinberg (1988) found the detrimental effect of extrinsic rewards on intrinsic motivation. However, out of 88 effect size reported, 5 studies showed positive effect of extrinsic rewards on intrinsic motivation. Another meta-analysis conducted by Wiersma (1992) found that extrinsic motivation undermines intrinsic motivation. Additionally, he found that extrinsic motivators improved task performance. In summary, the early literature mostly asserted the detrimental effect of extrinsic motivators on intrinsic motivation based on their findings.

Recent findings, however, reveal contradictory findings. For example, Liu and Hou (2018) analyzed NELS88 (National Education Longitudinal Study of 1988) dataset which includes three waves of dataset of eight-grade students in 1988, 10th-grade students in 1990 and 12th-grade students in 1992. Their analyses revealed positive correlation between intrinsic motivation and extrinsic motivation (test-taking motivation); namely, both motivations predicted
greater achievement. Similarly, Lee and Stankov (2013) analyzed PISA dataset. They found positive correlation between intrinsic and extrinsic motivation (r = 0.60). Pelletier et al. (1995) also conducted a study about student motivation toward sport. Their result indicated positive correlation between intrinsic and extrinsic motivation. The only negative correlation they found was between intrinsic motivation and amotivation. Moreover, Leung (2001) emphasized the culture as a mediator between the relationship among intrinsic and extrinsic motivation. He claimed that the relationship between intrinsic and extrinsic motivation and their effect on achievement may differ in East Asian countries. Along the same line, Areepattamannil, Freeman and Klinger (2011) and Areepattamannil (2014) conducted studies on Indian adolescents in India and Indian immigrant adolescents in Canada. They reported that intrinsic and extrinsic motivation have different effects on achievement when the context is taken into account. For instance, they found that intrinsic motivation was a positive predictor of mathematics achievement while extrinsic motivation was a negative predictor of mathematics achievement among Indian adolescents in Canada. However, for Indian adolescents, extrinsic motivation had a positive but nonsignificant effect. A study conducted by Corpus and Wormington (2014) in the U.S. showed negative correlation between intrinsic motivation and extrinsic motivation. Taken all these findings into account, literature indicates distinctive effect of cultural context. In other words, there is no clear-cut distinction or antagonist effect between intrinsic motivation and extrinsic motivation. Furthermore, they might be complementary (Lynn, 1988). Thus, because theoretical foundations about intrinsic and extrinsic motivation differ in distinct cultural contexts, the effects of these types of motivation on mathematics achievement might follow a different path in the educational and cultural context of Turkey.
In summary, in contrary to past debate about the detrimental effect of extrinsic motivation on intrinsic motivation, recent research findings provide evidences for the counter argument. As Lepper et al. (1996) suggest, extrinsic motivation that results in achievement and competence can enhance intrinsic motivation. The detrimental effect of extrinsic motivation on intrinsic motivation can occur when extrinsic motivators result in constraints and control that leads to less autonomy.

2.1.2.3 Extrinsic motivation and mathematics achievement

As discussed above, research in extrinsic motivation has showed mixed results. With respect to mathematics achievement, Areepattamannil (2014) and Areepattamannil, Freeman, & Klinger (2011) found that extrinsic motivation is a negative predictor of mathematics achievement for the Indian immigrant adolescents in Canada. However, extrinsic motivation was a positive but nonsignificant predictor of mathematics achievement among Indian adolescents in India. Murayama, Pekrun, Lichtenfeld and Vom Hofe (2013) conducted a longitudinal study in Germany on 3530 students. The study tracked students from grade five through grade 10. They found reciprocal relationship between extrinsic motivation and academic achievement.

Liu and Hou (2018) analyzed National Education Longitudinal Study of 1988 (NELS88) dataset which includes three waves of dataset of eight-grade students in 1988, 10th-grade students in 1990 and 12th-grade students in 1992. Their analyses revealed that test-taking motivation, which is extrinsic motivation, significantly predicted mathematics achievement. Moreover, the analyses showed that mathematics achievement significantly predicted their future extrinsic motivation. Murayama, Pekrun, Lichtenfeld and Vom Hofe (2013) conducted a longitudinal study on 2530 students (grade 5 through 10) in Germany. Latent growth curve modeling results indicated that extrinsic motivation predicted initial levels of mathematics achievement but did not predict the growth in mathematics achievement. In other words,
extrinsic motivation was shown to be a short-lived, unstable and near-term predictor in comparison with intrinsic motivation, which predicted longer term mathematics achievement. Zhu and Leung (2011) analyzed TIMSS 2003 dataset and the sample included eight-grade students from nine countries: five East Asia countries (Hong Kong, Japan, Republic of Korea, Singapore, and Chinese Taipei) and four Western countries (Australia, England, The Netherlands, and the USA). Their item that represent extrinsic motivation is described as productivity-related motivation (i.e., learning for utilitarian purposes) and corresponds to Deci & Ryan’s (1985) concept of identified regulation. They found positive correlation between productivity-related motivation and mathematics achievement in all nine countries. Moreover, regression analyses revealed that productivity-related motivation positively and significantly predicted mathematics achievement in Hong Kong, Japan, Korea, and Taiwan. Among East Asia countries, only in Singapore, there was negative but nonsignificant association between productivity-related motivation and mathematics achievement. On the contrary, all four Western countries showed negative association between productivity-related motivation and mathematics achievement and the results were significant for Australia, The Netherlands, and the US.

Pertaining to Turkish educational context, Akben-Selcuk (2017) analyzed Turkey portion of PISA 2012 dataset. Her findings revealed positive but nonsignificant relationship between extrinsic motivation and mathematics achievement. As a result, recent research findings mostly indicate positive but not very significant association between extrinsic motivation and mathematics achievement. Another crucial point is the fact that particular educational and societal context may change the degree and the direction of this association. There is no universal agreement about the relationship between types of motivation and mathematics achievement.
2.2 Expectations

2.2.1 Theoretical Developments over Expectations

A review of past literature indicates a relatively narrow coverage of the effects of expectations on student mathematics achievement. A historical glance at the theoretical developments of expectations acknowledges this fact. Mostly utilized theoretical perspective about expectations date back to 1948 when Merton defined self-fulfilling prophecy. Merton described prophecies as the public interpretation of a situation. He believed prophecies influence subsequent actions and consequences. Pertaining to academic achievement, for example, if a teacher conveys his negative perceptions and beliefs to a student about his incapability of passing an exam, and if subsequently, student internalize such belief and alter his goals, effort and performance according to this belief or expectation, then failing the exam becomes a high probability scenario. Here, a new behavior, which is created based on a false definition (i.e., the teacher’s negative expectation of the student), comes true. Merton (1948) describes this situation as self-fulfilling prophecy. According to him, this phenomenon is a result of ‘perversities of social logic’ when the initial prophecies are false. Merton expressed his views within the field of sociology. Yet, the same phenomenon often occurs in educational settings in the form of expectations. Brophy and Good (1970) explained the mechanism of this phenomenon in the form of teachers’ communication of differential expectations for children’s achievement. The authors claimed that teachers’ initial expectations depend on many factors like student past performance, student behaviors, and dyadic interactions with students. They, further, modeled their findings and explained the cycle of self-fulfilling prophecy as: 1) teacher forms different expectations for students; 2) teacher treatment to students differs based on his expectations, that is, teacher praises better performance of students for whom he holds higher expectations and accepts lower performance of students he holds lower expectations, or even though sometimes happens, teacher
more likely ignores lower performance of students he holds higher expectations but less likely praises higher performance of students he holds lower expectations; 3) the quality and quantity of teacher interaction with students differ; 5) students’ perceive teacher expectations and their perception alters their motivation, interest in school work and self-concept; 6) student achievement improves/decreases based on expectations; and 7) teacher realizes the change in achievement and feels supported in the judgement of his expectations of students.

Previous research mostly focused on student intelligence as the determinant of scholastic achievement. Utilization of intelligence tests (such as Weschler, 1939) as the determinant of student achievement was a common practice. One of the most noticeable publication of the time was Coleman Report (1966), which opened a new door in educational research. After Coleman Report, researchers widened their perspectives, and apart from intelligence test scores, they began studying student background characteristics, school characteristics, peer influences, motivation and expectations of significant others to explain student achievement. For example, Rosenthal and Jacobson (1968) published their seminal work ‘Pygmalion in the Classroom’. They conducted an experiment on first through sixth grade students. They randomly picked a group of children (the experimental group) within each classroom and introduced them to teachers as ‘growth spurters’ based on a non-existent intelligence scale. The researchers, who sought to find the degree to which teachers’ expectations of students influence student achievement, found startling effect of teachers’ expectations on first- and second-grade students’ subsequent achievement. Total IQ gains in experimental group in these grades was much higher than control group. They suggested two possible interpretations for the result: i) younger children are more sensitive to change in critical ages and teacher expectations may have larger effect on their success, and ii) children in first grades have less well-established reputation by teachers and
nonsignificant change found in higher grades might be related to teachers’ familiarity with older students and disbelief of the prophecy. The authors concluded that one’s expectation of another person may give rise to self-fulfilling prophecies. Similarly, Rist (1970) conducted an observational study in an urban school with the purpose of investigating how schools help social class structures to persist in society in the form of self-fulfilling prophecy. The author found that teacher expectations were altered by student socioeconomic background. For example, kindergarten teacher defined ‘fast learners’ as those who possess the norms and behaviors of ‘middle class educated adults’. In other words, the teacher did not base her evaluation of students on any measurable academic potential. Furthermore, first- and second-grade teacher base her expectations on students’ socioeconomic background and prior achievement. Consequently, as a repeatedly accumulating self-fulfilling effect, differing treatment to students (e.g., seating arrangements, teachers’ stimulus, and feedback to student responses) emerged in classroom. The author concluded that “within the system of segregation established by the teachers, the group perceived as slow learners were ascribed a caste position that sought to keep them apart from the other students. Those expected to do well by the teacher did so” (p. 444). These seminal works attracted attention to the effects of expectations in educational research.

Another contribution to theory of expectations was made by Bandura. Bandura (2004) proposed that outcome expectations and efficacy beliefs play central roles in behavioral change. According to him, outcome expectations have three subdomains. These domains are physical outcome expectations, social outcome expectations and self-evaluative outcome expectations. Physical outcome expectations refer to the beliefs that individuals engage in certain activities for desired physical experiences (i.e., pleasurable and aversive effects). Social expectations reflect the belief that behaviors are regulated depending on social approval or disapproval. Self-
evaluative outcome expectations reflect the belief that individuals set personal standards and regulate their behaviors based on perceived self-evaluative reflections such as self-satisfaction, self-worth, or self-concept (Bandura, 2004; Wójcicki, White & McAuley, 2009). Among these types of expectations, physical outcome expectation reflects and impacts student expectation. Social expectations are assumed to influence student behavior and expectation upon satisfying demands by environment. For instance, teacher expectation and parent expectation can have positive influences on student mathematics achievement if student regulates his effort and performance for gaining social approval by teachers and parents. Finally, self-evaluative outcome expectations explain a continuous formation of behavioral change via self-evaluative reflections on the behavior. This concept implies that the effect of student expectation, teacher expectation and parent expectation are consistently regulated by students’ reflections (i.e., efficacy, satisfaction, and self-concept) about the outcome.

Following the findings that are reported earlier, Luce and Hoge (1978) and Parsons, Kaczala and Meece (1982) analyzed the effect of teacher expectations on student achievement, and although they reported differential treatment of teachers toward low- and high-expectancy children. They claimed the existence of small or negligible effect of teacher expectations on student achievement. However, Jussim and Eccles (1992) analyzed data gathered from 1731 students and 98 teachers. They found that teacher expectation of student predicted student final grades, which is an evidence for self-fulfilling prophecy. Their findings also revealed that teachers’ expectations predicted student final grades but had little relation to standardized test scores. This finding indicates perceptual bias in teachers’ expectations. Apart from teacher expectations, Smead and Chase (1981) studied the effect of student expectations on achievement along with the effect of parent and peer expectations on student expectations. Additionally,
Thompson, Alexander and Entwistle (1988) studied the effect of parents’ expectations on mathematics and reading achievement. Both studies found significant effect of expectations (i.e., student expectations, parent expectations) on achievement outcomes. In summary, although some contrary findings are reported in the literature, early research on the effect of student, teacher, and parent expectation on student future achievement provides fairly strong evidences for the theory.

2.2.2 Research on Teacher Expectations and Mathematics Achievement

NCTM’s position statement (https://www.nctm.org/Standards-and-Positions/Position-Statements/High-Expectations) indicate that teachers are responsible for helping students build a positive mathematical identity and a sense of agency by communicating high expectations to all students. Nevertheless, mathematics teachers implicitly or explicitly naturally develop high or low expectations with respect to students’ previous achievement, motivation, effort or classroom behavior. Consistent with the self-fulfilling prophecy (Merton, 1948), research findings indicate that teacher expectation of student can significantly impacts student mathematics achievement (e.g., Bergh, Denessen, Hornstra, Voeten, & Holland, 2010; Benner & Mistry, 2007; Peterson, Rubie-Davis, Osborne, & Sibley, 2016; Smith, Jussim & Eccles, 1999) and is impacted by it (Jussim & Eccles, 1992). Miller and Turnbull (1986) propose that the effect of teachers’ expectations on students’ achievement is much greater than the influence of students’ achievement on teachers’ expectations of the student. In a similar vein, Wooley, Strutchens, Gilbert, and Martin (2010) found that teachers’ expectations have a larger impact on students’ motivation than the effect of students’ motivation have on teachers’ expectation. Thus, teachers have a significant impact on students’ motivation, effort, performance and achievement.

Researchers, therefore, warn the degree of accuracy of teacher’ expectations may have immense consequences on students’ academic achievement. According to Murata (2013),
teachers in the United States sets high expectations for their students albeit these expectations are “stratified and varied according to the assumed ability levels and backgrounds of the particular students” (p. 330). Although teachers’ expectations of their students are mostly accurate, if biased, their expectations can have tremendous effect on stigmatized student groups (Jussim & Harber, 2005; McKown & Weinstein, 2002). According to these claims, if teacher expectations of students are determined by their prejudices, low expectancy students may attribute their academic failure to internal or external factors, and consequently, when confronted with difficulties, they will less likely to show desired level of effort (Elliot, Hufton, Hildreth, & Illusion, 1999), and subsequently, may self-fulfill teachers’ initial false prophecy. Such biased teacher expectation essentially has long-term detrimental effects since majority of such bias is sustained in time (De Boer, Bosker, & Werf, 2010). For these reasons, research evidences with respect to the effect of teacher expectation of students must be seriously taken into account.

In parallel with these claims, understanding the extent to which teacher expectations create or reflect reality (i.e., student achievement) is fundamentally important. Jussim and Eccles (1992) analyzed data collected from 1731 sixth-grade students and 98 teachers. They found that teachers’ expectations were predicted by students’ previous standardized test scores, final marks in fifth-grade mathematics class, and students’ mathematics self-concept. This finding indicates that teacher expectation partly reflects student achievement. On the other hand, researchers also found that teachers’ perceptions of effort and performance predicted students’ grades more than their standardized test scores. In other words, 20% of students’ standardized test achievement represented self-fulfilling prophecy while 35%-65% of student grades represented self-fulfilling prophecy. This finding provides evidences for the claim that teacher expectations partly create
student achievement. Combining these results, it can be concluded that there must be a reciprocal relationship between teacher expectation and student mathematics achievement.

From these results, it can be inferred that experimentally intervening in teacher expectations will result in higher student mathematics achievement. A recent intervention study by Rubie-Davis and Rosenthal (2016) was conducted in New Zealand that aimed at investigating the effect of teacher expectation on student mathematics achievement. In the study, intervention group consisted of teachers who attended a series of workshops at which research in teacher expectations and mathematics achievement was taught. The teachers in control group did not attend those workshops though. Over a one year, students in intervention group significantly improved mathematics achievement in comparison to the control group students. The authors concluded that students’ mathematics achievement can be improved by informing mathematics teachers through workshops or professional development trainings about research findings related to the effect of teachers’ high expectations on students’ improved mathematics achievement. From a practical point of view, manipulating all factors that influence students’ mathematics achievement may not be feasible. However, an advantage of manipulating teacher expectation is described by Wineburg (1987) as:

Educational researchers are naturally drawn to studying variables they can control, and obviously teachers’ expectations are much easier to manipulate than students’ social class or parents’ educational attainments. (p. 35)

2.2.3 Research on Parents Expectations and Mathematics Achievement

Parents’ educational expectations constitute a form of cultural capital (Tan, 2015). Theoretically, self-fulfilling theory posits that communication of parents’ expectations to students may impact their future achievement. Moreover, expectancy-value theorists assert that parent expectations exert an effect on student achievement by improving student expectations (Wigfield & Eccles, 2000). Self-determination theorists, on the other hand, assert that parent
expectations improve student motivation, which subsequently improves student achievement (Farkas & Grolnick, 2010). Similar to the effect of teachers’ expectations on students’ mathematics achievement, research studies indicate that parents’ expectations might have a reciprocal relationship with student achievement. The majority of studies found that parents’ expectations predict students’ achievement (e.g., Benner & Mistry, 2007; Froiland & Davison, 2016; Ma, 2001; Parsons, Adler, & Kczala, 1982; Thompson, Alexander, & Entwisle, 1988). However, A longitudinal study conducted by Goldenberg, Gallimore, Reese and Garnier (2001) on K-6th grade Latino students showed the opposite effect, namely, student achievement influences parent expectations. This finding shows that child mathematics achievement can influence parents’ expectations. Moreover, although parents’ SES is shown to predict parent expectations, Fan and Williams (2010) found that parent expectations of students’ long-term education achievement predicted students’ intrinsic motivation for mathematics even after controlling for gender and SES.

Despite belonging to different countries, ethnicities, or socioeconomic levels, parents generally hold high aspiration and expectations for their children achievement. Parents’ expectations have been shown to be more realistic than their aspiration though. Rubie-Davis et al. (2010) conducted a study in New Zealand in three schools with 26 teaches and 19 parents. Their qualitative analyzed showed that parents had high and realistic expectations for their children’s future achievement. In this study, teachers also confirmed positive influence of parents’ expectation on student achievement. Based on an intervention study (i.e., Head Start-Public School Transition) of 124 U.S. parents of kindergarten children who live below poverty level, Galper, Wigfield and Seefeldt (1997) reported that 55.8% of parents aspired their children to earn a college degree while 21.7% of parents actually expected that their children would earn
a college degree. Similarly, Goldenberg, Gallimore, Reese and Garnier (2001) asserted that parents’ expectations were not as high as their aspirations. Parents’ expectations also vary across countries. Stevenson et al. (1990) conducted a mixed-method longitudinal study on 1440 students from U.S., Japan and Taiwan. Their analysis revealed that American mothers were less interested in their children’s academic achievement. They were more concerned about children’s general cognitive development. In comparison, Chinese and Japanese mothers were more concerned about their children’s academic achievement and hold higher expectations. They found that American mothers were more satisfied with their children’s accomplishments and they overestimated their abilities. However, Japanese and Chinese mothers emphasized hard work more than American mothers. Another interesting result was American mothers’ attribution of students’ achievement to innate abilities more than Chinese and Japanese mothers does. In conclusion, although parents’ expectations and aspirations for their students differ across cultures or countries, they generally have high expectations for their children.

In summary, the literature provides abundant evidences that parents’ expectations have a significant impact on students’ mathematics achievement either directly, through student expectation or student motivation. Additionally, intervention studies offer promising results. Thus, rising parents’ expectations of students’ mathematics academic achievement requires a greater attention from policymakers, educational researchers, school administration and teachers.

2.3 Mathematics Self-Concept

Mathematics self-concept refers to students’ perception of their competence and ability for learning mathematics and performing well in mathematics tasks (Reyes, 1984). Research studies have shown positive association between mathematics self-concept and mathematics achievement (e.g., Goetz, Cronjaeger, Frenzel, Ludtke, & Hall, 2010; Jussim & Eccles, 1992; Marsch, Trautwein, Ludtke, Koller, & Baumert, 2006; Pitsia, Biggart, & Karakolidis, 2017;
Students who have higher mathematics self-concept tend to have higher mathematics achievement. Pipere and Mierina (2017) found that mathematics self-concept was one of the most significant predictor of mathematics achievement. Additionally, studies indicated that student self-concept can be improved by positive expectations of teachers and parents (e.g., Banner & Mistry, 2007; Lazarides, Viljaranta, Aunola, Pesu, & Nurmi, 2016; Lazarides & Watt, 2015). Therefore, teacher and parent expectations not only directly influence students’ mathematics achievement, but also indirectly influence student mathematics achievement through mathematics self-concept. Therefore, modeling teacher and parent expectations requires consideration of mathematics self-concept as a potential mediator between these expectations and mathematics achievement.

2.4 Other Factors

Since the influence of socioeconomic status on education outcomes are well-established, most studies control for socioeconomic status because of its direct and indirect effects on educational outcomes. A meta-analysis conducted by Hattie (2009) showed that SES is moderately correlated with student achievement. As an indicator, SES accounted for 7% of student achievement variance. Additionally, SES is found to have significant effects on parent expectations (Hao & Bornstead-Bruns, 1998), teacher expectations (Fitzpatrick, Côté-Lussier, & Blair, 2016); and self-concept of ability (Trusty, Peck & Mathews, 1994).

2.5 The Present Study

Based on the theoretical framework that is explained in literature review, the following research questions and hypotheses will be investigated:

**Research Question 1:** Do intrinsic and extrinsic motivation predict eighth-grade student mathematics achievement or are they predicted by mathematics achievement?
The purpose of answering this question is to seek reciprocal relationship between intrinsic motivation, extrinsic motivation, and mathematics achievement. There are abundant evidences about significant predictive effect of intrinsic motivation on student mathematics achievement. The similar result is expected in this study. Research on extrinsic motivation mostly showed neutral or negative effect on mathematics achievement. Considering eighth-grade students, it is hypothesized that extrinsic motivation must be negatively correlated with mathematics achievement. Therefore, the correlation between intrinsic and extrinsic motivation is expected to be negative.

**Research Question 2:** Does congruence-dissonance of teacher and parent expectations influence eighth-grade students’ mathematics achievement?

The existence of a correlation between teacher expectation and parent expectation is expected. However, the strength of this correlation might be mediated by parent SES. With respect congruence-dissonance, congruence between teacher and parent expectations is expected to significantly predict student mathematics achievement. However, dissonance of their expectations should have non-significant effect on student mathematics achievement.

**Research Question 3:** Is the effect of parents’ expectations on eighth-grade students’ mathematics achievement is larger than the effect of students’ expectations on eighth-grade students’ mathematics achievement?

Since the sample consists of eighth-grade students, parent expectation is expected to predict student mathematics achievement more strongly than the effect of student expectations on student mathematics achievement.

**Research Question 4:** Do gender and socioeconomic status mediate the relationship between ‘constructs of interest’ (i.e., intrinsic and extrinsic motivation, expectations of
significant others, and mathematics self-concept) and eighth-grade student mathematics achievement?

Although recent research rarely examined mediation of gender and socioeconomic status, proxy associations imply that socioeconomic status should significantly mediate the relationship between ‘construct of interest’ and mathematics achievement. On the other hand, no significant mediation of gender with respect to the relationships is expected. The effect of mediations will be investigated separately for each relationship.

**Research Question 5:** What is the association between expectation of significant others (i.e., parent and teacher expectations), motivation (i.e., intrinsic motivation and extrinsic motivation), and mathematics self-concept on Turkish eighth-grade students’ mathematics achievement?

Based on findings obtained from the test of earlier hypotheses, significant associations and relationships will be included in this model. The directions connecting intrinsic and extrinsic motivation with other variables are constructed based on self-determination theory and recent research findings. Additionally, the directions which connects teacher expectation with mathematics achievement and parent expectation are defined according to self-fulfilling prophecy. Furthermore, the principals of Bandura’s social cognitive theory are utilized for constructing directions connecting parent expectation and SES with other variables. Specifically, the arrows connecting parent expectation and teacher expectation to mathematics self-concept represents the principles of self-evaluative outcome expectation. Additionally, the direction from mathematics self-concept to mathematics achievement was constructed based on immense amount of evidences provided in the literature. The model is expected to fit the data well.
Considering evidences obtained from the literature review, the theoretical model can be demonstrated in Figure 2-1. In this figure, solid lines represent significant association; dashed lines represent nonsignificant or uncertain (mixed/lack of research findings) relationships; green color shows positive association; and red color shows negative association.

Figure 2-1. Theoretical model of motivation, expectations, self-concept and mathematics achievement
CHAPTER 3
METHOD

The present study was conducted on Turkey portion of the 2015 TIMSS data, which is a secondary source of data. The purpose of the study is to understand mechanism of student mathematics achievement by investigating its relationship with motivation, expectations of significant others and mathematics self-concept. Hence, the following constructs were operationalized: student mathematics achievement, student motivation, expectations of student, parents and teachers, and mathematics self-concept. In this chapter, later analyses were conducted to answer the research questions sequentially. First, descriptions of TIMSS dataset, item development and the sample selection procedures are explained. Then, for operationalization of the constructs, related TIMSS items were selected. Following this step, data analytic techniques are outlined; and then data analysis procedures are elucidated. The results of data analyses are outlined in results section.

3.1 Development Processes of TIMSS Items and Sample Selection

TIMSS surveys are conducted by International Association for the Evaluation of Educational Assessment (IEA). This survey is administered in participating countries every four years. All dataset consists of public use files. The purpose of the survey is to collect valuable content- and cognitive-related information from fourth- and eighth-grade students about their multifaceted knowledge and skills in mathematics and science while tracking curricular implementation and specifying beneficial instructional practices within participating countries. For eight-grade students, TIMSS 2015 mathematics items by content domain include number, algebra, geometry, and data and chance. Cognitive domain items include knowing, applying, and reasoning.
3.1.1 TIMSS 2015 Mathematics Item Selection and Development Procedure

For TIMSS 2015, item development processes started in July 2012 and continued until June 2015. Country representatives were trained in workshops about TIMSS assessment frameworks, guidelines for writing items and the specific characteristics of items (e.g., how to obtain an item that measures the intended construct well, the processes of translation and other procedures determined in TIMSS 2015 Item Writing Guidelines). Therefore, country representatives collaborated in the processes of item development and the translation of items. In general terms, the item development processes for TIMSS 2015 include (Martin, Mullis, & Hooper, 2016): i) development of frameworks; ii) development of items and their scoring guides by experts and researchers; iii) field testing; iv) selection of items based on predetermined frameworks, field test results, and items from previous examinations; and v) trainings survey administrators for obtaining reliable responses; v) translation of items by participating countries. Science and Mathematics Review Committee (SMIRC), additionally, meet periodically to evaluate and discuss TIMSS items. This committee met four times to finalize item selection processes. Thus, the item selection, development and translation processes involved staff from TIMSS & PIRLS International Study Center, members of SMIRC, and expert committees from participating countries. Moreover, meticulous procedure for item selection, administration of field testing, and repetitive reviews and revisions of items demonstrate the effort for obtaining a valid and reliable scale. Hence, these explicit and rigorous procedures render the selection of TIMSS 2015 items suitable for this study.

Fourth-grade content domains for TIMSS 2015 mathematics achievement items include number (52.7% of total score), geometric shapes and measures (33.1% of total score), and data display (14.2% of total score). Eight-grade content domains include number (30.1% of total score), algebra (29.2% of total score), geometry (19.8% of total score), and data and chance
(20.2% of total score). Most of the items are multiple-choice items; however, other items require constructed responses.

### 3.1.2 Sample Selection

TIMSS is an international examination that include a relatively large sample of students. Yet, its methodology for sample selection is based on scientific foundations. For TIMSS 2015, a stratified two-stage cluster sample design was administered (Martin, Mullis, & Hooper, 2016). During the first sampling stage, among the list of the eligible schools, target schools with ‘probabilities proportional to their size’ are selected. For both field testing and the actual data collection, random sampling methodology was employed. Each country selected participating schools in this stage. During the second sampling stage, classes were sampled. In eligible schools, classes were selected by Within-School Sampling Software (WinW3S). This software selects classes that have equal probabilities within schools.

Basically, the purpose of stratification is to obtain reliable survey estimates by enhancing the efficiency of the sample design. Stratified samples divide a population into subgroups (strata), then each stratum is selected based on its proportion to the population. As a result, the study population is divided into homogenous groups that includes subjects with similar characteristics (Cohen, Manion, & Morrison, 2007). Random sampling or other sampling methods can be used during the selection of strata. The stratification of the schools for TIMSS 2015 was decided based on the importance of the demographics of the location of the school. Schools that shared common characteristics (e.g., region, school type, source of funding, socioeconomic indicators) was stratified when necessary.

### 3.1.3 Sampling Weights

One of the main goals of working with large datasets is to get a correct overview of the population of interest. Sampling weights assign a weight to account for sampling bias when the
sample is disproportionate to the population (Lei & Wu, 2007). Therefore, special attention must be paid to sampling weights when using large and complex datasets. In such situations, Asparouhov (2005) asserts that non-use of sampling weights can result in ‘unequal probability of selection’ that may cause bias in parameter estimates. TIMSS dataset include appropriate sampling weights pertaining to the unit of analysis such as school weight, class weights and student weights (Martin, Mullis & Hooper, 2016). In this study, student background questionnaire dataset and five plausible values for students’ mathematics achievement were utilized. Therefore, total student weight (TOTWGT) is used as the sampling weight.

3.2 Sample Selection Processes and Administration of TIMSS 2015 in Turkey

In this study, Turkish portion of eight-grade students in TIMSS 2015 is the population of this study. According to Yildirim, Ozgurluk, Parlak, Gonen and Polat (2016), Ministry of National Education (MEB, Milli Egitim Bakanligi) initiated the administration of TIMSS procedures in 2012. Items that were developed by IEA and reviewed during SMIRC meetings were translated to Turkish. This translation had been negotiated with TIMSS authorities, and following the mutual agreement, new items are field tested in 2014 in order to evaluate the validity and the reliability of the items. Provincial directorates of education as well as school principals are informed. In eighth-grade level, 238 schools, including 6079 students, participated in TIMSS 2015. Table 3-1 shows the distribution of Turkish eighth-grade student population and the distribution of Turkish eighth-grade student population who participated in TIMSS 2015. The distribution by gender provide evidence of a nationally representative sample. Additionally, the distribution of the TIMSS 2015 eight-grade Turkish student sample by regions also indicates a fairly homogenous distribution across regions. This is another evidence for viability of generalization of TIMSS 2015 results to national sample. These evidences support the justification of generalizing the findings obtained from this study to Turkey’s student population
by the use of certain analyses techniques and inferences which contributes to the validity of the results.

Table 3-1. Distribution of Eighth Grade Students in Turkey and TIMSS 2015

<table>
<thead>
<tr>
<th>Gender</th>
<th>Total number of eighth-grade students in Turkey</th>
<th>Total number of eighth-grade Turkish students in TIMSS 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>573,352</td>
<td>2,943</td>
</tr>
<tr>
<td></td>
<td>48.3%</td>
<td>48.4%</td>
</tr>
<tr>
<td>Male</td>
<td>614,542</td>
<td>3,136</td>
</tr>
<tr>
<td></td>
<td>51.7%</td>
<td>51.6%</td>
</tr>
<tr>
<td>Total</td>
<td>1,108,572</td>
<td>6,079</td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Note: These Turkish Portion of TIMSS statistics are derived from Yildirim, Ozgurluk, Parlak, Gonen, & Polat (2016).

3.3 Operationalization of the Variables

TIMSS 2015 eight-grade dataset contains student, teacher and school level variables as well as parent information. Student is the unit of analyses, therefore student-level data will be used and total student weight (TOTWGT) is the weighting variable. The following items are initially included as the variables of interest, however, for variables that included more than one items, exploratory factor analyses will be employed and the items with acceptable factor loadings will be kept for the analyses.

3.3.1 Mathematics Achievement Items

Mathematics achievement item was aggregated from five plausible mathematics values reported in the dataset. These values are calculated by two- and three-parameter IRT models to accurately calculate students’ ability in mathematics and

…to ensure the accuracy of estimates of the proficiency distributions for the TIMSS populations as a whole and particularly for comparisons between subpopulations. A further advantage of this method is that the variation between the five plausible values generated for each student reflects the uncertainty associated with proficiency estimates for individual students. (Martin, Mullis & Hooper, 2016, pp. 443)
These variables were renamed as math1, math2, math3, math4, and math5 (Table 3-2). These measured values have a range of 92.40 to 764.53 and were used to estimate the underlying latent factor “math” variable.

Table 3-2. Descriptive statistics of Mathematics Achievement items

<table>
<thead>
<tr>
<th></th>
<th>Obs</th>
<th>Mean</th>
<th>SD</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>math1</td>
<td>6,079</td>
<td>458.15</td>
<td>103.49</td>
<td>77.00</td>
<td>773.03</td>
</tr>
<tr>
<td>math2</td>
<td>6,079</td>
<td>458.65</td>
<td>104.19</td>
<td>30.88</td>
<td>780.64</td>
</tr>
<tr>
<td>math3</td>
<td>6,079</td>
<td>457.46</td>
<td>105.75</td>
<td>54.71</td>
<td>808.36</td>
</tr>
<tr>
<td>math4</td>
<td>6,079</td>
<td>455.40</td>
<td>107.72</td>
<td>69.46</td>
<td>794.79</td>
</tr>
<tr>
<td>math5</td>
<td>6,079</td>
<td>458.49</td>
<td>105.95</td>
<td>55.51</td>
<td>785.09</td>
</tr>
</tbody>
</table>

3.3.2 Motivation Items

Intrinsic motivation and extrinsic motivation variables consist of multiple items (Table 3-3). Intrinsic motivation variables include student responses to the following items: BSBM17A ‘Enjoy learning mathematics’ is reverse coded and renamed as enj_math; BSBM17E ‘Like mathematics’ is reverse coded and renamed as like_math; BSBM17G ‘Like mathematics problem’ is reverse coded and renamed as like_math_prob; and BSBM17C ‘Mathematics is boring’ is renamed as math_boring. All new items have four categories: 4 ‘Agree a lot’, 3 ‘Agree a little’, 2 ‘Disagree a little’ and 1 ‘Disagree a lot’. Omitted or invalid values are recoded as missing values. These items (except ‘Mathematics is boring’) are reverse coded because initially smaller values represent more positive characteristics while larger values represent more negative characteristics. Extrinsic motivation items consist of student responses to items: BSBM20I ‘It is important to do well in mathematics’ is reverse coded and renamed as impor_math; BSBM20A ‘I think math learning will help me in daily life’ is reverse coded and renamed as math_helps; BSBM20B ‘Need mathematics to learn other school subject’ is reverse
coded and renamed as need_math_oth; BSBM20C ‘Need mathematics to get into the university’ is reverse coded and renamed as need_math_univ; BSBM20D ‘need mathematics to get the job I want’ is reverse coded and renamed as need_math_job; BSBM20E ‘Would like a job that involves using mathematics’ is reverse coded and renamed as like_job_math; and BSBM20G ‘Mathematics provides more job opportunities’ is reverse coded and renamed as math_more_job.

Each of these new items has four categories: 4 ‘Agree a lot’, 3 ‘Agree a little’, 2 ‘Disagree a little’ and 1 ‘Disagree a lot’.

Table 3-3. Frequency Table for Motivation Items

<table>
<thead>
<tr>
<th></th>
<th>Disagree a lot</th>
<th>disagree a little</th>
<th>Agree a little</th>
<th>Agree a lot</th>
<th>Missing Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>enj_math</td>
<td>8.59%</td>
<td>8.14%</td>
<td>31.97%</td>
<td>50.56%</td>
<td>0.74%</td>
</tr>
<tr>
<td>like_math</td>
<td>12.70%</td>
<td>9.19%</td>
<td>31.60%</td>
<td>45.27%</td>
<td>1.24%</td>
</tr>
<tr>
<td>like_math_prob</td>
<td>15.00%</td>
<td>13.19%</td>
<td>33.96%</td>
<td>36.36%</td>
<td>1.49%</td>
</tr>
<tr>
<td>math_boring*</td>
<td>18.11%</td>
<td>28.09%</td>
<td>17.53%</td>
<td>34.64%</td>
<td>1.64%</td>
</tr>
<tr>
<td>impor_math</td>
<td>3.89%</td>
<td>3.88%</td>
<td>16.95%</td>
<td>74.36%</td>
<td>0.91%</td>
</tr>
<tr>
<td>math_helps</td>
<td>12.61%</td>
<td>9.55%</td>
<td>28.42%</td>
<td>48.58%</td>
<td>0.84%</td>
</tr>
<tr>
<td>need_math_oth</td>
<td>9.94%</td>
<td>11.81%</td>
<td>33.75%</td>
<td>43.55%</td>
<td>0.95%</td>
</tr>
<tr>
<td>need_math_univ</td>
<td>6.90%</td>
<td>7.79%</td>
<td>23.56%</td>
<td>60.82%</td>
<td>0.93%</td>
</tr>
<tr>
<td>need_math_job</td>
<td>7.38%</td>
<td>9.29%</td>
<td>26.40%</td>
<td>55.85%</td>
<td>1.09%</td>
</tr>
<tr>
<td>like_math_job</td>
<td>25.45%</td>
<td>16.69%</td>
<td>30.15%</td>
<td>26.59%</td>
<td>1.12%</td>
</tr>
<tr>
<td>math_more_job</td>
<td>6.38%</td>
<td>7.65%</td>
<td>25.58%</td>
<td>59.38%</td>
<td>1.00%</td>
</tr>
</tbody>
</table>

3.3.3 Expectations Items

Teacher expectation variable is indicated by the variable BTBG06C. This likert-type scale consists of five categories, which are labeled as 1 ‘Very high’, 2 ‘High’, 3 ‘Medium’, 4
‘Low’, and 5 ‘Very low’. It is reverse coded and renamed as teachexp. Parent expectation variable is indicated by the variable BTBG06H. This likert-type scale similarly consists of five categories, which are labeled as 1 ‘Very high’, 2 ‘High’, 3 ‘Medium’, 4 ‘Low’, and 5 ‘Very low’. It is reverse coded and renamed as parexp. Student expectation variable is indicated by the variable BSBG08. This item consists of five categories, which are labeled as 1 ‘Finish lower secondary’, 2 ‘Finish upper secondary’, 4 ‘Finish short-cycle tertiary’, 5 ‘Finish bachelor’s or equivalent’, and 6 ‘Finish postgraduate degree’. It is renamed as studexp.

Table 3-4. Frequency Table for Teacher and Parent Expectation Items

<table>
<thead>
<tr>
<th></th>
<th>Very low</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>Very high</th>
<th>Missing Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>teachexp</td>
<td>1.91%</td>
<td>10.07%</td>
<td>29.65%</td>
<td>45.72%</td>
<td>12.65%</td>
<td>0.62%</td>
</tr>
<tr>
<td>parexp</td>
<td>3.82%</td>
<td>15.67%</td>
<td>30.85%</td>
<td>34.84%</td>
<td>14.81%</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 3-5. Frequency Table for Student Expectation Item

<table>
<thead>
<tr>
<th>studexp</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finish lower secondary</td>
<td>2.54%</td>
</tr>
<tr>
<td>Finish upper secondary</td>
<td>6.63%</td>
</tr>
<tr>
<td>Finish short cycle tertiary</td>
<td>4.90%</td>
</tr>
<tr>
<td>Finish bachelors or equivalent</td>
<td>49.08%</td>
</tr>
<tr>
<td>Finish postgraduate degree</td>
<td>35.37%</td>
</tr>
<tr>
<td>Missing Data</td>
<td>1.48%</td>
</tr>
</tbody>
</table>

3.3.4 Mathematics Self-Concept and SES

Mathematics self-concept variable consist of student responses to the following items:
BSBM19A ‘I usually do well in mathematics’ is reverse coded and renamed as do_well_math;
BSBM19D ‘Learn quickly in mathematics’ is reverse coded and renamed as lquick_math;
BSBM19F ‘Good at working out mathematics problems’ is reverse coded and renamed as good_mathprob; BSBM19G ‘I am good at mathematics’ is reverse coded and renamed as good_math; and BSBM19H ‘Mathematics is harder for me than for many of my classmates’ is renamed as math_hard. Each of these new items had four categories: 4 ‘Agree a lot’, 3 ‘Agree a little’, 2 ‘Disagree a little’ and 1 ‘Disagree a lot’.

Table 3-6. Frequency Table for Mathematics Self-Concept Items

<table>
<thead>
<tr>
<th></th>
<th>Disagree a lot</th>
<th>little</th>
<th>Agree a little</th>
<th>Agree a lot</th>
<th>Missing Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>do_well_math</td>
<td>10.46%</td>
<td>14.79%</td>
<td>42.75%</td>
<td>31.22%</td>
<td>0.78%</td>
</tr>
<tr>
<td>lquick_math</td>
<td>12.88%</td>
<td>19.79%</td>
<td>41.87%</td>
<td>24.18%</td>
<td>1.28%</td>
</tr>
<tr>
<td>good_mathprob</td>
<td>27.27%</td>
<td>21.76%</td>
<td>35.11%</td>
<td>14.33%</td>
<td>1.52%</td>
</tr>
<tr>
<td>good_math</td>
<td>19.32%</td>
<td>20.73%</td>
<td>34.67%</td>
<td>22.78%</td>
<td>2.49%</td>
</tr>
<tr>
<td>math_hard</td>
<td>37.72%</td>
<td>27.34%</td>
<td>13.40%</td>
<td>20.12%</td>
<td>1.42%</td>
</tr>
</tbody>
</table>

In TIMSS 2015, there is no composite SES variable. Indeed, TIMSS does not gather information on family income or parents’ occupation. Therefore, the following variables will be used to construct a measure for SES: BSDGEDUP ‘Parents’ highest education level’, BSBG04 ‘Number of books in your home’, and BSBG06E ‘Possession of internet connection at home’. BSDGEDUP variable is coded as 1 ‘University or higher’, 2 ‘Post-secondary but not university’, 3 ‘Upper secondary’, 4 ‘Lower secondary’, 5 ‘Some primary’ and 6 ‘Don’t know’. This variable is reverse coded and renamed as pareduc. BSBG04 variable is coded as 1 ‘0-10 books’, 2 ’11-25 books’, 3 ’26-100 books’, 4 ‘101-200 books’ and 5 ‘more than 200 books’. This variable is renamed as homebooks. And the variable BSBG06E has only two categories: 1 for ‘Yes’ and 0
for ‘No’. This variable is renamed as homeinternet. These three variables, then, are added to create a composite SES variable.

Table 3-7. Parents’ highest education level

<table>
<thead>
<tr>
<th>pareduc</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Don’t know</td>
<td>3.05%</td>
</tr>
<tr>
<td>Some Primary, Lower Secondary or No School</td>
<td>21.27%</td>
</tr>
<tr>
<td>Lower Secondary</td>
<td>29.44%</td>
</tr>
<tr>
<td>Upper Secondary</td>
<td>26.8%</td>
</tr>
<tr>
<td>Post-secondary but not University</td>
<td>5.08%</td>
</tr>
<tr>
<td>University or Higher</td>
<td>12.97%</td>
</tr>
<tr>
<td>Missing Data</td>
<td>1.38%</td>
</tr>
</tbody>
</table>

Table 3-8. Number of books in your home

<table>
<thead>
<tr>
<th>homebooks</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10 books</td>
<td>16.22%</td>
</tr>
<tr>
<td>11-25 books</td>
<td>34.54%</td>
</tr>
<tr>
<td>26-100 books</td>
<td>29.81%</td>
</tr>
<tr>
<td>101-200 books</td>
<td>10.53%</td>
</tr>
<tr>
<td>More than 200 books</td>
<td>8.1%</td>
</tr>
<tr>
<td>Missing Data</td>
<td>0.8%</td>
</tr>
</tbody>
</table>

Table 3-9. Possession of internet connection at home

<table>
<thead>
<tr>
<th>homeinternet</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>38.55</td>
</tr>
<tr>
<td>Yes</td>
<td>60.46</td>
</tr>
<tr>
<td>Missing data</td>
<td>0.99</td>
</tr>
</tbody>
</table>
3.4 Validity and Reliability Check

Validity and reliability are the most important components of research studies for obtaining meaningful and scientifically accurate inferences. In educational research, multiple types of validity along with the threats to these types of validity are proposed (e.g., internal validity, external validity, construct validity). Additionally, threats to the types of validity were extensively discussed and recommendations for minimizing the threats to these types of validity were explicated (e.g., Cohen, Manion, & Morrison, 2007). There are three types of reliability: stability, equivalence and internal consistency. Most commonly used strategy to account for reliability in quantitative analyses is to calculate the internal consistency (e.g., Cronbach’s alpha). In this study, several strategies were employed for obtaining evidences for validity and reliability of the values of the variables selected from TIMSS. Additionally, during the statistical analyses, necessary steps were taken for attenuating threats to validity and reliability of the results.

During the design and data collection state, Martin, Mullis and Hooper (2016, in Methods and Procedures in TIMSS 2015) state that the necessary steps were taken for minimizing threats to validity and reliability, since threats to validity and reliability can never be completely eliminated (Cohen, Manion, & Morrison, 2007). Furthermore, ecological validity (also a component of external validity) is particularly important in educational research—which refers to the ability to generalize results of a research across settings—that demonstrates the implementation of educational policies in broader context (Brock-Utne, 1996). Evidences for ecological validity can be addressed by including as many characteristics or factors as possible; conducting observations in their natural settings (rather than a contained and controlled environment, i.e., experimental research); and using proper sampling strategies for obtaining a sample that is large and representative of the population of interest (Cohen, Manion, & Morrison,
2007). Considering the design and data collection stages, administration of TIMSS survey addresses these concerns by i) selecting a representative sample with a probability sampling strategy, ii) containing a large number of variables that represents various characteristics of the sample, and iii) gathering information on the actual environment of participants. Additionally, the preparation of the questionnaires by experts, multiple reviews and standard procedures, and conducting field tests provide evidences for construct and content validity.

During the statistical analyses in this study, threats to ecological validity were minimized by including a large number of variables/factors and analyzing these variables with structural equation modeling technique. Moreover, for obtaining reliable results, each item’s Cronbach’s alpha was calculated, and statistical analyses were conducted by using reliable items. For establishing factorial validity, exploratory factor analyses will be performed on latent variables (i.e., underlying constructs that are combination of multiple observed items) and items with acceptable factor loadings were kept for further statistical analyses. The purpose of this step is to ensure that items that uniquely define the latent variable will be kept.

3.5 Data Analysis Procedures and Statistical Model

In this section, missing data and missing data pattern were examined through Stata software. Internal consistency of the remaining items are reported. Then, exploratory factor analyses technique were employed for decisions on keeping the related items. Furthermore, for answering each research question, corresponding statistical methods are discussed. For the final comprehensive model, structural equation modeling technique was used. Pertaining to this step, the assumptions of structural equation modeling was checked. In the next chapter, descriptive statistics and statistical analyses were carried out and reported.
3.5.1 Missing Data

Although often overlooked, the problem of missing values is common in many datasets in social sciences (Little, 1988; Rubin, 1996) especially in large-scale datasets when the amount of missing values exceeds 5% of the cases (Graham & Hoffer, 2000). To observe how missing values were dispersed into the remaining data, missing values were tabulated. Out of 6079 cases, either variables did not have missing values or the number of missing values were less than 3% of the cases. Variables ‘math’ and ‘parexp’ did not have missing values. Moreover, there was no systematic pattern of missing data. Therefore, the dataset is scanned and cases with extreme amount of missing values are removed. Cases outside 1.5 interquantile ranges from the lower and upper quartile are labeled as outliers and they were removed from the dataset. In total, 664 extreme cases were removed. After this step, remaining dataset had no missing value.

3.5.2 Internal Consistency

For checking reliability, Cronbach’s alpha and inter-item correlation coefficients as an indication of internal consistency were calculated. Cronbach’s alpha coefficient of each item was greater than 0.8. These values are plausible for diagnostic reliability. Very high inter-item correlation is often an indication of multicollinearity. Inter-item correlations of individual items were calculated and they were less than 0.30. These findings provide evidences for the reliability of the items.

3.5.3 Exploratory Factor Analyses and Reliability of Scales

Based on the theoretical framework derived from the literature, items that are assumed to define each latent variable were included in the analyses. Sets of observable items defining each latent variable (i.e., intrinsic motivation, extrinsic motivation and mathematics self-concept) are included in exploratory factor analyses (EFA). Principal component factor analysis using varimax rotation technique was used to check if these variables measured the same construct.
Most commonly, factor loadings greater than 0.50 are considered as an acceptable criterion implying that the item measures the construct with an acceptable degree of accuracy. In the tables below, factor loadings of each scale, percent of variance explained in each factor and the reliability coefficient of each scale is reported.

Table 3-10. Principal Component Factor Analysis of Intrinsic Motivation Scale

<table>
<thead>
<tr>
<th>Variable</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>enj_math</td>
<td>0.871</td>
</tr>
<tr>
<td>like_math</td>
<td>0.914</td>
</tr>
<tr>
<td>like_math_prob</td>
<td>0.848</td>
</tr>
<tr>
<td>math_boring</td>
<td>0.769</td>
</tr>
</tbody>
</table>

Percent of variance explained: 72.6%
Cronbach’s alpha: 0.872

Table 3-11. Principal Component Factor Analysis of Extrinsic Motivation Scale

<table>
<thead>
<tr>
<th>Variable</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>impor_math</td>
<td>0.709</td>
</tr>
<tr>
<td>need_math_oth</td>
<td>0.692</td>
</tr>
<tr>
<td>math_helps</td>
<td>0.642</td>
</tr>
<tr>
<td>need_math_univ</td>
<td>0.769</td>
</tr>
<tr>
<td>need_math_job</td>
<td>0.795</td>
</tr>
<tr>
<td>like_job_math</td>
<td>0.681</td>
</tr>
<tr>
<td>math_more_job</td>
<td>0.768</td>
</tr>
</tbody>
</table>

Percent of variance explained: 52.4%
Cronbach’s alpha: 0.847
Table 3-12. Principal Component Factor Analysis of Mathematics Self-Concept Scale

<table>
<thead>
<tr>
<th>Variable</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>do_well_math</td>
<td>0.848</td>
</tr>
<tr>
<td>lquick_math</td>
<td>0.840</td>
</tr>
<tr>
<td>good_mathprob</td>
<td>0.837</td>
</tr>
<tr>
<td>good_math</td>
<td>0.816</td>
</tr>
<tr>
<td>math_hard</td>
<td>0.569</td>
</tr>
</tbody>
</table>

Percent of variance explained: 62.3%
Cronbach’s alpha: 0.842

Analysis of each scale provided satisfactory outcomes with respect to factor loadings, percent of variance explained for each latent factor, and the Cronbach’s alpha reliability coefficient. These evidences provide evidences for unidimensionality of the items for defining related latent factors.

Although individual items were included in structural equation model to account for measurement error, composite variables for latent factors are necessary for answering remaining research questions. Gerbing and Anderson (1988) proposed that utilization of the composite score is meaningful if the observed variables are unidimensional. EFA results showed that the items unidimensionally defined the respective latent factors. Therefore, composite variables for intrinsic motivation, extrinsic motivation and mathematics self-concept were calculated by averaging underlying observed variables. Thus, statistical analyses that were performed and reported in the Results section were carried out with these items and latent factors.

3.5.4 Research Questions and Statistical Analyses

Research Question 1: Do intrinsic and extrinsic motivation predict eighth-grade student mathematics achievement or are they predicted by mathematics achievement?
To answer this research questions, correlations of intrinsic and extrinsic motivation with mathematics achievement were calculated. Regression analyzes were performed. An exploratory approach was taken to investigate the reciprocal relations between intrinsic motivation and mathematics achievement and between extrinsic motivation and mathematics achievement. However, the results were interpreted with caution since the dataset is cross-sectional.

**Research Question 2:** Does congruence-dissonance of teacher and parent expectations influence eighth-grade students’ mathematics achievement?

Correlation between teacher expectations and parent expectations was calculated. Later, values of parent expectations subtracted from the values of teacher expectations. The degree to which congruence-dissonance of their expectations predicting mathematics achievement was checked via regression analysis.

**Research Question 3:** Is the effect of parents’ expectations on eighth-grade students’ mathematics achievement is larger than the effect of students’ expectations on eighth-grade students’ mathematics achievement?

This research question answered by using regression analyses. While holding the other variable constant, regression coefficients reveal the effect of parent expectations on student mathematics achievement and its comparison with the effect of student expectations on student mathematics achievement.

**Research Question 4:** Do gender and socioeconomic status mediate the relationship between ‘constructs of interest’ (i.e., intrinsic and extrinsic motivation, expectations of significant others, and mathematics self-concept) and eighth-grade student mathematics achievement?
Mediation analyses were conducted to answer these relations. Mediation analysis is central to social science and psychology (Hicks & Tingley, 2011). Preacher and Hayes (2008) state that mediation analyses allow discovering the difference between the direct effect of a predictor (X) on an outcome (Y) and the indirect effect of X on Y after accounting for the mediator (M). The procedure for the conventional mediation analysis approach (Baron & Kenny, 1986; Sobel, 1982) is: i) the independent variable must significantly predict the dependent variable; ii) tested mediator variable must significantly predict the dependent variable; iii) the independent variable must not predict the dependent variable after accounting for the mediator variable, which indicates full mediation; and iv) if mediation effect is detected, implementation of bootstrapping method to estimate the bias-corrected significance of indirect effect, robust standard errors and confidence intervals (MacKinnon, 2008; Shrout & Bolger, 2002). Apart from advantages of this method, the limitations of the conventional approach are provided in the Discussion section.

**Research Question 5:** What is the association between expectation of significant others (i.e., parent and teacher expectations), motivation (i.e., intrinsic motivation and extrinsic motivation), and mathematics self-concept on Turkish eighth-grade students’ mathematics achievement?

To answer this question, structural equation modeling (SEM) techniques were used based on the theoretical model illustrated in Figure 2-1. According to theoretical model, intrinsic motivation, parent expectations, teacher expectations, mathematics self-concept, and SES are assumed to predict mathematics achievement. Extrinsic motivation is expected to predict mathematics achievement negatively. Moreover, parent expectation and teacher expectation is expected to influence each other recursively. These and other directionalities that are shown in
the model, will be defined in the structural model and all these relations will be tested in measurement model.

SEM consists of a family of statistical techniques including analysis of covariance, multiple regression, path analysis and exploratory and confirmatory factor analyses (Bollen, 1989; Kline, 2011). There are three reasons for adopting SEM techniques. First, the final model consists of multiple latent variables and SEM techniques allow testing a model that includes multiple latent variables with multiple indicators. Second, variables are assumed to be predicting one another via a predetermined direction as shown in Figure 2-1. SEM allows taking the structural relations into account. Third, SEM techniques takes measurement error into account when multiple variables with multiple indicators are estimated. Commonly used regression analyses via ordinary least square methods, for example, assume that all variables are perfectly measured without errors (Kline, 2011). However, for multiple latent variables, this is not the case. Therefore, maximum likelihood estimation method will be adopted to account for measurement error. More specifically, robust maximum likelihood estimation method will be adopted since TIMSS 2015 dataset contains sampling weights (Asparouhov, 2005). To confirm a plausible model via SEM: 1) an implied-covariance matrix is defined by a predefined structural equation model; 2) another covariance matrix is obtained from the existing dataset; and 3) these covariance matrices are compared, and the model fit is evaluated about predefined associations (Kline, 2011). As can be seen in the theoretical model illustrated in Figure 2-1, the literature does not have consensus about the direction of the effect between some variables. Alternative models will be generated for these non-significant or uncertain relationships. As always, the goal is to find a model that is: i) based on the theoretical model which is derived from previous theories and research findings, ii) fairly parsimonious, and iii) fitting the data well.
Because of the nature of the data (cross-sectional dataset), errors of the motivations, expectations, and mathematics self-concept variables are allowed to correlate since observations are obtained within the same period (Froiland & Davison, 2016). Assumptions of SEM were checked. Specifically, teacher and parent expectations were slightly negatively skewed. Maximum likelihood estimation method will be adopted to account for measurement error. More specifically, robust maximum likelihood estimation method was adopted since TIMSS 2015 dataset contains sampling weights (Asparouhov, 2005) and robust to normality violations (Muthén & Muthén, 2012). Finally, model fitting procedures were employed. Bentler (2007) recommend that structural equation models must be checked at least with two indices of fit. In this study, the following indices were checked for evaluating model fit: root mean square error of approximation (RMSEA), comparative fit index (CFI) and standardized root mean square residual (SRMR). Although there is no absolute consensus among researchers, as a rule of thumb, RMSEA less than 0.10, CFI greater than 0.90, and SRMR less than 0.08 will represent a good fit of theoretical model to the data (Wang & Wang, 2012).
CHAPTER 4
RESULTS

In this chapter, first, data is examined, and data management techniques are applied. These techniques include graphical analysis of variables, detection of outliers, and examination of missing values, removal of extreme cases of outliers and missing cases. Second, descriptive statistics are tabulated. Finally, results of statistical analyses answering each research question is conducted and the results are reported.

4.1 Descriptive Statistics

The histogram of each variable is analyzed for checking normality. The variables were fairly normal except extrinsic motivation and parent expectation variables. These two variables were slightly negatively skewed. However, the dependent variable (i.e., mathematics achievement variable) was normally distributed, which is a required assumption for multiple regression. After data cleaning and management procedures, descriptive statistics are calculated using the analytic weights. In Table 4-1, intercorrelations between variables, their means, standard deviations, and minimum and maximum values are reported.

Table 4-1. Inter-item Correlations, Means and Standard Deviations

<table>
<thead>
<tr>
<th></th>
<th>math</th>
<th>intrm</th>
<th>extrm</th>
<th>teachexp</th>
<th>parexp</th>
<th>studexp</th>
<th>mselfconcept</th>
<th>ses</th>
</tr>
</thead>
<tbody>
<tr>
<td>math</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>intrm</td>
<td>0.23</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>extrm</td>
<td>0.13</td>
<td>0.59</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>teachexp</td>
<td>0.19</td>
<td>-0.00</td>
<td>-0.00</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>parexp</td>
<td>0.30</td>
<td>-0.04</td>
<td>-0.03</td>
<td>0.58</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>studexp</td>
<td>0.41</td>
<td>0.19</td>
<td>0.20</td>
<td>0.12</td>
<td>0.17</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mselfconcept</td>
<td>0.43</td>
<td>0.71</td>
<td>0.53</td>
<td>0.05</td>
<td>0.02</td>
<td>0.22</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>ses</td>
<td>0.49</td>
<td>0.02</td>
<td>0.00</td>
<td>0.20</td>
<td>0.35</td>
<td>0.28</td>
<td>0.17</td>
<td>1.00</td>
</tr>
<tr>
<td>M</td>
<td>462.58</td>
<td>3.00</td>
<td>3.23</td>
<td>3.58</td>
<td>3.43</td>
<td>5.04</td>
<td>2.59</td>
<td>7.73</td>
</tr>
<tr>
<td>SD</td>
<td>100.72</td>
<td>0.88</td>
<td>0.68</td>
<td>0.90</td>
<td>1.03</td>
<td>1.16</td>
<td>0.81</td>
<td>2.28</td>
</tr>
<tr>
<td>Min</td>
<td>92.40</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Max</td>
<td>764.53</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>6</td>
<td>4</td>
<td>13</td>
</tr>
</tbody>
</table>

Note: Obs=5,415. math: average plausible values in mathematics; intrm: composite intrinsic motivation; extrm: composite extrinsic motivation; teachexp: teacher expectation; parexp: parent expectations; studexp: student expectations; mselfconcept: composite mathematics self-concept; ses: composite socioeconomic status.
The results show that correlations between the following variables are quite high: intrinsic motivation and extrinsic motivation, parent expectation and teacher expectations, student expectation and mathematics achievement, SES and mathematics achievement, mathematics self-concept and intrinsic motivation, and mathematics self-concept and extrinsic motivation.

4.2 Results for Research Questions

**Research Question 1:** Do intrinsic and extrinsic motivation predict eighth-grade student mathematics achievement or are they predicted by mathematics achievement?

To answer this research question, correlations of intrinsic and extrinsic motivation with mathematics achievement were calculated. The results showed that all pairwise correlations between mathematics achievement, intrinsic motivation and extrinsic motivation are significant (Table 4-2).

Interpretation of the regression outputs relies on sensible results. For example, when the dependent variable is mathematics achievement score and the independent variable is intrinsic motivation, and if the regression coefficient of intrinsic motivation is 20, then the interpretation is made as ‘one unit increase in intrinsic motivation—on average—results in 20 points change in mathematics achievement’. However, one-unit change in intrinsic motivation is an intuitively vague value since it ranges between 1 and 4. Therefore, for scaling purposes, which will render the interpretation of the coefficients sensible, intrinsic motivation and extrinsic motivation variables are logged. In this way, coefficients on the natural-log scale will be directly interpretable as approximate proportional differences (Gelman & Hill, 2006).

Referring to Yang’s (2012) interpretation of logarithmic transformations, the estimated coefficient of log-transformed intrinsic motivation variable will be interpreted as ‘1% change in
intrinsic motivation will result in approximately $x \times \ln\left(\frac{101}{100}\right) \approx (0.01 \times x)$ change in mathematics achievement’. Additionally, if only the dependent variable is log-transformed, the interpretation is ‘one unit increase in $X$ results in approximately $100 \times x$ percent change in $Y$’ and if both independent variable and the dependent variable is log-transformed, then the interpretation is ‘1% change in $X$ results in approximately $x\%$ change in $Y$’ (capital letters refer to the variable while $x$ is the estimated coefficient).

Log-transformed variables of intrinsic motivation and extrinsic motivation were used in regression analyses and the results are shown in the following tables. SES variable is included as the control variable. The general principle of log-transformation is applied to the analyses, which is: if an independent variable is log-transformed, all independent variables (except categorical and proportional variables) must be log-transformed.

Table 4-2. Summary of Regression Analyses for Intrinsic Motivation Predicting Mathematics Achievement

<table>
<thead>
<tr>
<th></th>
<th>$\beta$</th>
<th>Robust SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>intrm (logged)</td>
<td>57.550***</td>
<td>3.358</td>
</tr>
<tr>
<td>SES (logged)</td>
<td>164.688***</td>
<td>4.374</td>
</tr>
<tr>
<td>constant</td>
<td>72.993***</td>
<td>9.509</td>
</tr>
<tr>
<td>Adjusted</td>
<td>0.281</td>
<td></td>
</tr>
<tr>
<td>Obs</td>
<td>5,415</td>
<td></td>
</tr>
</tbody>
</table>

Note: + p < 0.10, * p < .05, ** p < .01, *** p < .001

Regressions results in Table 4-2 show that intrinsic motivation has a significant effect on 8th student mathematics achievement score even after controlling for student’s socioeconomic status. If student SES is held constant, one percentage increase in students’ intrinsic motivation level increases student mathematics achievement score approximately by 0.58. Moreover,
intrinsic motivation and extrinsic motivation account for approximately 28% of variance in mathematics achievement score.

In the methodology section, it was stated that an exploratory approach will be taken. Thus, in Table 4-3, the average impact of mathematics achievement on student intrinsic motivation is analyzed. In this case, only the dependent variable is logged.

Table 4-3. Summary of Regression Analyses Mathematics Achievement Predicting Intrinsic Motivation (logged)

<table>
<thead>
<tr>
<th></th>
<th>β</th>
<th>Robust SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>math</td>
<td>0.001***</td>
<td>0.000</td>
</tr>
<tr>
<td>SES</td>
<td>-0.023***</td>
<td>0.002</td>
</tr>
<tr>
<td>constant</td>
<td>0.763***</td>
<td>0.025</td>
</tr>
<tr>
<td>Adjusted</td>
<td>0.054***</td>
<td></td>
</tr>
<tr>
<td>Obs</td>
<td>5,415</td>
<td></td>
</tr>
</tbody>
</table>

Note: + p < 0.10, * p < .05, ** p < .01, *** p < .001

These results show that one unit increase in mathematics achievement score is associated with approximately 0.1% increase in student intrinsic motivation when SES is held constant. Although mathematics achievement and SES have significant association with intrinsic motivation, the coefficients are relatively low, and the model has a low adjusted R-square which indicates that the model does not perfectly explain the variation in intrinsic motivation. As stated previously, this result should be interpreted with caution since the dataset is cross-sectional which prevents valid causal associations.

The same steps taken for the association between mathematics achievement and extrinsic motivation.
Table 4-4. Summary of Regression Analyses for Extrinsic Motivation Predicting Mathematics Achievement

<table>
<thead>
<tr>
<th></th>
<th>β</th>
<th>Robust SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>extrm (logged)</td>
<td>48.604***</td>
<td>4.629</td>
</tr>
<tr>
<td>SES (logged)</td>
<td>163.843***</td>
<td>4.475</td>
</tr>
<tr>
<td>constant</td>
<td>79.047***</td>
<td>10.540</td>
</tr>
<tr>
<td>Adjusted</td>
<td>0.253</td>
<td></td>
</tr>
<tr>
<td>Obs</td>
<td>5,415</td>
<td></td>
</tr>
</tbody>
</table>

Note: + p < 0.10, * p < .05, ** p < .01, *** p < .001

Table 4-5. Summary of Regression Analyses Mathematics Achievement Predicting Extrinsic Motivation (logged)

<table>
<thead>
<tr>
<th></th>
<th>β</th>
<th>Robust SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>math</td>
<td>0.001***</td>
<td>.000</td>
</tr>
<tr>
<td>SES</td>
<td>-0.011***</td>
<td>0.002</td>
</tr>
<tr>
<td>constant</td>
<td>1.030***</td>
<td>0.018</td>
</tr>
<tr>
<td>Adjusted</td>
<td>0.020</td>
<td></td>
</tr>
<tr>
<td>Obs</td>
<td>5,415</td>
<td></td>
</tr>
</tbody>
</table>

Note: + p < 0.10, * p < .05, ** p < .01, *** p < .001

Results in Table 4-4 indicate that logged intrinsic motivation and SES are significantly associated with mathematics achievement and one percentage change in extrinsic motivation is associated with 0.48 increase in mathematics achievement score when SES is held constant. Additionally, this model explains 25% of the variation in mathematics achievement. Results in Table 4-5 indicate that mathematics achievement and SES are significantly associated with extrinsic motivation, although SES is negatively associated with extrinsic motivation. On average, one-point increase in mathematics achievement is associated with 0.01% change in
extrinsic motivation when SES is held constant. The model also has a very low R-square, which is 0.02. In other words, mathematics achievement and SES explain approximately 0.02% variation in extrinsic motivation.

Overall, these results show that intrinsic motivation and extrinsic motivation are significantly associated with eighth-grade student mathematics achievement. However, the degree of association with mathematics achievement is larger for intrinsic motivation compared to that of extrinsic motivation. Additionally, the data show that increase in SES is positively associated with intrinsic motivation while the association is negative for extrinsic motivation. In other words, higher SES is associated with higher intrinsic motivation and lower extrinsic motivation.

It was hypothesized—based on literature—that intrinsic motivation and extrinsic motivation would be negatively correlated. However, a positive correlation was found. Positive effect of intrinsic motivation on mathematics achievement was expected. The results supported this hypothesis. Additionally, negative effect of extrinsic motivation on mathematics achievement was expected. However, the results indicated a positive association.

**Research Question 2:** Does congruence-dissonance of teacher and parent expectations influence eighth-grade students’ mathematics achievement?

The results indicate that there is a significant and positive correlation between parent expectations and teacher expectation ($r = 0.58$). In general, average teacher expectation is higher than parent expectation (3.58 vs 3.43). Therefore, teacher expectation values are subtracted from parent expectation values to obtain the congruence-dissonance of their expectations. After the log transformation, the regression analysis is performed.
Table 4-6. Summary of Regression Analyses: Congruence-dissonance Predicting Mathematics Achievement

<table>
<thead>
<tr>
<th></th>
<th>( \hat{\beta} )</th>
<th>Robust SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>cong_diss (logged)</td>
<td>-14.425*</td>
<td>7.271</td>
</tr>
<tr>
<td>SES (logged)</td>
<td>134.818***</td>
<td>9.309</td>
</tr>
<tr>
<td>constant</td>
<td>185.590***</td>
<td>10.16</td>
</tr>
<tr>
<td>Adjusted</td>
<td>0.176</td>
<td></td>
</tr>
<tr>
<td>Obs</td>
<td>1,463</td>
<td></td>
</tr>
</tbody>
</table>

Note: + p < 0.10, * p < .05, ** p < .01, *** p < .001

The regression results indicate that congruence-dissonance between teacher expectation and parent expectation has a significant association with mathematics achievement even after controlling for SES. The association is negative, which means that if parent expectation is lower than teacher expectation, student mathematics achievement is negatively impacted. In other words, even if the effect of SES is controlled, 1% increase in congruence-dissonance is associated with 0.14 point decrease in eighth-grade student mathematics achievement.

It was hypothesized that a positive correlation would exist between teacher expectation and parent expectation. The result supported this hypothesis. Additionally, congruence-dissonance of teacher and parent expectation was expected to negatively affect student mathematics achievement. The results supported this hypothesis.

**Research Question 3:** Is the effect of parents’ expectations on eighth-grade students’ mathematics achievement is larger than the effect of students’ expectations on eighth-grade students’ mathematics achievement?

To answer this question, parent and student expectation variables are logged and SES variables is included as control variable. The results showed that both student expectation and parent expectation have significant association with mathematics achievement scores and student
expectation ($\beta = 78.607, p < 0.001$) has a larger effect on mathematics achievement in comparison with the effect of parent expectation ($\beta = 37.984, p < 0.01$) on eighth-grade student mathematics achievement. This result fails to satisfy aforementioned hypothesis. Parent expectation was expected to affect mathematics achievement more strongly than the effect of student expectation on mathematics achievement. The results reveal the opposite.

**Research Question 4:** Do gender and socioeconomic status mediate the relationship between ‘constructs of interest’ (i.e., intrinsic and extrinsic motivation, expectations of significant others, and mathematics self-concept) and eighth-grade student mathematics achievement?

Mediation analyses were conducted in Stata using ‘sem’ command. To test the bias-corrected significance of indirect effect, a bootstrap estimation approach with 1000 replications (Shrout & Bolger, 2002) was taken.

**Mediation Variable is SES: Intrinsic Motivation on Mathematics Achievement:** Results indicated that i) SES was a significant predictor of mathematics achievement ($\beta = 21.893, SE = 0.564, p < 0.05$); ii) intrinsic motivation was a significant predictor of mathematics achievement ($\beta = 25.510, SE = 1.422, p < 0.05$); iii) intrinsic motivation was not a significant predictor of SES ($\beta = 0.033, SE = 0.039, ns$); and iv) intrinsic motivation was not a statistically significant predictor of mathematics achievement after accounting for the mediator SES ($\beta = 0.719, SE = 0.855, ns$). Approximately, 6.7% of the variation in mathematics achievement score was accounted by the predictors. The significance of indirect effect was tested with bootstrapping estimation approach. The result indicated that the indirect effect of intrinsic motivation on mathematics achievement through SES was not significant ($\beta = 0.870, SE =$
Therefore, SES does not mediate the effect of intrinsic motivation on mathematics achievement.

Extrinsic Motivation on Mathematics Achievement: Results indicated that i) SES was a significant predictor of mathematics achievement ($\beta = 22.052$, $SE = 0.580$, $p < 0.05$); ii) extrinsic motivation was a significant predictor of mathematics achievement ($\beta = 18.751$, $SE = 1.837$, $p < 0.05$); iii) extrinsic motivation was not a significant predictor of SES ($\beta = -0.020$, $SE = 0.051$, $ns$); and iv) extrinsic motivation was not a statistically significant predictor of mathematics achievement after accounting for the mediator SES ($\beta = -0.444$, $SE = 1.115$, $ns$). Only 2.1% of the variation in mathematics achievement score was accounted by the predictors. The significance of indirect effect was tested with bootstrapping estimation approach. The result indicated that the indirect effect of extrinsic motivation on mathematics achievement through SES was not significant ($\beta = 0.085$, $SE = 0.944$, $ns$). Therefore, SES does not mediate the effect of extrinsic motivation on mathematics achievement.

Mathematics Self-concept on Mathematics Achievement: Results indicated that i) SES was a significant predictor of mathematics achievement ($\beta = 19.320$, $SE = 0.545$, $p < 0.05$); ii) mathematics self-concept was a significant predictor of mathematics achievement ($\beta = 44.433$, $SE = 1.493$, $p < 0.05$); iii) mathematics self-concept was a significant predictor of SES ($\beta = 0.487$, $SE = 0.043$, $p < 0.05$); and iv) mathematics self-concept was a statistically significant predictor of mathematics achievement after accounting for the mediator SES ($\beta = 9.406$, $SE = 0.890$, $p < 0.05$). About 19% of the variation in mathematics achievement score was accounted by the predictors. The significance of indirect effect was tested with bootstrapping estimation approach. The result indicated that the indirect effect of mathematics self-concept on mathematics achievement through SES was significant ($\beta = 9.013$, $SE = 0.890$, $p < 0.05$).
Thus, SES partially mediates the effect of mathematics self-concept on mathematics achievement. The ratio of indirect effect to total effect was 0.17.

Teacher Expectation on Mathematics Achievement: Results indicated that i) SES was a significant predictor of mathematics achievement ($\beta = 21.243$, $SE = 0.598$, $p < 0.05$); ii) teacher expectation was a significant predictor of mathematics achievement ($\beta = 10.015$, $SE = 1.489$, $p < 0.05$); iii) teacher expectation was significant predictor of SES ($\beta = 0.498$, $SE = 0.035$, $p < 0.05$); and iv) teacher expectation was a statistically significant predictor of mathematics achievement after accounting for the mediator SES ($\beta = 10.586$, $SE = 0.819$, $p < 0.05$). Only 4.8% of the variation in mathematics achievement score was accounted by the predictors. The significance of indirect effect was tested with bootstrapping estimation approach. The result indicated that the indirect effect of teacher expectation on mathematics achievement through SES was significant ($\beta = 10.319$, $SE = 0.714$, $p < 0.05$). Hence, SES partially mediates the effect of teacher expectation on mathematics achievement. The ratio of indirect effect to total effect was 0.49. In other words, 49% of the effect of teacher expectation on mathematics achievement is mediated by SES.

Parent Expectation on Mathematics Achievement: Results indicated that i) SES was a significant predictor of mathematics achievement ($\beta = 19.802$, $SE = 0.610$, $p < 0.05$); ii) parent expectation was a significant predictor of mathematics achievement ($\beta = 13.223$, $SE = 1.366$, $p < 0.05$); iii) parent expectation was significant predictor of SES ($\beta = 0.822$, $SE = 0.030$, $p < 0.05$); and iv) parent expectation was a statistically significant predictor of mathematics achievement after accounting for the mediator SES ($\beta = 16.292$, $SE = 0.795$, $p < 0.05$). About 16% of the variation in mathematics achievement score was accounted by the predictors. The significance of indirect effect was tested with bootstrapping estimation approach.
The result indicated that the indirect effect of parent expectation on mathematics achievement through SES was significant ($\beta = 14.921$, $SE = 0.686$, $p < 0.05$). Therefore, SES partially mediates the effect of parent expectation on mathematics achievement. The ratio of indirect effect to total effect was 0.51. In other words, 51% of the effect of parent expectation on mathematics achievement is mediated by SES.

**Mediation Variable is Gender:** In order to find the effect of gender as mediator variable between the construct of interest and mathematics achievement, gender is dummy coded for female. Therefore, reported coefficients of gender indicated the estimated difference between female and male student mathematics achievement score. The procedure for the conventional mediation analysis approach (Baron & Kenny, 1986; Sobel, 1982) is: i) the independent variable must significantly predict the dependent variable; ii) tested mediator variable must significantly predict the dependent variable; iii) the independent variable must not predict the dependent variable after accounting for the mediator variable, which indicates full mediation; and iv) if mediation effect is detected, implementation of bootstrapping method to estimate the bias-corrected significance of indirect effect, robust standard errors and confidence intervals (MacKinnon, 2008; Shrout & Bolger, 2002). Following this procedure, the mediation effects of gender on mathematics achievement—with respect to the construct of interest—were tested; however, the first step of this procedure failed for the constructs of interest (except for mathematics self-concept) since gender was not a significant predictor of mathematics achievement in these models. For the mediation effect of gender on the relationship between mathematics self-concept and mathematics achievement, analysis showed that i) controlling for mathematics self-concept, gender has a significant effect on mathematics achievement ($\beta = 7.115$, $SE = 2.794$, $p < 0.05$); ii) mathematics self-concept significantly predicted
iii) mathematics self-concept has a significant effect on gender ($\beta = -0.023, SE = 0.009, p < 0.05$); and iv) indirect effect of mathematics self-concept on mathematics achievement was not significant ($\beta = -0.163, SE = 0.092, p = 0.077$). Overall, the model explained 18.7% of the variation in mathematics achievement. Bootstrapping estimation with 1000 replication is performed. The analysis with robust standard errors showed that the indirect effect of mathematics self-concept via gender was significant ($\beta = -0.184, SE = 0.008, p < 0.05$).

Although the mediation effect is small (0.003% of the total effect), the result indicated that mathematics self-concept through the mediator variable gender significantly predicted mathematics achievement ($\beta = -0.184, SE = 0.008, p < 0.05$).

Summary of Mediation Analyses: It was hypothesized that SES would mediate the relationship between the constructs of interests and mathematics achievement. However, the results failed this hypothesis for the mediation effect of SES on intrinsic motivation and extrinsic motivation. Mediation analyses results showed that SES does not mediate the effect of intrinsic motivation and extrinsic motivation on mathematics achievement, and partially mediates the effect of mathematics self-concept, teacher expectation and parent expectation on mathematics achievement. It was also hypothesized that gender would not mediate the relationship between the constructs of interest and mathematics achievement. The results considering gender showed that gender did not mediated the effect of intrinsic motivation, extrinsic motivation, teacher expectation and parent expectation. Gender, however, partially mediated the effect of mathematics self-concept on mathematics achievement.

**Research Question 5:** What is the association between expectation of significant others (i.e., parent and teacher expectations), motivation (i.e., intrinsic motivation and extrinsic
motivation), and mathematics self-concept on Turkish eighth-grade students’ mathematics achievement?

To answer this question, structural equation modeling (SEM) technique was used based on the theoretical model illustrated in Figure 2-1. The data is transformed from Stata data format to Mplus-compatible format. For the verification of the correct transformation of the dataset, descriptive statistics were obtained from the transformed dataset and they were compared to the earlier descriptive statistics found in Stata. The results showed that datasets were identical. Structural equation modeling analyses were performed in Mplus 8 software.

The following hypotheses were tested: intrinsic motivation, parent expectations, teacher expectations, mathematics self-concept, and SES significantly and positively predict mathematics achievement; extrinsic motivation predicts mathematics achievement negatively; parent expectation and teacher expectation are influenced by each other recursively; and other associations that are shown in the theoretical model (Figure 2-1), is defined in the structural model and all these relations were supposed to be significant.

Two structural equation modeling analyses were performed. The latter analysis is an adjusted structural model that included related terms that will be explained in detail. The final structural equation modeling resulted in a good fit with the data based on the fit indices (RMSEA=0.061; CFI=0.908; SRMR=0.052). The chi-square test was also significant ($\chi^2(159) = 3349.92, p < 0.001$). Results of the structural equation modeling analysis are shown in Table 4-6 and illustrated in Figure 4-8. To compare the relative strength of associations across variables, standardized coefficients are reported along with unstandardized coefficients in Table 4-6. Factor loadings on latent variables (i.e., intrinsic motivation, extrinsic motivation, and mathematics self-concept) were above the commonly used threshold of 0.50 (Figure 4-1) and all
factor loadings were statistically significant. The factor loading of math_hard on mathematics self-concept was very close to the threshold (i.e., 0.498), therefore, this item was kept in the model.

It was hypothesized that intrinsic motivation is positively associated with mathematics achievement. In the first structural equation modeling analysis, results failed to support this hypothesis: intrinsic motivation was negatively associated with mathematics achievement among eighth-grade Turkish students. Considering standardized coefficients, one standard deviation increase in intrinsic motivation is estimated to decrease mathematics achievement in TIMSS 2015 by 0.15 standard deviation. In other words, pertaining to unstandardized coefficients, one unit increase in intrinsic motivation was estimated to decrease mathematics achievement score by 19.72 point. Extrinsic motivation was hypothesized to be negatively related to mathematics achievement. The results supported the hypothesis. However, these results are contrary to the in multiple regression analyses results. An in-depth investigation was carried out to explain different directionality between intrinsic motivation and mathematics achievement. In other words, the reasons for positive effect of intrinsic motivation (and extrinsic motivation) on mathematics achievement in multiple regression and negative effect of intrinsic motivation (and extrinsic motivation) on mathematics achievement in structural equation modeling were scrutinized. Regression line of intrinsic motivation and extrinsic motivation on mathematics achievement was fitted and the figures (Figure 4-1 and Figure 4-2) showed that both intrinsic motivation and extrinsic motivation is positively associated with mathematics achievement. These figures are consistent with the results obtained in Table 4-2 and Table 4-4.
Figure 4-1. Intrinsic motivation and mathematics achievement

Figure 4-2. Extrinsic motivation and mathematics achievement
Later, a review of literature indicated that very few studies included mathematics self-concept and intrinsic motivation into structural equation modeling analysis. The association between intrinsic motivation and mathematics self-concept was investigated. Regression line was fitted to this association and was plotted (Figure 4-3). The figure shows that a high degree of interaction between intrinsic motivation and mathematics self-concept. According to the figure, the association between eighth-grade student mathematics self-concept and their mathematics achievement is influenced by different levels of intrinsic motivation. A comparison of intercepts shows that among the students with lowest mathematics self-concept, students with very high intrinsic motivation are estimated to have lowest mathematics achievement but students with very low intrinsic motivation are estimated to have highest mathematics achievement. On the contrary, among the students with highest mathematics self-concept, students with very high intrinsic motivation are estimated to have highest mathematics achievement but students with very low and low intrinsic motivation are estimated to have lower mathematics achievement. An analysis of slopes indicates that concordant increases of intrinsic motivation and mathematics self-concept results in higher mathematics achievement scores in comparison with interactions of other levels of intrinsic motivation and mathematics self-concept. In other words, for students with very high intrinsic motivation, increasing mathematics self-concept is associated with the highest increase in mathematics achievement in comparisons with students with other levels of intrinsic motivation and mathematics self-concept. This high level of interaction necessitated the inclusion of interaction term in the final structural equation modeling analysis.
Similarly, a possible interaction between extrinsic motivation and mathematics self-concept was investigated. Regression lines of mathematics self-concept with respect to different levels of extrinsic motivation was fitted (Figure 4-4). The figure showed an interaction between extrinsic motivation and mathematics self-concept. Analysis of intercepts indicated that for students with lowest mathematics self-concept, students with high and very high extrinsic motivation, on average, had lower mathematics achievement score while students with low and very low extrinsic motivation had higher mathematics achievement scores. An examination of the slopes indicated that while mathematics self-concept increases, students with high and very high extrinsic motivation had higher mathematics achievement scores and the degree of change for this sample was higher in comparison with students with low and very low extrinsic motivation. Because of the observable interaction between extrinsic motivation and mathematics self-concept, their interaction term was included in the final structural equation modeling.
Figure 4-4. Interaction between extrinsic motivation and mathematics self-concept

The goal for inclusion of interaction terms to the final structural equation modeling is the observation of high level of these interactions and to explain the differential sign of the effect of intrinsic motivation and extrinsic motivation on mathematics achievement. In the final structural equation modeling analysis (Table 4-8), results indicated that intrinsic motivation had negative but nonsignificant effect on eighth-grade student mathematics achievement ($\beta = -3.762$, $SE = 3.050$, ns) which does not support the hypothesis, and extrinsic motivation had smaller but still negative and significant effect on mathematics achievement ($\beta = -11.883$, $SE = 4.059$, $p < 0.05$) as hypothesized. Surprisingly, the interaction between intrinsic motivation and mathematics self-concept had positive and significant effect on mathematics achievement ($\beta = 25.242$, $SE = 3.344$, $p < 0.05$). The effect of interaction between extrinsic motivation and mathematics self-concept on mathematics achievement was negative but significant ($\beta = -14.080$, $SE = 5.776$, $p < 0.05$). As expected, mathematics self-concept had the highest
effect on mathematics achievement ($\beta = 55.671$, $SE = 2.571$, $p < 0.05$) among the other variables.

As hypothesized, parent expectation was positively associated with mathematics achievement ($\beta = 14.929$, $SE = 1.545$, $p < 0.05$). Surprisingly, the effect of teacher expectation on mathematics achievement was very small and nonsignificant ($\beta = 0.902$, $SE = 1.668$, $ns$). This result is contrary to the hypothesis. In order to explain this unexpected and counterintuitive result, the mediating effect of SES on the relationship between teacher expectation and mathematics achievement was suspected. A histogram of the distribution of student SES (Figure 4-5) showed that most students are aggregated around or below the average SES. In Figure 4-6, regression lines are fitted to represent the association between student SES and teacher expectation. The figure shows that teacher expectation increases when student SES increases.

Figure 4-5. Distribution of student SES
Figure 4-6. SES and teacher expectation

Figure 4-7. Teacher expectation and mathematics achievement by SES levels
Finally, Figure 4-7 shows that the effect of teacher expectation on mathematics achievement differs among students with different SES levels. Therefore, not only teacher expectation is influenced by SES, but also SES influence the association between teacher expectation and mathematics achievement. Nonsignificant effect of teacher expectation can be the result of these reasons.

A reciprocal relationship between teacher and parent expectation was hypothesized. The results showed that teacher expectation had a positively significant and large effect on parent expectation ($\beta = 0.574$, $SE = 0.015$, $p < 0.05$). However, parent expectation had no significant effect on teacher expectation. Therefore, nonsignificant direction was removed from the final analysis. Moreover, teacher expectation, parent expectation, and SES on mathematics self-concept had significant effect on mathematics self-concept (Table 4-7). As expected based on the hypotheses depicted on Figure 2-1, SES had significant effect on mathematics achievement, mathematics self-concept, parent expectation and teacher expectation. In standardized units, the effects of SES were 0.36, 0.19, 0.27 and 0.20, respectively. As results indicate, mathematics self-concept and SES had the largest effects on mathematics achievement scores. Additionally, based on the literature, extrinsic motivation was expected to be negatively associated with intrinsic motivation. The results showed that extrinsic motivation significantly and positively impacted intrinsic motivation. One unit increase in extrinsic motivation is estimated to increase intrinsic motivation by 0.65 standard deviation.

In summary, by using the Turkish portion of the TIMSS, aforementioned hypotheses were tested. In this context, the results supported some hypotheses derived from the literature while results failed to support some hypotheses. In Discussion section, the findings will be interpreted more elaborately and implications of the findings will be discussed.
Table 4-7. Standardized and unstandardized regression weights

<table>
<thead>
<tr>
<th>Mathematics Achievement</th>
<th>Standardized</th>
<th>Unstandardized Coefficient</th>
<th>Unstandardized Standard error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intrinsic motivation</td>
<td>-0.029</td>
<td>-3.762</td>
<td>3.050</td>
</tr>
<tr>
<td>Extrinsic motivation</td>
<td>-0.055</td>
<td>-11.883**</td>
<td>4.059</td>
</tr>
<tr>
<td>Mathematics self-concept</td>
<td>0.417</td>
<td>55.671***</td>
<td>2.571</td>
</tr>
<tr>
<td>Teacher expectation</td>
<td>0.008</td>
<td>0.902</td>
<td>1.668</td>
</tr>
<tr>
<td>Parent expectation</td>
<td>0.151</td>
<td>14.929***</td>
<td>1.545</td>
</tr>
<tr>
<td>SES</td>
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<td>15.808***</td>
<td>0.586</td>
</tr>
<tr>
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<td>25.242***</td>
<td>3.344</td>
</tr>
<tr>
<td>and mathematics self-concept</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interaction 2 (extrinsic motivation</td>
<td>-0.050</td>
<td>-14.080*</td>
<td>5.776</td>
</tr>
<tr>
<td>and mathematics self-concept</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intrinsic motivation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extrinsic motivation</td>
<td>0.650</td>
<td>1.079***</td>
<td>0.041</td>
</tr>
<tr>
<td>Mathematics self-concept</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher expectation</td>
<td>0.060</td>
<td>0.050**</td>
<td>0.015</td>
</tr>
<tr>
<td>Parent expectation</td>
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<td>-0.074***</td>
<td>0.014</td>
</tr>
<tr>
<td>SES</td>
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<td>0.064***</td>
<td>0.006</td>
</tr>
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<td>Parent Expectation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher expectation</td>
<td>0.501</td>
<td>0.574***</td>
<td>0.015</td>
</tr>
<tr>
<td>SES</td>
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<td>0.123***</td>
<td>0.006</td>
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<tr>
<td>Teacher expectation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SES</td>
<td>0.196</td>
<td>0.077***</td>
<td>0.006</td>
</tr>
</tbody>
</table>

Note: + p < 0.10, * p < .05, ** p < .01, *** p < .001
In this section, the purpose of this study will be summarized. Following the purpose of the study, main findings pertaining to the constructs of interest will be discussed. Afterwards, the implications concerning educational research and practices will be disputed. Pertaining to the data, methodology and theory, the limitations of the study will be discussed next. After providing some suggestions for further research, the chapter will be concluded.

5.1 Overview of the Study

The purpose of the present study is to improve our understanding with respect to the associations between intrinsic motivation, extrinsic motivation, teacher expectation, parent expectation, mathematics self-concept and mathematics achievement. Apart from previously stated research gaps, two main reasons necessitated the conduct of the study. First of all, the literature depicts a mixed picture about the effects of intrinsic motivation and extrinsic motivation on student mathematics achievement. For example, while intrinsic motivation has positive effect on mathematics achievement in some studies (e.g., Akben-Selcuk, 2017; Froiland & Davison, 2016; Murayama, Pekrun, Lichtenfeld, & Hofe, 2013), other studies show negative effect or nonsignificant effect (e.g., Areepattamannil, 2014; Areepattamannil, Freeman, & Klinger, 2011). Similarly, although some studies indicate negative effect of extrinsic motivation on mathematics achievement (Areepattamannil, 2014; Areepattamannil, Freeman, & Klinger, 2011), certain studies indicate positive or nonsignificant effect of extrinsic motivation on mathematics achievement in some cultural contexts (e.g., Akben-Selcuk, 2017; Liu & Hou, 2018; Zhu & Leung, 2011). The second reason is the limited coverage of these factors in many studies. Namely, many studies include limited number of factors to analyze their effect on mathematics achievement. For instance, a review of literature in major databases (i.e,
EBSCOHOST and JSTOR) revealed no research study that simultaneously analyzed the effects of intrinsic motivation and mathematics self-concept on mathematics achievement. As reported in the Results section, not only the type of method used for data analysis (e.g., regression analysis vs mediation analysis or structural equation modeling), but also the inclusion of related variables into the model results in varying degree of the strength of associations. For example, while a unit increase in SES is estimated to directly impact mathematics achievement by 25.51 in mediation analysis, the effect is reduced to 15.81 point change in mathematics achievement when measurement error and other variables are taken into account in structural equation modeling analysis. Another example is the positive and significant effect of intrinsic motivation on eighth-grade student mathematics achievement in multiple regression analysis while in structural equation modeling, the effect was nonsignificant. Moreover, the type of method used may change the sign of the association. For instance, while intrinsic motivation and extrinsic motivation were positively associated with mathematics achievement using multiple regression analysis, they had negative effect on mathematics achievement when structural equation modeling analysis is implemented. In addition to these main reasons, lack of research studies about the influence of intrinsic motivation, extrinsic motivation, parent expectation, teacher expectation and mathematics self-concept on mathematics achievement within the educational context of Turkey is another reason for conducting this study. This reason and relatively lower mathematics achievement among Turkish students compared to the average mathematics achievement score of Organization for Economic Co-operation and Development (OECD) countries are other reasons for conducting this study. In summary, the purpose of this study is to contribute to theory in educational research by adding to the literature by answering aforementioned research gaps and analyzing contradictory research results in previous studies.
Additionally, from a pragmatic point of view, another purpose of this study is to investigate specific factors that influence overall mathematics achievement scores of eighth-grade Turkish students in order to interpret findings and provide possible recommendations for educational practices in Turkey. These recommendations could be taken into consideration in similar educational systems and cultural contexts, and they could be tested in other contexts for verification of the theoretical framework.

5.2 Findings

This study analyzed specific associations between types of motivation, teacher and parent expectation and mathematics self-concept, and their effects on each other as well as on eighth-grade student mathematics achievement. Although data analyses results imply causality, the results should be interpreted with caution since the assumption of causality requires covariation, temporal precedence, and elimination of extraneous variables. Cross-sectional datasets fail to satisfy temporal precedence condition. Nevertheless, the directions of associations between the variables can be implied as possible causal relationships by considering statistical evidences obtained from earlier theoretical perspectives and research studies.

For the first research question, the relationships between intrinsic motivation, extrinsic motivation and mathematics achievement were analyzed. The results showed that intrinsic and extrinsic motivation are relatively highly and positively correlated with each other. In other words, students with high intrinsic motivation have high extrinsic motivation or vice versa. Although majority of past research found negative correlation between intrinsic and extrinsic motivation (e.g., Deci, 1975; Deci & Ryan, 1985; Greene & Lepper, 1974; McCullers, Fabes, & Moran, 1987), the findings of this study are consistent with recent findings (Lee & Stankov, 2013; Liu & Hou, 2018; Pelletier et al., 1995).
Data analysis results concerning the effect of intrinsic motivation on mathematics achievement showed that intrinsic motivation positively predicted mathematics achievement when controlled for SES. This finding is in line with the recent studies that mostly reported positive effect of intrinsic motivation on mathematics achievement (e.g., Akben-Selcuk, 2017; Areepattamannil, 2014; Areepattamannil, Freeman, & Klinger, 2011; Froiland & Davison, 2016). Contrary to expectations, extrinsic motivation positively predicted mathematics achievement when controlled for SES. Earlier research generally indicated mixed results about the effect of extrinsic motivation on mathematics achievement while majority of studies reporting the negative effect of extrinsic motivation on mathematics achievement. For example, Areepattamannil, Freeman, and Klinger (2011) found negative effect of extrinsic motivation on mathematics achievement. Their sample consisted of Indian students in India and Indian immigrant students in Canada. In contrast, Liu and Hou (2018) used NELS88 dataset—which consists of US students—and found positive effect of extrinsic motivation on mathematics achievement. Additionally, Zhu and Leung (2011) analyzed TIMSS 2013 dataset and included samples from nine countries. They found positive association between extrinsic motivation and mathematics achievement in East Asian countries and negative association in Western countries. Related to Turkish students, the finding of this study is partially in accord with the study of Akben-Selcuk (2017) which analyzed Turkey portion of PISA 2012 dataset and found positive but nonsignificant effect of extrinsic motivation on mathematics achievement. In summary, findings of this study support the claim that transporting motivational theories to new cultural or social settings may cause unexpected consequences (McInerney, 2007). Difference between cultural and/or educational context might be the origin of mixed results of past research. Aside from intrinsic and extrinsic motivation having significant and positive association with eighth-
grade student mathematics achievement, intrinsic motivation had slightly greater effect on mathematics achievement as expected.

An exploratory approach was taken to explore a possible effect of mathematics achievement on intrinsic motivation and extrinsic motivation. The results indicated that the effect of mathematics achievement scores on intrinsic and extrinsic motivation was significant but very low. The effect of mathematics achievement was 0.001% (per one-point increase of mathematics achievement) on both types of motivation. However, this last finding must be interpreted with caution since a cross-sectional dataset was used.

The results of the first research question indicated that when intrinsic motivation or extrinsic motivation are considered alone while controlled for SES, they have positive effect on eighth-grade student mathematics achievement. In other words, enhancing eighth-grade student intrinsic motivation and/or extrinsic motivation will be expected to result in higher mathematics achievement regardless of student SES. Moreover, in the literature, there were very few research studies that investigated the effect of intrinsic motivation on student mathematics achievement. A single study (i.e., Keklik & Keklik, 2013) was conducted in Turkey that investigated the effect of extrinsic motivation on high school student mathematics achievement. This finding provides a substantial contribution to the research by examining the effects of intrinsic motivation and extrinsic motivation on eighth-grade student mathematics achievement in the context of Turkey.

The analyses concerning the second research question sought to find the effects of teacher expectation and parent expectation on 9th grade student mathematics achievement. The results indicated significant and positive correlation between parent expectation and teacher expectation. On average, teachers have higher expectations than parents for eighth-grade student future achievement. Furthermore, the influence of congruence-dissonance of teacher-parent
expectation on mathematics achievement was tested and the results showed that congruence-
dissonance between teacher expectation and parent expectation had significant and negative
effect on 9th grade student mathematics achievement. Particularly, when parent expectation is
lower than teacher expectation—which is the case based on descriptive statistics—student
mathematics achievement is negatively impacted. This result is consistent with Benner and
Mistry’s (2007) study. They also found that congruently high (or low) parent and teacher
expectations have positive (or negative) effect on student expectation and mathematics
achievement. They stated that if parent expectation is higher than teacher expectation, this serves
as a buffering effect that partially reduces negative effects of low teacher expectation. Two
possible reasons can be conjectured to interpret these findings: i) differential expectations across
teacher and parents may negatively influence student expectation and mathematics achievement;
and ii) parent expectation has a greater effect on student mathematics achievement and when
parent expectation is lower than teacher expectation (i.e., dissonance), student mathematics
achievement scores—on average—decreases. These findings imply that Turkish parent
expectation needs to be enhanced and the best scenario for improving eighth-grade student
mathematics achievement scores is to have teachers and parents share equivalent level of
expectation.

Third research question sought to compare the effects of student and parent expectation
on student mathematics achievement. The findings revealed that both parent expectation and
student expectation had significant effect on mathematics achievement. However, student
expectation had larger effect on mathematics achievement in comparison with parent
expectation. This study is contrary to the findings of Froiland and Davison’s study (2016). They
performed a structural equation modeling in HSLS dataset and the effect of parent expectation on
mathematics achievement was much greater than the effect of student expectation on mathematics achievement. Because expectancy-value theory asserts that student expectations and their subjective values have higher effects on student mathematics achievement in comparison with the effect of parent and teacher expectations, they concluded that expectancy-value theory needs a revision. However, the finding of the current study supports the assertion of the expectancy-value theory. Furthermore, the finding of this study is consistent with the findings of Ou and Reynold (2008). They conducted a longitudinal study and found that the effect of student expectation had greater effect than the effect of parent expectation on high school completion. This finding highlights the importance of improving eighth-grade student expectation, which consequently improves their mathematics achievement. Additionally, results related to the second and the third question addressed the need to explore student, teacher, and parent expectations with a large-scale dataset (Widdowson & Dixon, 2010).

To answer the fourth research question, several mediation analyses were tested to explore the mediator effect of SES and gender with respect to the effects of intrinsic motivation, extrinsic motivation, teacher expectation and parent expectation on eighth-grade student mathematics achievement. As expected, SES was a significant predictor of mathematics achievement in the analyses. The findings revealed that SES does not mediate the effect of intrinsic motivation and extrinsic motivation on mathematics achievement. The indirect effect of both intrinsic motivation and extrinsic motivation via SES was nonsignificant. However, SES partially mediated the effect of mathematics self-concept, teacher expectation and parent expectation on mathematics achievement. Results showed that indirect effect of mathematics self-concept on mathematics achievement was statistically significant. SES mediated 17% of the effect of mathematics self-concept on mathematics achievement. Similarly, indirect effects of
teacher expectation and parent expectation via SES were statistically significant. SES mediated 49% of the effect of teacher expectation on mathematics achievement and 51% of the effect of teacher expectation on mathematics achievement. In summary, SES is not a mediator of the effect of intrinsic motivation and extrinsic motivation on mathematics achievement. However, SES partially mediates mathematics self-concept, teacher expectation, and parent expectation. Especially, mediation effect of SES on teacher expectation and parent expectation is remarkable. Therefore, this finding implies a necessity to pay particular attention to teacher and parent expectations since their effects are mediated by SES which seem to impact inequalities among students with different level of SES. Although enhancing student mathematics self-confidence to dilute negative effects of low SES on student mathematics achievement is relatively more difficult, assisting teachers and parents to have higher expectations for students may reduce the mediating effect of SES on the relationship between teacher expectation (and parent expectation) and mathematics achievement. This finding also requires more research about the causal effect of increasing teacher expectation or parent expectation pertaining to the mediating effect of SES on mathematics achievement.

Additionally, it was hypothesized that gender would not mediate the relationship between the constructs of interest and mathematics achievement. The only mediation effect was found for mathematics self-concept. Gender mediated the effect of mathematics self-concept on mathematics achievement to a rather small degree. This finding evokes biased role of gender on mathematics self-concept and mathematics achievement. However, very small mediating effect of gender points to a positive direction with respect to the opportunity to learn among girls and boys. A search of literature indicated no study that specifically analyzed the mediation effect of
SES or gender on the constructs of interest. Therefore, findings of this study contribute to the field on this gap.

For the final research question, the effect of all the constructs of interest on mathematics achievement as well as on each other were modeled. The following hypotheses were tested (Figure 2-1): 1) intrinsic motivation, mathematics self-concept, parent expectation, teacher expectation, and SES positively influence eighth-grade student mathematics achievement while extrinsic motivation negatively affects eighth-grade student mathematics achievement; 2) teacher expectation and parent expectation influence each other; 3) SES has direct effects on teacher expectation and parent expectation; 4) SES and parent expectation directly affect mathematics self-concept; and 5) extrinsic motivation negatively influences intrinsic motivation.

The findings revealed that intrinsic motivation has negative but nonsignificant effect on eighth-grade student mathematics achievement. As previously stated, majority of past studies found positive effect of intrinsic motivation on mathematics achievement. However, the findings of this study depicted a different picture. Related to this unexpected result, the interaction between intrinsic motivation and mathematics self-concept was plotted and the interaction term was included in the structural equation model. Graphical observation of the interaction between intrinsic motivation and mathematics self-concept (Figure 4-3) revealed a remarkable interaction. The interaction term in the structural equation model was significant. Namely, the findings showed that mathematics self-concept catalyzes the effect of intrinsic motivation on mathematics achievement. When mathematics self-concept was lower, high levels of intrinsic motivation actually had a deteriorating effect on mathematics achievement. Moreover, when both intrinsic motivation and mathematics self-concept are increased, congruence among high level of intrinsic motivation and mathematics self-concept had the largest effect on eighth-grade student
mathematics achievement. In other words, improving student mathematics self-concept must be a priori condition before enhancing intrinsic motivation so that an optimum effect on eighth-grade student mathematics achievement can be achieved. A similar effect was found related to the effect of extrinsic motivation on mathematics achievement. Figure 4-4 showed a high degree of interaction between extrinsic motivation and mathematics achievement. One possible reason for this interaction is the consideration of extrinsic motivation on its own without taking its four types into account. Self-determination theory proposes that integrated regulation is the most internalized form of extrinsic motivation (Deci & Ryan, 1985). In this study, the items for constructing extrinsic motivation scale seem to be defining less internalized forms of extrinsic motivation than integrated regulation. For example, the item ‘mathematics provides more job opportunities’ was used to define extrinsic motivation. However, it describes external regulation type of extrinsic motivation. Deci and Ryan (1985) proposed that the more a person has more internalized forms of extrinsic motivation, the more the person is self-determined. Because of the constraints of the secondary data, types of extrinsic motivation were not analyzed separately. Therefore, the interaction between extrinsic motivation and mathematics self-concept can be the result of this approach. Intuitively, the more internalized types of extrinsic motivation may not interact with mathematics self-concept which needs to be investigated more thoroughly in future studies.

Furthermore, inclusion of the interaction term (i.e., the interaction between extrinsic motivation and mathematics self-concept) in the structural equation model had significant effect on eighth-grade student mathematics achievement. Negative effect of intrinsic motivation and extrinsic motivation on mathematics achievement seemed to be resulted from the fact that the interaction terms acted as moderator effect and accounted for some portions of the effect of
intrinsic and extrinsic motivation on mathematics achievement. More research is necessary to explain i) why the sign of the effect of intrinsic motivation and extrinsic motivation on eighth-grade student mathematics achievement changed when structural equation modeling is used instead of regression analysis and ii) if mathematics self-concept or the aforementioned interactions moderated the effect of intrinsic and extrinsic motivation on eighth-grade student mathematics achievement. These findings have unique contribution to the literature since this is the only study that included mathematics self-concept into a structural equation model that already included intrinsic motivation and extrinsic motivation. Moreover, for the first time, this study included both interaction terms and found significant effects.

In this study, especially mathematics self-concept was included in the model because of the absence of research study in the major databases that involved middle or high school students in Turkey. The structural equation model results showed that mathematics self-concept has positive and significant effect on eighth-grade student mathematics achievement as was hypothesized. This finding is in line with the earlier research (e.g., Goetz, Cronjaeger, Frenzel, Lidtke, & Hall, 2010; Jusim & Eccles, 1992; Pitsia, Biggart, & Karakolidis, 2017). Indeed, mathematics self-concept had the largest effect on mathematics achievement in comparison with other factors. This finding aligns with the findings of Pipere and Mierian (2017). They conducted a web survey on 9th grade Latvian students and found that mathematics self-concept had the largest effect on mathematics achievement. Similarly, Suárez-Álvarez, Fernández-Alonso and Muñiz (2014) conducted a study in Spain on the second grade of Compulsory Secondary Education and found that mathematics self-concept predicted mathematics achievement and had the largest effect in comparison with other variables. Additionally, the findings of this study revealed that the interactions of intrinsic motivation and extrinsic motivation with mathematics
self-concept had significant effects on mathematics achievement. As a result, these findings highlight the importance of mathematics self-concept and its role in improving eighth-grade student mathematics achievement scores, which needs to be carefully taken into consideration by educators, policy makers and researchers.

Parent expectation had positive effect on mathematics achievement as expected. The literature dominantly supports this finding (e.g., Benner & Mistry, 2007; Froiland & Davison, 2016; Ma, 2001; Parsons, Adler, & Kczala, 1982). However, contrary to the hypothesis, teacher expectation did not have a significant effect on eighth-grade student mathematics achievement in the structural equation model. The literature has mostly indicated significant and positive association between teacher expectation and mathematics achievement (e.g., Bergh, Denessen, Hornstra, Voeten, & Holland, 2010; Benner & Mistry, 2007; Peterson, Rubie-Davis, Osborne, & Sibley, 2016; Smith, Jussim & Eccles, 1999). Moreover, the final variable that are conjectured to influence eighth-grade student mathematics achievement was SES. As expected, positive effect of SES on eighth-grade student mathematics achievement was found.

Rubie-Davis, Peterson, Irving, Widdowson and Dixon (2010) suggested that more research is needed to examine the association between teacher and parent expectation. Therefore, the relationship between teacher and parent expectation was also tested. It was found that teacher expectation has a direct effect on parent expectation while the effect of parent expectation on teacher expectation was nonsignificant. The contribution of this finding to the literature can be further extended by examining the association between teacher and parent expectations and their effect on mathematics achievement with the consideration of cluster effect. In other words, parents are clustered within the sample of teachers, thus, their cluster effect needs to be taken into account in future studies.
Moreover, the effect of SES on parent expectation and teacher expectation were tested. SES had positive and significant effect on teacher expectation and parent expectation. The effect of SES on parent expectation was higher than its effect on teacher expectation. Interpreting this finding with the earlier findings—positive and significant effect of parent expectation on mathematics achievement and nonsignificant effect of teacher expectation on mathematics achievement—reveals a remarkable aspect. Namely, SES not only influences eighth-grade student mathematics achievement, but also influences mathematics achievement via the path passing through parent expectation. Therefore, although improving teacher expectation of eighth-grade student mathematics achievement is unquestionably essential, improving parent expectation should be a priority for educators and policy makers.

Mathematics self-concept had the largest effect on eighth-grade student mathematics achievement. Additionally, mediation analyses showed that SES mediates the relationship between mathematics self-concept and mathematics achievement. Therefore, the path connecting these three variables to mathematics self-concept were tested. Teacher expectation and SES had positive and significant effect on mathematics self-concept. Although teacher expectation had smaller effect, SES had the largest effect on mathematics self-concept. On the contrary, parent expectation had negative and significant effect on student mathematics self-concept. This surprising finding contrasts with past research (e.g., Banner & Mistry, 2007; Lazarides, Viljaranta, Aunola, Pesu, & Nurmi, 2016; Lazarides & Watt, 2015) which suggested that mathematics self-concept can be improved by teacher and parent expectation. Negative effect of parent expectation on student mathematics self-concept provides a contrary evidence to this claim. A set of potential reasons can be attributed to this finding. First, average parent expectation was relatively lower in comparison with teacher expectation. Therefore, increasing
lower levels of parent expectation may not have a significant effect on student mathematics self-concept. Second, omittance of a possible interaction effect between parent expectation and mathematics self-concept is probable. Third, mathematics self-concept might be moderating the effect of parent expectation on mathematics achievement and its path that is passing through mathematics self-concept. Fourth, mathematics self-concept was defined by parent expectation, teacher expectation, and SES. SES was shown to influence each of these variables as well as mathematics self-concept. Moreover, in mediation analyses, SES was shown to mediate the effect of parent expectation on mathematics achievement. Hence, when the effect of SES was singled out, loss of the effect of parent expectation through the mediation of SES may has left the effect of parent expectation on mathematics self-concept to be negative. In addition to the necessity of more research replicating this association, alternative explanations are necessary to explain this unexpected finding.

Finally, the effect of extrinsic motivation on intrinsic motivation was hypothesized to be negative. The structural equation modeling analyses results showed that extrinsic motivation has positive and significant effect on intrinsic motivation. This finding is contrary to findings of earlier research (e.g., Corpus & Wormington, 2014; Deci, 1975; Deci & Ryan, 1985; Greene & Lepper, 1974; Lepper & Greene, 1975; Lepper, Greene, & Nisbett, 1973; McCullers, Fabes, & Moran, 1987). However, more recent research generally provides evidences for positive correlation between extrinsic motivation and intrinsic motivation (e.g., Lee & Stankov, 2010; Liu & Hou, 2018; Pelletier et al., 1995). The finding of this study contributes to research not only by finding positive correlation between intrinsic motivation and extrinsic motivation but also by providing evidence for the positive direct effect of extrinsic motivation on intrinsic motivation. Different effects found in the past research as well as in this study can be attributed to the unique
cultural context (Leung, 2001). Moreover, with respect to construct validity of the scales that measure intrinsic motivation or extrinsic motivation, the meaning respondents attach to the items of the scale and the response they give to the items may cause these results. In other words, some items may impose a western framework on other countries. For this reason, how students interpret and respond to specific items may matter since students’ reaction to some questions may differ. For example, in some Asian countries, responding to the item (i.e., “I enjoy learning mathematics”), which defines student intrinsic motivation, may receive lower rating from both high or low achieving students since ‘enjoy’ may connotate different meanings in some cultures. For the sample of this study (i.e., Turkish eighth-grade students), this case is not likely though. Nevertheless, this point needs to be taken into consideration in interpreting mixed findings that are obtained within different cultural contexts or when constructing scales for the future studies.

5.3 Implications of the Study

There are numerous factors that influence student mathematics achievement such as teaching practices, psychological factors, cognitive factors, social factors, family socioeconomic status, family-school communication and so on. In this study, the associations between intrinsic motivation, extrinsic motivation, teacher expectation, parent expectation, mathematics self-concept, SES, and eighth-grade student mathematics achievement were analyzed. The findings have multiple implications for teachers, parents, school administrators and policy makers for improving 8ht grade student mathematics achievement.

5.3.1 Intrinsic Motivation and Extrinsic Motivation

The literature mostly show that intrinsic motivation has a larger effect on mathematics achievement than the effect of extrinsic motivation has on mathematics achievement. On the contrary, the findings reveal that Turkish eighth-grade students have greater level of extrinsic motivation than intrinsic motivation. While intrinsic motivation is an inner energy that activate
the organism, extrinsic motivation is contingent on extrinsic outcomes. Since students may not continuously receive or expect extrinsic outcomes, improving intrinsic motivation should be priority for teachers and parents. Related to this point, higher extrinsic motivation than intrinsic motivation might be one of the causes for relatively low mathematics achievement of Turkish students because intrinsic motivation directly predicts mathematics achievement as shown in regression analyses and indirectly influence mathematics achievement via its interaction with mathematics self-concept as was shown in structural equation modeling analysis. Furthermore, investigation of the interaction between intrinsic motivation and mathematics self-concept showed that mathematics self-concept is a priori condition for obtaining positive and significant effect of intrinsic motivation on eighth-grade student mathematics achievement. Therefore, for the future studies or practices that aimed at improving mathematics achievement via enhancing intrinsic motivation, manipulation of both intrinsic motivation and mathematics self-concept should be considered. Additionally, significant effect of extrinsic motivation on intrinsic motivation implies that students’ intrinsic motivation level may be improved by providing extrinsic motivators that can push their motive to achieve. Findings obtained from structural equation modeling show that intrinsic motivation and extrinsic motivation have negative effects on mathematics achievement when measurement error and other variables are considered. This finding is counterintuitive since intrinsic motivation and extrinsic motivation are expected to help students to study more. Graphical analyses indicated that intrinsic and extrinsic motivation interact with mathematics self-concept. Therefore, for improving eighth-grade student mathematics achievement via increasing extrinsic motivation, both extrinsic motivation and mathematics self-concept needs to be congruently manipulated. In summary, in the context of Turkey, improving intrinsic motivation or extrinsic motivation is expected to increase eighth-
grade student mathematics achievement. Although students’ average extrinsic motivation was larger than intrinsic motivation, intrinsic motivation is expected to have greater effect on mathematics achievement. As a result, as improving mathematics self-concept congruently with intrinsic motivation and extrinsic motivation is crucial to help improve average mathematics achievement of eighth-grade student, more attention needs to be paid to improving intrinsic motivation.

Findings of this study might be related to the context of Turkey. The results of some earlier studies imply that the effect of intrinsic motivation and extrinsic motivation might depend on the cultural context where the study takes place. This situation might also be related to different meanings or importance assigned to types of the items—that define types of motivation—in different cultural contexts. For example, Areepattamannil, Freeman and Klinger (2011) conducted a study on Indian adolescents living in India and immigrant Indian students living in Canada and the researchers found no significant effect of intrinsic motivation and extrinsic motivation on mathematics achievement among Indian adolescents in India while they found a positive association among immigrant Indian adolescents in Canada. Liu and Hous (2018) analyzed National Education Longitudinal Study of 1988 (NELS88) and they found positive effect of intrinsic motivation and extrinsic motivation on American student mathematics achievement. Moreover, Zhu and Leung (2011) analyzed TIMSS 2013 dataset and included samples from East Asian and Western countries. They found positive association between extrinsic motivation and mathematics achievement in East Asian countries and negative association in Western countries. These findings highlight the importance of consideration of cultural context in forming theoretical frameworks as well as the necessity of more research examining the meanings and importance attributed to the items of intrinsic motivation and
extrinsic motivation by different cultural contexts. Nevertheless, the findings of this study can have similar implications for other countries because Turkish students should have given similar meanings to the items that define intrinsic and extrinsic motivation. Thus, the suggestions and implications made for the context of Turkey can be extended to include other countries.

These findings have implications for researchers about its relations to self-determination theory. Self-determination theory (Deci & Ryan, 1985) assumes that intrinsic motivation and extrinsic motivation are positively associated with mathematics achievement. Although regression analysis supported this assumptions, structural equation modeling results depicted a different picture. Namely, intrinsic motivation had negative and nonsignificant effect on mathematics achievement and extrinsic had negative and significant effect on mathematics achievement. Self-determination theorists must investigate and clarify the reasons for the studies that have found contrary evidences.

Another important finding is related to the mediating effect of SES on the relationship between intrinsic/extrinsic motivation and mathematics achievement. SES did not mediate these relationships. This finding has implications for opportunity to learn because SES has direct and indirect effects on some factors that are related to mathematics achievement. Therefore, students with different SES levels face unequal treatment and expectations by teachers and parents which causes inequality of opportunity to learn. Since SES does not mediate the association between intrinsic/extrinsic motivation and mathematics achievement, manipulation of intrinsic/extrinsic motivation might be a more feasible action to take in comparison with manipulating other constructs or SES.

5.3.2 Mathematics Self-Concept

Among other constructs of interests, mathematics self-concept consistently has the largest effect on mathematics achievement. The analyses also illustrated interactions between
mathematics self-concept and intrinsic/extrinsic motivation. These findings stress the important role of teachers and parents in forming and developing student mathematics self-concept throughout school years. Learning mathematics through grades is an accumulated and connected process. In other words, while students partly revise old mathematics topics in schools when learning new mathematics topics, believing in their competence of learning and doing mathematics depends on their previous achievement, and students subsequently and concurrently develops their mathematics self-concept. Therefore, remedying students’ learning gaps while teaching new topics may help improve their mathematics self-concept, which directly improves their mathematics achievement.

Additionally, researchers generally recommend that mathematics self-concept can be improved by positive expectations of teachers and parents (Benner & Mistry, 2007; Lazarides, Viljaranta, Aunola, Pesu, & Nurmi, 2016; Lazarides & Watt, 2015). This study provided evidence for positive effect of teacher expectation on mathematics self-concept. Having teacher to hold higher expectation for their students can be achieved by professional development trainings. Although teacher resistance to reforms is a known matter, introducing teachers with research evidences and methodology might be more persuasive. Moreover, parent expectation was found to have negative effect on eighth-grade student mathematics self-concept. Although this result might be attributed to the unique characteristics of the cultural context, the method that is used or the interaction of parent expectation with other variables might be other reasons for this outcome. Therefore, more research is needed i) to confirm or refute whether increasing parent expectation supports eighth-grade student mathematics self-concept, ii) to examine the conditions in which parent expectation has negative effect on student mathematics achievement,
iii) to compare these findings with that of other countries by replicating this study in other cultural contexts.

5.3.3 Teacher and Parent Expectation

Past research indicated significant and positive effect of parent expectation (e.g., Benner & Mistry, 2007; Froiland & Davison, 2016; Ma, 2001; Parsons, Adler, & Kczala, 1982; Thompson, Alexander, & Entwisle, 1988) and teacher expectation on mathematics achievement (e.g., Bergh, Denessen, Hornstra, Voeten, & Holland, 2010; Benner & Mistry, 2007; Peterson, Rubie-Davis, Osborne, & Sibley, 2016; Smith, Jussim & Eccles, 1999). Intuitively, high teacher expectation influences their teaching practices and efforts, and this positively impacts student expectation and parent expectation, and thus, student mathematics achievement. This study, however, indicated that teacher expectation has no significant effect on mathematics achievement. This result is contrary to self-fulfilling hypothesis. However, it can be interpreted within the context of Turkey. Several interpretations can be made for this finding: i) mathematics teachers generally do not convey their expectations to students effectively; ii) teacher expectation does not significantly impact eighth-grade student mathematics achievement; iii) generally teachers’ biased expectations do not have a significantly negative effect on student mathematics achievement; iii) since teacher expectation has significant effect on parent expectation and parent expectation has significant effect on mathematics achievement, teacher expectation can be improved to indirectly influence eighth-grade student mathematics achievement.

Policy makers in Turkey should consider noticeable associations between teacher expectation, parent expectation and mathematics achievement. Moreover, they must delve into this issue and conduct intervention studies with respect to the significant and effective associations found among these constructs. Via effective interventions, national mathematics achievement scores can be improved. Additionally, related to theoretical considerations, future
research must compare the effect teacher expectation on mathematics achievement by using multi-national datasets such as TIMSS or PISA in order to investigate whether the effect of teacher expectation on mathematics achievement depends on the cultural, economic, and social context of countries.

Other critical findings are related to the effect of SES on teacher and parent expectations. SES had significant effect on parent and teacher expectations, but the effect was larger for parent expectation. These findings suggest that informing parents and teachers about the effect of their expectations on eighth-grade student mathematics achievement can encourage their willingness to hold higher expectations. To acquaint teachers and parents with these findings, professional development trainings can be organized for informing teachers and school-family meetings can be arranged by school authorities for informing parents.

5.4 Limitations

Student psychology and educational context are complex entities. As is the case for most research studies within educational research, the omitted variables are the biggest threats to the validity of research studies. In this study, multiple variables that are assumed to strongly affect each other were included in the analysis. However, using secondary dataset put constraints on the inclusion of more variables. Mostly used control variable when researching mathematics achievement is student background information (i.e., previous achievement). In this study this variable was not included as the control variable because of its absence in TIMSS 2015 dataset.

Although structural equation modeling and regression analyses imply causal directions, for causal relationships longitudinal datasets that are obtained from controlled experiments are needed. In this study, cross-sectional dataset is used. By using cross-sectional dataset, associations between variables can be analyzed but the interpretation of the direction of the effect must be regarded as tentative when causality is asserted. However, data analyses based on the
theoretical framework which is created from evidences obtained in earlier studies might partly compensate this limitation.

Related to methodology, a conventional mediation analysis approach was implemented. Conventional mediation analysis approach has several limitations (MacKinnon & Valente, 2014). These limitations are acknowledged in the literature (see MacKinnon, 2008; Pearl, 2012; VanderWeele & Vansteelandt, 2009). For example, mostly known Baron & Kenny (1986) approach has several assumptions: “(1) no confounders of the X to M (i.e., mediator variable) relation, (2) no confounders of the M to Y relation, (3) no confounders of the X to Y relation and (4) no effects of X on confounders that then affect the relation of X to Y” (MacKinnon & Valente, 2014, p. 200). This approach assumes no confounder among the relations between independent variable, mediator and dependent variable. For assuming causal paths among these variables, the randomization of independent variable along with the randomization of mediator variable is necessary since randomization of X does not ensure that the mediator has been randomized.

Although advantages of using a large national dataset, inclusion of multiple and related variables, partly randomized sampling design, and implementation of advanced statistical methods might reduce the threats to validity of the results, the limitations of this study should guide future research to lessen the threats to validity of results.

5.5 Suggestions for Future Research

As previously stated, a multinational longitudinal research study that include omitted variables (specifically, student previous achievement variable) can be conducted to replicate data analysis on the theoretical framework of this study. Moreover, mixed findings related to intrinsic motivation, extrinsic motivation and teacher expectation requires more research and consistent results for establishing sound theories in this field. Controlled experimental designs are costly.
and mostly conducted on small sample sizes with the inclusion of a few variables. For establishing valid causal relationships among intrinsic motivation, extrinsic motivation, teacher and parent expectations, manipulation of different combination of these variables are necessary in controlled experimental research studies which may provide more accurate results to synergistically improve student mathematics achievement (Froiland & Davison, 2016; Woolley, Strutchens, Gilbert, & Martin, 2010). Organizations that administer TIMSS and PISA exams may consider conducting such experiments, or at least, providing longitudinal datasets that can yield causal inferences. Additionally, the items defining intrinsic and extrinsic motivation may impose western framework on other countries. The meaning students attribute to these items may differ in distinct cultures or countries. Future research should investigate if this is the reason for the existence of mixed results in the literature. Related to the instruments, exploratory factor analyses were performed to provide evidences for validity of the scales representing intrinsic motivation, extrinsic motivation and mathematics self-concept. Nevertheless, the constructed scales need to be validated cross-culturally.

In this study, extrinsic motivation and mathematics self-concept had significant interaction. Because of the constraints of the secondary data, types of extrinsic motivation were not analyzed separately in this study. Therefore, the interaction between extrinsic motivation and mathematics self-concept can be the result of this approach. Intuitively, more internalized types of extrinsic motivation may not interact with mathematics self-concept. Future studies should investigate if mathematics self-concept interacts with different types of extrinsic motivation. Additionally, a significant interaction was found between intrinsic motivation and mathematics self-concept. More research is needed to provide evidence for the interaction of mathematics self-concept with intrinsic and extrinsic motivation in other cultural contexts.
Literature and this study show positive and significant effect of parent expectation on mathematics achievement. More research with different research approaches are needed to investigate the effect of parental characteristics on student achievement (Cao, Bishop, & Forgasz, 2007; Wang, Deng, & Yang, 2016). Teacher expectation did not have a significant effect on eighth-grade student mathematics achievement when other constructs are included in the structural equation model. A replication of this study in different countries will provide more evidences for making accurate interpretations. Besides these suggestions, more research is needed with respect to the effect of congruence-dissonance of adult expectations on students’ academic achievement (Benner & Mistry, 2007). More specifically, three specific samples can be investigated: i) teacher expectation is greater than parent expectation; ii) parent expectation is greater than teacher expectation; and iii) parent expectation and teacher expectation are the same. Comparison of the effect of these samples on student mathematics achievement can provide suggestions for determining the most efficient area/sample to intervene.

Additionally, Bandura’s (2004) self-evaluative outcome expectation implies that the effect of student expectation, teacher expectation and parent expectation are consistently regulated by students’ reflections (i.e., efficacy, satisfaction, and self-concept) about the outcome. The literature lacks to confirm these relations. Longitudinal research studies can be conducted to investigate the effects of self-efficacy, self-satisfaction and mathematics self-concept on student expectation, teacher expectation, and parent expectation.

Finally, this study contributed to the literature with unique findings that is absent in the literature. One unique finding was the significant interaction between intrinsic motivation and mathematics self-concept, and significant interaction between extrinsic motivation and mathematics self-concept. Exclusion of mathematics self-concept from the models that examine
intrinsic motivation and extrinsic motivation and their effect on mathematics achievement can have limited explanatory power. Future research must provide explanations for the mechanisms of these interactions. Moreover, the inclusion of mathematics self-concept into the structural equation model changed the sign of the effect of intrinsic motivation on mathematics achievement. Researchers must clarify the conditions in which theories hold. For example, in regression analysis, intrinsic motivation had positive and significant effect on mathematics achievement which aligns with the assertion of self-determination theory. However, inclusion of mathematics self-concept into structural equation modeling changed the sign of the effect and the evidence obtained from structural equation modeling is contrary to the assertion of self-determination theory. Therefore, to achieve consensus when forming specific theories, the conditions in which evidences are obtained for validating the theory must be specified.

Additionally, this study contributed to literature pertaining to obtaining new and unique evidences about the congruence-dissonance between teacher expectation and parent expectation its effect on eighth-grade student mathematics achievement. Furthermore, this study revealed new evidences about mediating effect of SES on mathematics self-concept, parent expectation and teacher expectation. These findings should be investigated more strongly in future studies and comparative studies should investigate these effects and associations for different countries.

5.6 Concluding Remarks

The findings of this study contributed to the theory in the concepts of motivation, expectation and mathematics self-concept by addressing previously stated research gaps that are stated in the literature. The association between these variables and comparison with the earlier research studies indicate that a more comprehensive redefinition of the theories of motivation and expectations is necessary. The findings obtained from earlier studies and this study on types of motivation and expectation indicate that there is no de facto theory that explains the
phenomena in the same manner within different contexts. In other words, some theories of education need to be interpreted within specific contexts.

Improving student mathematics achievement is a priority in many countries. Mathematics teachers can benefit from research findings by applying scientifically based findings into their teaching practices. Furthermore, parent-school communication and parental involvement in school activities can be opportunities to inform them about useful research findings. In conclusion, education is a collective endeavor that affects and influenced by student, parents, teachers, and administrators.
TITLE: TIMSS 2015 Turkey 8th Grade Math
DATA:
  FILE IS clustimss.dat;
VARIABLE:
  NAMES ARE teachid weight math intrm1 intrm2 intrm3 intrm4 extrm1 extrm2 extrm3 extrm4 extrm5 extrm6 extrm7 teachexp parexp msc1 msc2 msc3 msc4 msc5 ses;
  usevariables are weight math intrm1 intrm2 intrm3 intrm4 extrm1 extrm2 extrm3 extrm4 extrm5 extrm6 extrm7 teachexp parexp msc1 msc2 msc3 msc4 msc5 ses;
  weight = weight;
MODEL:
  !Defining latent varaibles:
  intrm by intrm1 intrm2 intrm3 intrm4;
  extrm by extrm1 extrm2 extrm3 extrm4 extrm5 extrm6 extrm7;
  msc by msc1 msc2 msc3 msc4 msc5;
  !Structural model:
  math on intrm extrm msc parexp teachexp ses int int2;
  msc on ses teachexp parexp;
  parexp teachexp on ses;
  parexp on teachexp;
  intrm on extrm;
  !Interactions
  int | intrm XWITH msc;
  int2 | extrm XWITH msc;
ANALYSIS:
  ALGORITHM=INTEGRATION;
  type = RANDOM;
  estimator is MLR;
OUTPUT: SAMPSTAT TECH1 TECH4 STDYX;
LIST OF REFERENCES


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BIOGRAPHICAL SKETCH

Orhan Kaplan completed his bachelor’s degree in Teaching Mathematics in Elementary Schools in 2006 from Gazi University in Ankara/Turkey. He earned study abroad scholarship from Ministry of Education of Turkey. After participating in a year-long language course in Houston/Texas, he studied his master’s in mathematics at Arkansas State University and graduated with M.S.E. degree in mathematics in 2009. He received his Ph.D. in Curriculum and Instruction from the University of Florida in the summer of 2018.