Exploration of Relationships between Teacher and Parent Attitudes and Student Affective Characteristics in Mathematics

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This study explores the relationships between students' perceptions of their teachers' and parents' attitudes toward them as learners of mathematics and mathematics and their attitudes related to mathematics learning through path analysis. Data was collected from 1,960 7th-grade students enrolled in 19 public elementary schools in a city in Turkey. Results revealed that, through students' perceptions of their mothers, fathers, and teachers, their confidence in learning mathematics, belief about the usefulness of mathematics, and belief about the importance of mathematics were associated primarily with their mother's, father's, and teacher's positive or negative attitudes regarding the students as mathematical learners and their teacher's positive or negative views of teaching.

Introduction

Affective variables play important roles in the teaching and learning of mathematics. They can be important in students' decisions about how much mathematics they will need in the future and how to approach the mathematical content they study (Reyes, 1984). Besides affective variables (e.g., motivation, self-concept, attitude, interest, enjoyment, self-efficacy), environmental variables are also important for success and persistence in mathematics (Zhang & Post, 2000). Environmental variables are generally considered those related to teachers, parents, peer groups, and society (Vanayan et al., 1997). The teacher-student relationship and the teacher's behavior toward the student can affect the student's self-belief and academic behaviors. Besides, parents' support for their children's learning can influence students' psychological and cognitive development. Fan and Chen (2001) argue that parental aspiration and expectation of their child's achievement have a strong relationship with achievement, which in turn is related to their child's attitudes toward mathematics. For example, children with high mathematics achievement and positive attitudes toward mathematics generally have parents supporting their mathematical ability and success. Moreover, parents' personal attitudes toward mathematics and beliefs can influence their children's perceptions about the value and importance of mathematics in their lives.

Many studies have examined students' attitudes and beliefs toward mathematics (Vanayan et al., 1997). They adopted different meanings of these attitudes and focused on different dimensions of these constructs. Traindis's (1971) definition of attitude, which includes many of the central ideas used by attitude theorists, is "an idea charged with emotion which predisposes a class of actions to a particular class of social situations" (p. 2). In this definition, the words 'idea,' 'emotion,' and 'a class of actions' corresponds to three components of the concept of attitude—namely cognitive, affective, and behavioral factors. Within the field of mathematics education, many explicit definitions of attitude refer to this multidimensional definition (Di Martino & Zan, 2015), describing attitude using three components: the emotional disposition towards mathematics, the set of beliefs regarding mathematics, and the behavior related to mathematics (Hart, 1989; Leder, 1992; Ruffell et al., 1998).

This present study adapts a multidimensional definition of attitude toward mathematics which includes: beliefs about self and mathematics (i.e., confidence in learning mathematics and beliefs about the usefulness and importance of mathematics), feelings about mathematics (i.e., liking or disliking mathematics and mathematics anxiety), and behaviors related to mathematics (i.e., involvement in math classes and time spent on mathematics at home). Further, it is stated that attitude would constitute a single second-order factor. At the same time, beliefs, affective responses, and related behavior alone would operate as first-order affective factors or aspects in pupils' learning processes (Malmivuori, 2001). Therefore, the findings of this study will provide evidence for a three-component view of attitude toward mathematics, including some attitudinal variables selected for the study.

Many recent studies have addressed mathematics achievement or literacy regarding environmental and affective variables (e.g., Akyüz & Pala, 2010; Anıl et al., 2015; Kadijević, 2008; Klieme et al., 2009; Okatan & Tomul, 2021; Sarıer, 2020). Some of the researchers have explored these relationships through investigative models that denote which affective variables played the greatest mediating roles in explaining the effects on achievement (Engin, 2022; Genç & Çolakoğlu, 2021; Papanastasiou, 2000; 2002; Patrick et al., 2007). A more limited number of researchers have directly investigated the effect of environmental factors such as family and teacher characteristics, classroom climate, and teaching practice on students' affective constructs such as self-efficacy, attitude, self-concept, interest, anxiety, and motivation in mathematics (Croissant, 2014; Demaray et al., 2009; Liu et al., 2018; Rice et al., 2013; Sağkal & Sönmez, 2022; Vandecandelaere et al., 2012).

Similar to these latter studies, this study aims to explore the relationships between students' perceptions of their teachers' and parent's attitudes toward them as mathematics learners. The question is how these perceptions affect their attitudes toward mathematics, such as their confidence in learning mathematics, beliefs about the usefulness of mathematics currently and concerning their future education and vocation, feelings of liking or disliking mathematics, anxiety about mathematics, involvement in math classes and time that they spent on mathematics at home.

Research Rationale

Attitude is an ambiguous construct (Di Martino & Zan, 2001a; Ruffell et al., 1998). Several scales have been constructed to measure students' attitudes toward mathematics. They are generally intended to assess factors such as liking or disliking, usefulness, and confidence (Zan & Di Martino, 2003). Notably, most studies use a multidimensional approach to measure attitude and do not refer to cognitive, affective, and behavioral dimensions verbatim (Di Martino & Zan, 2001b). For example, it is often argued that self-confidence in mathematics, enjoyment of mathematics, and value of mathematics correspond respectively to cognitive, affective, and behavioral dimensions of attitude toward mathematics (e.g., Kadijević, 2008; Kiwanuka et al., 2017; Vandecandelaere et al., 2012). Since caution should be used in making such categorizations, the validity of the definition accepted through various instruments used in particular studies must be examined. To investigate students' attitudes toward mathematics, this present study selects a set of attitudinal variables most widely used in mathematics education research correlating to the cognitive, affective, and behavioral dimensions of attitude toward mathematics. Therefore, this study is important in that it illustrates how the theoretical framework can be useful for understanding the different aspects of students' attitudes toward mathematics, the integration between these aspects, and the influence of the students' social contexts.

Walberg's (1981) model of educational productivity identifies several key variables related to students' affective development. These variables can be classified into three groups: student personal variables, instructional variables, and environmental variables (Wilkins & Ma, 2003). Researchers have consistently used these variables to investigate students' attitudes and achievements in mathematics. Some opine that students' attitudes are influenced by various factors, including environmental factors such as teachers, parents, peers, school, and classroom environment (Klassen & Ulcer, 2010). For example, Papanastasiou (2002) proposes a model comparing various background factors (the educational background of the family, the reinforcement from the mother, friends, and the individual himself, and the school climate) in terms of their effect on student attitudes and beliefs related to mathematics and the teaching of the subject. The model indicates that teaching was the strongest influence on attitudes toward mathematics, followed by reinforcement of the students from their surroundings. Regarding student beliefs about mathematics, the strongest effect was exerted by the reinforcement given by mothers and friends. Most of the studies have focused on the role of either teacher beliefs and support behaviors or parent attitudes and support for the development of students' mathematics interests (Lazarides & Ittel, 2013). In the present study, we focus on both teachers and parents, as they represent two major environmental influences on children's development and are important for forming attitudes (Yee & Eccles, 1988), and analyze the joint influence of both sources of support.

Several studies indicate that children normally begin schooling with rather positive attitudes toward mathematics; these attitudes, however, tend to become less positive as children grow up, and they frequently become negative in high school (McLeod, 1992). The middle grades are reported as the most critical period in terms of the development of attitudes toward mathematics (Bergeson et al., 2000). Since the degree of students' perceived importance of social support gradually decreases from elementary school to higher school (Demaray & Malecki, 2003), it is crucial to investigate the associations between perceived teacher and parent attitudes toward students and mathematics and middle school students' affective characteristics in learning mathematics.

Some research has concluded that parental effects on students' beliefs may differ depending on the gender of the parent (Lazarides et al., 2015). Therefore, identifying the variables that have the greatest likelihood of being related to the effect on students' attitudes and beliefs, even if the effects are small, provides teachers, teacher educators, and school leaders with possible factors upon which to focus when they try to influence students' mathematical attitudes and beliefs. Although there are similar trends related to the types of variables used to predict affective measures, it is thought that the particular items that affect each variable can differ.

Relationships between Teacher Attitudes and Affective Variables

Students who believe that their math teachers consider their relatedness and competence exhibit more positive motivational beliefs and perform better. Notably, studies investigating components of supportive climates are often drawn on self-determination theory (Klieme et al., 2009), which postulates the need for competence, autonomy, and relatedness for maintaining intrinsic motivation (Ryan & Deci, 2000, 2002). It is argued that, since extrinsically motivated behaviors are not inherently interesting, they must first be externally promoted (Ryan & Deci, 2000). Individuals more readily accept this promotion from people with whom they feel connected (or related), whether that be a family, a peer group, or a society. Ryan et al. (1994) note that relatedness to teachers (and parents) was associated with a student's greater internalization of school-related behavioral regulations.

Patrick et al. (2007) highlight two types of teacher support: emotional and academic support. Teacher emotional support is "the belief that the teacher cares about and likes the student as a person, whereas academic support involves a perception that the teacher cares about how much the student learns and wants to help him or her learn" (p. 87). Research shows that perceived support from teachers positively contributes to students' classroom engagement, motivation, and attitudes toward school (Klusmann et al., 2008; Mata et al., 2012; Patrick et al., 2007; Rawnsley & Fisher, 1998; Ryan et al., 1994; Wentzel et al., 2010). Haladyna et al. (1983) propose modeling the relationship between attitude toward mathematics and other variables such as teacher quality and learning environment. The findings suggest a strong association between teacher quality measures (i.e., enthusiasm, respect, commitment to helping students learn, providing individual attention, fairness, and praise and reinforcement) and attitude toward mathematics.

Demaray et al. (2009) recognize that among types of students' perceived importance of social support, only teacher support was significantly related to self-concept. Another study examining the relationship between social support and attitude and self-efficacy in math has determined that students who perceive greater social support from teachers, parents, and friends regarding math have better attitudes and a greater sense of their competence in math (Rice, et al., 2013). Altogether, the level of students' perceptions of teacher support in the classroom can play a critical role in developing students' perceptions of self-concepts and increasing interest in mathematics (Demaray et al., 2009; Fauth et al., 2014; Wentzel et al., 2010). Moreover, Scherer and Nilsen (2016) indicate a strong relation between instructional quality (i.e., supportive classroom climate and clarity) and achievement motivation (i.e., self-concept, intrinsic value, and extrinsic value) in almost all countries that participated in the Trends in Mathematics and Science Study (TIMSS) 2011. Sakiz et al. (2012) indicate that perceived teacher affective support is associated with middle school students' emotional, motivational, and effort outcomes in mathematics classrooms.

A teacher's attitude toward students as mathematics learners can lead to a positive or negative attitude toward the subject. Midgley et al. (1989) suggest that the value of math increases for students who move from less supportive to more supportive teachers after the transition to junior high school. Similarly, Wilkins and Ma (2003) indicate that a teacher's mathematics *push* (encouragement of students' mathematical performance through students' perceived expectations of teachers regarding students doing their best, working hard, completing work, and taking additional math due to the importance of mathematics) is related to students' attitudes toward mathematics and beliefs about the social importance of mathematics. Students carefully observe the teacher's verbal and nonverbal behaviors and develop self-beliefs and beliefs about the subject matter (Weinstein & McKown, 1998). Murdock and Miller (2003) suggest that students who perceive their teachers as caring are more likely to view themselves as more academically capable.

Besides teachers' attitudes and expectations about students' learning of mathematics, their attitudes toward teaching mathematics can be influential in students' attitudes toward mathematics. Among other factors, non-positive teacher attitudes toward mathematics have a destructive impact on children's conceptions of mathematics (Philippou & Christou, 1998). Teachers' conceptions, beliefs, and attitudes toward mathematics shape their teaching practices and consequently impact students' attitudes toward mathematics (Di Martino & Zan, 2011; Pajares, 1992; Thompson, 1992). It is also well-known that negative attitudes toward mathematics are common among future primary school teachers (Panero et al., 2023). These teachers negatively influence their students' attitudes, moving into a vicious circle. Therefore, it is important to investigate whether and how perceived teacher attitudes toward teaching affect middle school students' attitudes toward mathematics.

Relationships between Parent Attitudes and Affective Variables

Among other environmental factors, parents are among the most influential reference groups in student attitude formation (Tocci & Engelhard, 1991). Many studies confirm that parental involvement strongly affects students' cognitive and personal development (Martinez-Pons, 1996; Taylor, 1996). Greenwood and Hickmen (1991) cite studies focusing on elementary grades that found relationships between parent involvement and student variables such as academic achievement, sense of well-being, attendance, student attitude, homework readiness, grades, and educational aspirations. Besides, Mohr-Schroeder et al. (2017) indicate that several qualitative studies reveal a strong relationship between parents' and students' attitudes toward mathematics. Tocci and Engelhard (1991) indicate that students' perceptions of parental support are one of the predictors of attitude toward mathematics (i.e., student perceptions of themselves as learners of mathematics, perceived usefulness of mathematics to society, mathematics as a male domain, and anxiety about mathematics) for eighth-grade students in the United States and Thailand. Research also shows that parents' attitudes toward mathematics, including perceptions of their own experiences with mathematics, beliefs about their children's attitudes toward math, and beliefs regarding their children's math abilities, affect their children's attitudes toward mathematics (Yee & Eccles, 1988). Lazarides and Ittel's results (2013) also revealed that parents' encouragement and interest in students' learning significantly predicted students' interest in mathematics. Therefore, considering the likelihood of the important influence of parents' mathematics attitudes on children's mathematics attitudes and the uncertainty of the nature of these relationships (Gunderson et al., 2012).

Parents' beliefs and feelings about mathematics will likely influence the messages they convey to their children (Gunderson et al., 2012). Commonly, many parents struggle to help their children since they are not confident in their mathematical ability, are unaware of the content, or do not have the necessary teaching skills to help their children (Mohr-Schroeder et al., 2017). Moreover, parents with negative feelings toward mathematics or who have openly acknowledged their own mathematics deficiencies tend to be associated with children having similar attitudes (Usher, 2009), initiating a continuance of intergenerational transmission of math attitudes (Gunderson et al., 2012).

Notably, Wilkins and Ma (2003) reveal that attitude toward mathematics is related to teacher and parent *push*. Indeed, they indicate a significant—albeit lesser than that of teachers—influence of parents is related to student's beliefs about mathematics (i.e., beliefs in the social importance and notions of the nature of mathematics). Students who demonstrated more positive attitudes regarding the importance of mathematics were more likely to have parents they perceived as having more positive feelings about the importance and usefulness of mathematics. In this current study, measures of parent mathematics push are based on a composite measure available in the data set regarding student responses to three items: "My parents (1) have always encouraged me to do well in math; (2) expect me to do well in math; (3) think math is important" (p. 54). Similarly, Puklek Levpušček and Zupančič (2009) indicate that Slovene eighth-grade students' perceptions of math teachers' behavior in the classroom (support, academic press, mastery goal) were predictive of motivational beliefs in math (mastery goal orientation and self-efficacy), over and above the account of students' evaluations of their parents' academic involvement (pressure, support, and help).

Many researchers have classified types of parental involvement in students' education, including

> participation in teacher-student interactions and school activities, participating in parent–teacher conferences and/or interactions, participating in school activities and/or functions, engaging in activities at home including but not limited to homework, engaging in students' extracurricular activities, assisting in the selection of student's courses, keeping abreast of student's academic progress, reaction to student's academic grades, imparting parental values (attitudes about the importance of effort and academic success), or the level of parental control and/or autonomy support offered in the home environment. (Gonzalez-DeHass et al., 2005, p. 108).

Therefore, as recognized by Gonzalez-DeHass et al. (2005), parental involvement in students' education is a multidimensional construct. This current study considers students' perceptions of their parent's interest in mathematics and attitudes regarding their children as learners of mathematics, their willingness to encourage their children, and their confidence in their children's abilities.

A few studies have investigated the relationship between either mothers' or fathers' attitudes regarding their children as learners of mathematics and students' attitudes toward mathematics. Mothers' beliefs have been studied more often than fathers' beliefs on children's mathematics self-concepts (Lazarides et al., 2015). Eccles and Jacobs (1986) indicate that students' beliefs (including their estimates of their mathematical abilities, their perceptions of the value of mathematics courses, and their levels of math anxiety) are related most strongly to the students' mothers' beliefs concerning the difficulty of mathematics for their children. There is also empirical evidence that mothers' expectations about their children's mathematics abilities are significantly related to children's interest in mathematics (Eccles, 1993).

Additionally, parental beliefs can play a different role (McGrath & Repetti, 2000). In their study, Eccles and Jacobs (1986) also found that fathers' beliefs did not contribute to predicting students' mathematics achievement or their course enrollment plans. Therefore, they omit this variable from their analyses. In line with the self-determination theory, Aunola et al. (2013) show that high levels of maternal support regarding their first-grade children's needs for autonomy and relatedness predicted the mathematics interest of children. Thus, children are more likely to adopt the attitudes of adults they like or with whom they strongly identify (Lane, 2012). Therefore it is crucial to investigate the effects of both mothers' and fathers' attitudes on students' attitudes toward mathematics.

Method

Participants

Participants were 1,960 seventh-grade students in nineteen elementary schools in Istanbul, Turkey. A convenience sampling selected students based on a school location and one grade (7th). Participants included 1,001 (51.1%) girls and 959 (48.9%) boys. The average student's previous year's school grade in the mathematics course was 3.15 on a 5-point scale. Regarding the respective parents' educational level, 54.2% of the students' mothers and 44.3% of their fathers went no further in formal education than graduating from primary school. This may have affected why 45.3% of the students had no help with math outside of school. While student gender, parent education level, etc., were not part of the study, this data was collected for potential future analysis.

Instruments

To explore the relationships among students' perceptions of their teacher's teaching profession, their teacher's and parent's attitudes toward the students as mathematics learners, and additional recognized affective variables, eleven scales were used. They were mainly adapted from the Fennema-Sherman Mathematics Attitude Scales (FSMAS) (Fennema & Sherman, 1976) and the Third International Mathematics and Science Study (TIMSS Attitude Scale (1999) by Tag (2000). Six FSMAS scales with twelve items (six positive, six negative) each (i.e., Confidence in Learning Mathematics Scale (CONF), Mathematics Usefulness Scale (USE), Mathematics Anxiety Scale (ANX), Father Scale (FA), Mother Scale (MO), and Teacher Scale I (TE)) were selected for use in the present study, as they spoke most directly to the research question. Item development and selection for the final version of the scales are described in detail by Fennema and Sherman (1976). They report split-half reliabilities for the scales ranging from .86 and .93 with 6-8th grade students. Tag (2000) obtained alpha-reliability coefficients for the scales ranging from .93 and .79 with 9th-grade students.

The Importance of Mathematics Scale (IMP) with five items (all positive) and Teacher Scale II (TE_TP) with seven items (five positive, two negative) adapted from TIMSS (1999) and previously employed by Tag (2000) were also used in the present study. Each statement in these scales was checked separately regarding possible misunderstanding or misinterpretation by the students. After determining the potentially problematic statements, the researchers reconstructed the instruments. Alpha-reliability coefficients for the IMP and TE_TP scales were found to be .69 and .79, respectively.

The last three scales, the Liking of Mathematics Scale (LIKE) with five items (four positive, one negative), Learner Behaviors toward Mathematics Scale (BEHA) with five items (three positive, two negative), and Time Spent on Mathematics at Home Scale (TIME) with four items (two positive, two negative), were translated and adapted by the researchers from the instruments of TIMSS (1999), Neustadt's (2005), and Mohamad-Ali's (1995), respectively. While adapting the scales, the statements selected from respective instruments were translated into Turkish by researchers and an expert in Foreign Language Education translated the statements selected from respective instruments into Turkish. Then the researcher translated the statements back into English, and the original statements were compared with the adapted ones. The factor structures of the items, the reliabilities of the scales, the usability of the items, and the existence of defective items were investigated in the pilot study preceding this present study.

Altogether, the literature and previous studies and scales led to the following variables for this study:

- **Perceived Mother Characteristics Related to Students (MO):** It refers to students' perception of their mother's attitudes toward them as mathematics learners. It includes the mothers' interest, encouragement, and confidence in the student's ability.
- **Perceived Father Characteristics Related to Students (FA):** It refers to students' perception of their father's attitudes toward them as mathematics learners. It includes the fathers' interest, encouragement, and confidence in the student's ability.
- **Perceived Teacher Characteristics Related to Students (TE):** It refers to students' perceptions of their teachers' attitudes toward them as mathematics learners. It includes teachers' interest, encouragement, and confidence in the student's ability.

- **Perceived Teacher Characteristics Related to Profession (TE_TP):** It refers to students' perceptions of their teacher's teaching profession.
- **Confidence in Learning Mathematics (CONF):** It refers to students' beliefs about their ability to learn and perform well on mathematical tasks. The dimensions range from a distinct lack of confidence to definite confidence.
- **Usefulness of Mathematics (USE):** It refers to students' beliefs about the usefulness of mathematics currently and in relation to their future education, vocation, or other activities.
- **Importance of Mathematics (IMP):** It refers to students' beliefs about the importance of mathematics in relation to their life.
- **Liking of Mathematics (LIKE):** It refers to a student's liking or disliking of mathematics and his/her positive and negative feelings about mathematics or himself/herself as a mathematics learner.
- **Mathematics Anxiety (ANX):** It refers to feelings of anxiety, dread, nervousness, and associated bodily symptoms related to doing mathematics. The dimensions range from feeling at ease to those distinct anxieties.
- **Learner Behaviors toward Mathematics (BEHA):** It refers to ways students learn mathematics (learning style), participation in math classes, hand rising, and doing mathematics homework.
- **Time Spent on Mathematics at Home (TIME):** It refers to students' estimate of the time they spent on mathematics at home.

As will later be seen, LIKE, ANX, BEHA, and TIME were relatively quickly omitted due to the items having low factor loadings in their respective factors.

Data Analysis

The reliability of the scales was assessed using Cronbach alpha coefficients. Principal components analysis was conducted to investigate whether the items were measuring the traits suggested by their placement on the eleven scales or whether, for this population and these items, a different factor pattern would emerge. To make an initial determination of the number of factors to extract and rotate, three criteria were considered: Kaiser's criterion (eigenvalues of 1.0 or greater), the scree test, and the interpretability of the factor solution. Principal factor analysis was conducted (squared multiple correlations in diagonals, with iterations), followed by oblimin rotation by using SPSS version 28.

Path analysis, a method for studying the direct and indirect effects of variables developed by Sewall Wright (Wright, 1921, 1934, 1960), was conducted using LISREL version 8.30 (Jöreskog & Sörbom, 1999). Rather than a method for discovering causes, path analysis tests theoretical relationships (Schumacher & Lomax, 2010). Lines directed from one variable to another variable denote *direct effects*, that is, the direct influence of one variable on another (Schumacher & Lomax, 2010). Therefore, in the model proposed, it was hypothesized that students' perceptions of their teacher's teaching profession and their teacher's, father's, and mother's attitudes toward them as learners of mathematics have a direct influence on their confidence in learning mathematics, beliefs about the usefulness and importance of mathematics, liking of mathematics, mathematics anxiety, behaviors toward mathematics, and the time they spent on mathematics at home. Path coefficients and other statistical analyses were used to assess the relative importance of direct paths to the attitudinal variables under consideration.

Listwise deletion of cases was used for missing data in all analyses. The multivariate normality and linearity of scales were evaluated through SPSS and LISREL. Due to the large sample size of this study and to avoid confounding the data or findings, the data from a few students with low scores on some scales were kept in the analysis. Using Mahalanobis distance, a few students were multivariate outliers, $p < .001$, and the data from these students were kept. The normality tests showed sufficient evidence that the assumption of a multivariate normal data distribution might be violated. Therefore, weighted least squares estimation was used to fit the models to the data set. For the model data fit assessment, Goodness-of-Fit Index (GFI), Adjusted Goodness-of-Fit Index (AGFI), Standardized Root Mean Squared Residual (SRMR), and Root-Mean-Square Error of Approximation (RMSEA) were used in the present study. A value of SRMR less than .05 is favorable, but a value of SRMR less than .10 is also acceptable (Kline, 2016); the RMSEA index should be .05 or below for a well-fitting model, or .08 or below for an "acceptable" model (Bandalos & Finney, 2010); values of GFI and AGFI indices should be .90 or above (Kline, 2016; Schumacher & Lomax, 2010).

Results

Descriptive Statistics

In the present study, the results of the descriptive statistics of the scales with 1960 7th-grade students are given in Table 1.

Table 1
Scales, Minimums and Maximums, Means, Standard Deviations, Medians

Scale	Min.	Max.	M	*SD*	Mdn
CONF	13	60	43.44	9.00	43.00
USE	18	60	48.71	8.05	50.00
IMP	5	25	20.12	4.01	21.00
LIKE	5	25	19.14	4.18	20.00
ANX	12	60	41.37	9.25	41.00
BEHA	6	20	16.52	2.86	17.00
TIME	4	20	13.19	3.65	13.00
FA	12	60	46.73	8.34	47.00
MO	16	60	47.51	8.50	48.00
TE	15	60	40.43	7.24	40.00
TE_TP	8	35	29.43	4.54	30.00

Descriptive statistics indicated that the mean scores of the scales were above the midpoint of the range and close to the highest end of the continuum. Thus, these students believed they had definite confidence rather than a distinct lack of confidence in learning mathematics. They were more likely to view mathematics as a useful field of study. Additionally, they perceived mathematics as useful relating to their future education, vocation, or other activities and important to their lives. They enjoyed mathematics and had feelings of ease rather than distinct anxiety related to doing mathematics. They were generally actively involved in math classes (e.g., attending classes, raising hands, and doing homework) and were likely to spend their time on mathematics at home. Moreover, students were more likely to think their father, mother, and mathematics teacher had positive attitudes toward them as mathematics learners and view their mathematics teacher as good at their teaching profession.

Reliability

The Cronbach alpha values for the CONF, USE, IMP, LIKE, ANX, BEHA, TIME, FA, MO, TE, and TE_TP were .88, .85, .78, .77, .83, .45, .66, .82, .83, .69, and .72 respectively.

The value of .45 for the BEHA required extreme caution. After analyzing the items in the BEHA separately, it was found that the removal of item 5 ("*I am more likely to raise my hand for a question than an answer*") would improve the Cronbach alpha value to .60. The value of the corrected-item total correlation of item 5 was very low (-.03). To improve the scale reliability, item 5 was removed. Most of the Cronbach alpha values exceed the recommended value of .7 (Nunnally, 1978), indicating adequate internal consistency. Moreover, the values can be quite small when a small number of items are in the scale (Pallant, 2020).

Principal Components Analysis

The sample was first assessed for its suitability for PCA. Inspection of the correlation matrix revealed the presence of many coefficients of .3 and above. Bartlett's Test of Sphericity was highly significant ($p < .001$), and the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy value of .9 exceeded the recommended value of .6 (Tabachnick & Fidell, 2013) supported the factorability of the matrix.

Although Kaiser's criterion suggested 18 factors underlying the measure, the scree test indicated ten factors. The scree test indicated that the items were not unidimensional. Using factor loadings of $|.40|$ or greater as a criterion, it was decided to begin by rotating from seventeen to fifteen factors. The interpretation of the fifteen components was consistent with Tag's research on CONF, USE, ANX, FA, MO, and TE scales, with positive and negative items loading strongly on separate factors for each of the scales. The $|.40|$ criterion resulted in 85 of the 97 items being identified with only one factor. Within those 85 items, two ANX items A9 loaded strongly (.480) and inappropriately onto the TE factor, and A11 loaded strongly (.522) and inappropriately onto the ANX factor. The pattern matrix for PCA with oblimin rotation of the fifteen-factor solution, along with the text of the items, is presented in Table 2. Fifteen factors explained 57% of the total variance in this particular analysis.

Analysis of the structure matrix (Appendix) indicated good discrimination between the factors. For each component, the lowest factor loading for its items was higher than the highest loading on that factor of other items (except for A9 and A11).

Overall, the results of the analysis showed that there were fifteen subdimensions, which are CONF_P (CONF with positive items), CONF_N (CONF with negative items), USE_P (USE with positive items), USE_N (USE with negative items), IMP, LIKE, ANX, BEHA, TIME, FA_P (FA with positive items), FA_MO_N (FA and MO with negative items), MO_P (MO with positive items), TE_P (TE with positive items), TE_N (TE with negative items), TE_TP. However, the contents of the factors obtained do not fully support the original structures of the ANX scale proposed by Tag. The major inconsistencies concerning this sample were the tendency of A9 item (A9: "*I get a sinking feeling when I think of trying* *math problems*") to show more substantial loadings on the TE_N factor and A11 item (A11: "*A math test would scare me*") to show more substantial loadings on the ANX with positive items factor.

Table 2

Pattern Matrix for PCA With Oblimin Rotation of the Fifteen-Factor Solution

Scale/ Item No.	Item	Component 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
C1+	Generally I have felt secure about attempting mathematics.	**.519**	-.060	.075	-.030	.056	.091	.124	-.119	.115	.031	.054	.062	.006	-.001	.074
C2+	I am sure I could do advanced work in mathematics.	**.617**	-.050	.111	-.005	.036	.088	.056	.011	.087	-.065	.042	.094	-.020	-.012	.032
C3+	I am sure that I can learn mathematics.	**.645**	-.117	.087	-.009	-.020	.002	-.054	-.080	-.049	-.004	-.040	.080	-.024	.022	.085
C4+	I think I could handle more difficult mathematics.	**.707**	-.057	-.043	-.002	-.070	.009	.044	.096	-.030	.030	-.010	.011	-.095	-.025	.023
C5+	I can get good grades in mathematics.	**.554**	-.253	.051	-.029	-.103	-.117	.033	-.161	-.080	.103	-.010	-.020	-.012	.030	.014
C6+	I have a lot of self-confidence when it comes to math.	**.543**	-.084	.027	-.002	.000	.051	.207	-.073	.068	.045	.043	-.029	-.082	.000	.077
C7-	I'm no good at math.	.115	**-.695**	.029	.075	.058	-.026	.027	-.020	.084	.027	.009	.025	-.018	-.004	-.003
C8-	I don't think I could do advanced mathematics.	.098	**-.605**	.051	.082	-.011	-.024	.027	.072	.014	.004	-.074	.021	.000	-.043	.026
C9-	I'm not the type to do well in math.	.128	**-.687**	.016	.135	-.035	-.034	-.005	-.024	-.033	.013	-.062	.045	.000	-.024	-.002
C10-	For some reason even though I study, math seems unusually hard for me.	-.026	**-.482**	-.058	.047	.049	.041	.286	.012	.014	-.021	.070	-.024	-.050	.090	-.035
C11-	Most subjects I can handle OK, but I have a knack for mucking up math.	.128	**-.688**	-.019	.094	-.022	.050	.038	-.006	-.014	.021	-.006	.038	.007	.064	-.016
C12-	Math has been my worst subject.	.052	**-.703**	-.046	.002	-.048	.134	-.034	.008	.008	-.022	-.009	.031	-.026	.064	-.032
U1+	I'll need mathematics for my future work.	.004	.012	**.685**	.132	-.019	-.051	.012	.045	.089	.084	.051	.010	.027	-.016	.104
U2+	I study mathematics because I know how useful it is.	.184	-.137	**.447**	-.052	-.051	.094	-.041	-.082	.120	.036	-.033	.057	-.049	-.001	.050
U3+	Knowing mathematics will help me earn a living.	.106	-.011	**.519**	.048	-.282	-.055	-.031	-.012	-.012	.046	-.011	.002	-.042	.050	.103
U4+	Mathematics is a worthwhile and necessary subject.	.069	.040	**.469**	.155	-.248	.052	.006	-.073	-.058	-.005	-.052	.059	.016	.007	.118
U5+	I'll need a firm mastery of mathematics for my future work.	.024	.087	**.566**	.203	-.234	.003	.108	.067	.017	.015	-.005	.031	-.060	-.010	.024
U6+	I will use mathematics in many ways as an adult.	.081	-.025	**.442**	-.012	-.144	.049	.096	.009	-.033	.045	-.045	.026	-.141	.048	-.015
U7-	Mathematics is of no relevance to my life.	-.027	-.079	.085	**.678**	-.034	.040	-.023	-.040	.002	.028	.003	-.031	-.033	.029	.007
U8-	Mathematics will not be important to me in my life's work.	-.009	-.031	.113	**.675**	.017	-.013	.005	-.036	-.027	.019	.009	.030	.006	.042	.023
U9-	I see mathematics as a subject I will rarely use in daily life as an adult.	-.022	-.084	.027	**.573**	.054	-.179	.059	.031	.106	-.009	.001	.027	-.054	.127	-.039
U10-	Taking mathematics is a waste of time.	-.031	-.063	.025	**.653**	-.026	.141	-.036	-.049	-.003	-.028	-.118	.024	-.004	.013	.051
U11-	In terms of my adult life it is not important for me to do well in math.	.015	-.107	-.003	**.594**	-.107	.104	-.113	-.070	-.072	-.009	-.121	.012	.028	.049	.039
U12-	I expect to have little use for mathematics when I get out of school.	.014	-.099	.076	**.550**	-.132	.099	.004	.022	.082	.025	-.099	.011	-.035	.029	-.005
I1+	I would like a job that involved using mathematics.	.062	-.078	.201	-.121	**-.359**	.154	.111	.082	.175	.069	.023	-.087	-.058	.046	.032
I2+	I need to do well in mathematics to get the job I want.	.044	-.002	.181	.042	**-.598**	.042	.056	.053	.093	.078	.036	-.077	-.047	.005	-.018

I3+	I need to do well in mathematics to get into the secondary school or university I prefer.	.058	-.045	.026	.035	**-.706**	-.024	-.002	-.052	-.018	.010	-.013	.070	.031	.015	-.016
I4+	Mathematics is important to everyone's life.	-.052	.032	.141	.033	**-.622**	.042	.045	-.053	-.039	.078	-.017	-.008	-.026	.007	.041
I5+	I think it is important to do well in mathematics at school.	.10	-.037	.168	.079	**-.581**	.061	.010	.005	-.045	-.047	-.089	.041	-.041	.012	.037
L1+	I like mathematics.	.170	-.158	.146	-.027	-.040	**.485**	.070	-.176	.172	.002	.025	.039	-.061	-.039	.083
L2+	I enjoy learning mathematics.	.150	-.097	.094	-.010	-.117	**.490**	.022	-.209	.122	-.011	-.016	.099	-.061	-.002	.076
L3-	Mathematics is boring.	-.010	-.176	-.073	.220	-.131	**.473**	.019	-.120	.093	-.045	-.103	-.062	-.070	-.008	.039
L4+	Mathematics is an easy subject.	.056	-.069	.142	-.133	.031	.299	**.336**	-.027	.106	-.058	.026	.074	-.085	.009	.008
L5+	I need to do well in mathematics to please myself.	.063	.045	.154	-.091	**-.384**	.243	-.043	-.168	-.037	.005	-.090	.097	-.085	-.036	-.008
A1+	Math doesn't scare me at all.	.123	.031	.146	-.005	.120	.143	**.559**	.040	.077	-.005	.043	.084	-.035	-.003	-.027
A2+	It wouldn't bother me at all to take more math courses.	.097	.099	.117	.083	-.108	**.301**	.152	-.096	.218	.011	-.041	-.014	-.090	.005	.013
A3+	I haven't usually worried about being able to solve math problems.	.077	-.043	.085	-.051	-.019	.069	**.522**	-.019	.095	.019	-.003	.063	-.116	-.023	.011
A4+	I almost never have got nervous during a math test.	-.044	.037	-.004	.000	.009	-.031	**.847**	.029	-.010	.004	.017	-.026	.001	-.053	.015
A5+	I usually have been at ease during math tests.	.006	-.005	-.031	-.040	-.024	-.069	**.825**	-.021	-.023	.008	.016	-.011	-.063	-.046	-.020
A6+	I usually have been at ease in math classes.	.034	-.031	-.009	-.004	-.144	-.084	**.650**	-.124	-.022	-.011	-.061	.049	.005	-.027	.028
A7-	Mathematics usually makes me feel uncomfortable and nervous.	.070	-.113	-.152	.242	-.108	**.390**	.103	.058	.039	-.030	-.152	.001	.059	.124	.113
A8-	Mathematics makes me feel uncomfortable, restless, irritable, and impatient.	.079	.028	-.087	.148	.049	-.290	.004	**-.393**	-.024	.050	-.055	.047	.069	.205	.098
A9-	I get a sinking feeling when I think of trying math problems.	.127	-.075	.160	.081	-.060	.096	.060	.182	.000	.134	-.037	-.013	.044	**.408**	.053
A10-	My mind goes blank and I am unable to think clearly when working mathematics.	.143	-.174	-.087	.083	-.013	.191	.061	.136	.036	.135	-.069	-.083	.035	**.378**	.027
A11-	A math test would scare me.	.070	-.123	-.097	.154	.050	.142	**.522**	.229	-.032	.045	-.050	-.045	.083	.183	.033
A12-	Mathematics makes me feel uneasy and confused.	.126	-.188	-.097	.173	-.081	**.340**	.192	.170	.018	.030	-.091	-.051	.016	.210	.027
B1+	I always do my math homework.	.080	.005	-.020	.016	-.034	.161	-.012	**-.540**	.284	.062	.095	.083	.020	.060	.020
B2+	I come to math classes on time.	.074	.019	-.003	.176	-.060	.007	.014	**-.629**	.004	.107	-.073	.039	.085	-.041	.044
B3-	I skip math classes.	.064	.054	-.082	.272	-.008	.002	.064	-.263	-.067	-.017	**-.376**	-.061	.045	-.057	.047
B4+	I often raise my hand in math classes.	.157	-.204	.009	-.038	.033	.048	.183	**-.337**	.174	.034	.034	.117	-.091	.088	-.016
TI1-	I spend very little time on mathematics at home.	.097	-.114	.063	.047	.064	-.159	.014	-.136	**.462**	.033	-.259	-.171	.048	.104	.013
TI2+	I spend a lot of my study time on mathematics when compared to other subjects.	-.020	.024	.040	.040	.017	.138	.016	-.045	**.665**	.058	.064	.134	-.098	-.051	.041
TI3-	Compared to other subjects, I spend the least time on mathematics at home.	.070	-.178	.025	.088	.021	-.150	-.007	-.102	**.473**	-.002	-.283	-.152	-.026	.144	-.005
TI4+	I spend a lot of my time at home on mathematics.	-.027	.042	.020	-.030	-.049	.107	.053	.020	**.655**	.073	.071	.110	-.093	.018	.015
F1+	My father thinks that mathematics is one of the most important subjects I have studied.	.000	.102	.057	.021	-.016	.050	-.040	.008	.132	**.682**	.021	.041	.042	-.006	.054
F2+	My father has always encouraged me to do well in mathematics.	.059	.006	-.025	.050	-.016	.000	-.033	.015	.007	**.721**	-.043	.057	-.040	-.065	.067

F3+	My father has always been interested in my progress in mathematics.	-.008	-.037	.090	-.067	.072	-.001	.052	.006	.057	**.683**	-.074	.035	-.086	-.014	.006
F4+	My father thinks I'll need mathematics for what I want to do after graduate.	.028	-.011	-.074	.046	-.217	-.107	-.003	-.036	-.008	**.611**	.022	.056	-.062	.004	-.012
F5+	My father thinks I'm the kind of person who could do well in mathematics.	.024	-.113	.108	-.071	.041	-.037	.100	-.156	-.145	**.486**	-.072	.256	-.131	.072	-.014
F6+	My father thinks I could be good in math.	-.058	-.154	.134	-.075	.061	.004	.133	-.265	-.104	**.465**	-.069	.203	-.090	.063	-.026
F7-	My father wouldn't encourage me to plan a career which involves math.	.070	-.073	.169	-.068	.034	-.158	.021	.049	.038	-.127	-.156	.020	.095	**.283**	.041
F8-	My father hates to do math.	-.082	-.023	.009	.077	.021	.158	.044	-.039	-.064	.194	**-.634**	-.108	.011	-.013	.014
F9-	As long as I have passed, my father hasn't cared how I have done in math.	-.043	-.020	.037	-.022	.098	.126	.004	-.055	-.075	.263	**-.691**	-.046	-.007	.090	-.038
F10-	My father thinks advanced math is a waste of time for me.	-.017	.009	.072	.151	.073	.030	.048	-.083	-.076	.071	**-.633**	.000	.073	.094	.001
F11-	My father thinks I need to know just a minimum amount of math.	-.044	-.022	.022	.126	.038	-.005	.024	-.080	-.038	.044	**-.653**	.006	.044	.104	-.040
F12-	My father has shown no interest in whether I take more math courses.	.027	-.021	.071	.002	.082	.126	-.056	.089	-.042	.209	**-.672**	-.050	.002	.031	-.032
M1+	My mother thinks I'm the kind of person who could do well in mathematics.	.051	-.064	.123	-.020	.111	.115	.029	-.010	-.095	.017	-.017	**.763**	-.066	.049	.019
M2+	My mother thinks I could be good in math.	.037	-.069	.119	-.024	.072	.073	.039	-.031	-.067	.021	-.090	**.752**	-.049	.061	.014
M3+	My mother has always been interested in my progress in mathematics.	.063	-.018	-.045	.003	-.046	-.046	.029	-.059	.101	.080	-.085	**.652**	.018	-.008	-.011
M4+	My mother has always encouraged me to do well in mathematics.	.032	.000	-.091	.074	-.097	-.083	.014	-.004	.087	.167	-.069	**.569**	-.025	-.089	.075
M5+	My mother thinks that mathematics is one of the most important subjects I have studied.	-.029	.057	-.058	.044	-.228	-.082	-.015	.056	.204	.205	-.068	**.447**	.020	-.022	.018
M6+	My mother thinks I'll need mathematics for what I want to do after graduate.	-.001	.041	-.128	.102	-.333	-.133	-.003	.016	.136	.220	.037	**.359**	-.038	.009	-.029
M7-	My mother thinks advanced math is a waste of time for me.	-.002	-.005	.017	.044	-.030	-.069	.030	-.046	.028	-.155	**-.634**	.095	.014	.170	.038
M8-	As long as I have passed, my mother hasn't cared how I have done in math.	-.020	-.040	-.036	-.035	-.067	-.034	-.034	-.033	.063	-.081	**-.721**	.175	-.024	.050	.034
M9-	My mother wouldn't encourage me to plan a career which involves math.	.142	-.130	.006	-.071	-.051	.100	-.006	.389	.035	-.061	**-.411**	-.027	.007	.116	-.017
M10-	My mother has shown no interest in whether I take more math courses.	.026	-.024	-.040	-.010	-.082	-.037	-.039	.084	.099	-.037	**-.700**	.142	-.055	.023	.017
M11-	My mother thinks I need to know just a minimum amount of math.	.055	-.017	.001	.143	-.053	-.138	-.012	-.034	.091	-.118	**-.606**	.076	.001	.092	.022
M12-	My mother hates to do math.	.043	-.032	-.052	-.019	-.141	-.028	.013	.103	.061	-.062	**-.675**	.067	-.004	-.063	.106
T1+	My teachers have encouraged me to study more mathematics.	.017	.087	-.001	.076	.064	.045	-.132	.152	.042	.079	.060	.001	**-.598**	-.085	.043

T2+	My teachers think I'm the kind of person who could do well in mathematics.	.126	-.048	.087	.046	.070	-.028	.088	-.031	-.028	-.015	-.038	.128	**-.612**	.072	-.052
T3+	Math teachers have made me feel I have the ability to go on in mathematics.	.067	-.068	.023	.049	.002	-.014	.099	-.086	-.045	-.026	-.006	.092	**-.644**	.073	-.012
T4+	My math teachers would encourage me to take all the math I can.	-.017	-.015	.020	.062	.017	-.008	-.003	.062	.031	.013	-.015	.011	**-.757**	-.055	.002
T5+	My math teachers have been interested in my progress in mathematics.	.033	.014	-.037	-.052	-.078	-.063	.107	-.080	-.021	.001	-.025	-.005	**-.642**	.052	.118
T6+	I would talk to my math teachers about a career which uses math.	-.076	-.057	-.027	-.149	-.127	.046	.065	-.019	.113	.073	.011	-.125	**-.539**	-.060	-.010
T7-	When it comes to anything serious I have felt ignored when talking to math teachers.	.001	.051	-.009	.086	.038	.032	.029	.019	.014	-.015	.032	.062	.122	**.562**	-.007
T8-	I have found it hard to win the respect of math teachers.	-.063	-.029	.017	-.082	.000	-.075	.011	-.002	.056	.012	.038	-.055	.066	**.613**	.042
T9-	My teachers think advanced math is a waste of time for me.	.088	-.023	.014	.187	-.013	-.038	-.098	-.061	.017	-.033	-.197	-.001	.001	**.488**	.005
T10-	Getting a mathematics teacher to take me seriously usually been a problem.	-.003	.016	.021	.045	.010	.014	-.025	-.012	-.010	-.055	-.073	.033	-.063	**.688**	.058
T11-	My teachers would think I wasn't serious if I told them I was interested in a career in science and mathematics.	-.008	-.001	.051	.067	-.032	.015	-.052	-.058	-.033	.009	-.053	.037	-.012	**.669**	-.054
T12-	I have had a hard time getting teachers to talk seriously with me about mathematics.	-.019	-.002	.010	-.038	-.010	-.007	-.043	-.010	.011	-.045	-.059	-.006	-.120	**.738**	-.042
P1+	My math teacher likes mathematics.	.124	.026	.065	-.070	.026	-.029	-.001	.069	.012	.027	-.041	-.024	.027	-.019	**.750**
P2+	My math teacher knows a lot about mathematics.	.066	.051	.053	.058	.078	-.038	.030	.102	.042	.045	-.022	.014	.036	-.107	**.773**
P3+	My math teacher values our work.	-.022	.015	.066	-.051	-.024	.099	-.022	-.034	.055	-.007	-.008	.071	-.047	.045	**.653**
P4-	My math teacher makes everything worse when I have a problem.	-.283	-.329	.055	.042	-.051	.024	-.019	-.074	-.024	-.009	-.034	-.049	-.005	.045	**.488**
P5+	My math teacher is very fair to me.	.123	.146	-.144	.074	-.115	.002	.059	-.234	-.081	.026	.063	-.059	-.155	.155	**.420**
P6+	My math teacher tells me when I do a good job.	.084	.066	.002	.029	-.024	.025	.023	-.082	-.054	.049	.017	.062	-.192	.085	**.453**
P7-	My math teacher treats boys and girls differently in the classroom.	-.263	-.329	-.032	.062	-.036	.009	-.038	-.109	-.015	-.061	-.017	.026	.005	.085	**.412**

[1]Note: C = confidence; U = usefulness; I = importance; L = liking; A = anxiety; B = behavior; TI = time; F = father; M = mother; T = teacher; P = profession. Negatively worded items are marked with a minus sign for item no.; positively worded items are marked with a plus sign for item no. Major loadings for each item are bolded.

Confirmatory Factor Analysis

Considering the factor structure indicated in Table 2, observed variables were formed for the path analytic model. Items that PCA identified with structure coefficients above the $|.40|$ criterion were selected in each dimension. An 85-item, fifteen-factor model identified through PCA, was investigated, allowing the factors to freely correlate. Factor loadings in this model were statistically significant. Inspection of the residuals and modification indices revealed some items failing to correlate. Therefore, the latent variables ANX, BEHA, and TIME and the observed variables C3, C5, U2, U6, U12, L3, T1, T6, T9, P4, P6, and P7 were removed from the model. Moreover, thirteen covariance terms were added to the model. Although the chi-square test was significant [chi-square (1631) = 4646.90, p = .0], the other fit indices (i.e., GFI (.93), AGFI (.92), SRMR (.036), and RMSEA (.031)) indicated a good fit. Lambda-x estimates analogous to factor loadings in exploratory factor analysis for the latent variables for the scales are presented in Table 3.

Table 3
Lambda-X Estimates for the Scales

Scale	Indicator	Lambda-x
Confidence in Learning Mathematics- Positive Items (CONF_P)	C1	.71
	C2	.67
	C4	.67
	C6	.81
Confidence in Learning Mathematics- Negative Items (CONF_N)	C7	.93
	C8	.77
	C9	.94
	C10	.73
	C11	1.03
	C12	.96
Usefulness of Mathematics- Positive Items (USE_P)	U1	.48
	U3	.67
	U4	.62
	U5	.66
Usefulness of Mathematics- Negative Items (USE_N)	U7	.83
	U8	.87
	U9	.73
	U10	.91
	U11	.91
Importance of Mathematics (IMP)	I2	.76
	I3	.70
	I4	.72
	I5	.71
Liking of Mathematics (LIKE)	L1	.98
	L2	.88

Father- Positive Items (FA_P)	F1	.59
	F2	.71
	F3	.79
	F4	.75
	F5	.78
	F6	.73
Father and Mother- Negative Items (FA_MO_N)	F8	.75
	F9	.93
	F10	.93
	F11	.93
	F12	.81
	M7	.91
	M8	.90
	M9	.63
	M10	.84
	M11	.94
	M12	.74
Mother- Positive Items (MO_P)	M1	.67
	M2	.70
	M3	.80
	M4	.74
	M5	.65
Teacher- Positive Items (TE_P)	T2	.81
	T3	.86
	T4	.67
	T5	.73
Teacher- Negative Items (TE_N)	T7	.64
	T8	.61
	T10	.90
	T11	.93
	T12	.82
Teacher- Teaching Profession (TE_TP)	P1	.43
	P2	.44
	P3	.65
	P5	.62

Phi values are the estimates for the covariances between the latent constructs. These are analogous to the scale correlations in exploratory factor analysis and are given in Table 4.

Table 4
Phi Estimates

	C_P	C_N	U_P	U_N	IMP	LIK	F_P	FM_N	M_P	T_P	T_N
C_N	.57										
U_P	.52	.32									
U_N	.22	.59	.47								
IMP	.43	.29	.81	.47							
LIK	.70	.54	.59	.34	.52						
F_P	.45	.29	.47	.24	.46	.43					
FM_N	.18	.48	.32	.70	.32	.25	.36				
M_P	.47	.31	.47	.27	.47	.41	.75	.39			
T_P	.61	.37	.49	.17	.43	.53	.56	.14	.52		
T_N	.17	.50	.17	.60	.18	.20	.11	.60	.15	.13	
T_TP	.42	.27	.54	.36	.46	.50	.35	.26	.32	.44	.25

[1]Note: C_P = CONF_P; C_N = CONF_N; U_P = USE_P; U_N = USE_N; LIK = LIKE; F_P = FA_P; FM_N = FA_MO_N; M_P = MO_P; T_P = TE_P; T_N = TE_N; T_TP = TE_TP

The alpha reliability coefficients were .80, .85, .79, .80, .78, .86, .83, .90, .82, .77, .73, and .70 for the observed variables of CONF_P, CONF_N, USE_P, USE_N, IMP, LIKE, FA_P, FA_MO_N, MO_P, TE_P, TE_N, and TE_TP, respectively, indicating adequate internal consistency.

Path Analysis

With the observed variables identified through CFA, a path analysis was carried out to assess the direct influences of FA_P, FA_MO_N, MO_P, TE_P, TE_N, and TE_TP on CONF_P, CONF_N, USE_P, USE_N, IMP, and LIKE. In addition to the model-data fit indexes (e.g., GFI, AGFI, SRMR, and RMSEA), the significance of the paths from independent to dependent variables was also considered with respect to the t-test results. To revise the model-data fit, the residuals and modification indices were also considered to revise the model-data fit.

The paths between CONF_P and FA_P, FA_MO_N, TE_TP; CONF_N and FA_P, MO_P, TE_TP; USE_P and TEA_P, TE_N; USE_N and FA_P, MO_P, TE_P; and lastly IMP and TE_P, TE_N indicated non-significant *t*-values (Table 5). Therefore, these paths were deleted from the model. Following the residuals and modification indices, the observed variable LIKE was removed from the model, and seven covariance terms were added to the model (Figure 1). Consequently, the model presented in Figure 1 was obtained with the chi-square test [chi-square (16) = 105.40, p = .0], which was significant, and the other fit indices (i.e., GFI (.98), AGFI (.92), SRMR (.047), and RMSEA (.053)) indicated a good fit. Table 5 displays the estimates, *t*-values of paths between observed variables, and squared multiple correlations (R^2).

Table 5

Estimates, t-values of the Paths Between Observed Variables, and R^2 Values for the Path Model

Paths Between Observed Variables	Estimates	*t*-values	R^2
CONF_P and FA_P	*	*	
CONF_P and FA_MO_N	*	*	
CONF_P and MO_P	0.17	8.20	0.28
CONF_P and TE_P	0.33	14.72	
CONF_P and TE_N	0.06	3.88	
CONF_P and TE_TP	*	*	
CONF_N and FA_P	*	*	
CONF_N and FA_MO_N	0.16	11.07	
CONF_N and MO_P	*	*	0.29
CONF_N and TE_P	0.39	11.22	
CONF_N and TE_N	0.33	10.84	
CONF_N and TE_TP	*	*	
USE_P and FA_P	0.11	6.24	
USE_P and FA_MO_N	0.02	2.77	
USE_P and MO_P	0.14	6.12	0.28
USE_P and TE_P	*	*	
USE_P and TE_N	*	*	
USE_P and TE_TP	0.24	8.52	
USE_N and FA_P	*	*	
USE_N and FA_MO_N	0.22	19.40	
USE_N and MO_P	*	*	0.42
USE_N and TE_P	*	*	
USE_N and TE_N	0.24	9.88	
USE_N and TE_TP	0.25	6.73	
IMP and FA_P	0.14	7.04	
IMP and FA_MO_N	0.03	4.03	
IMP and MO_P	0.15	5.52	0.25
IMP and TE_P	*	*	
IMP and TE_N	*	*	
IMP and TE_TP	0.25	7.37	

[1]Note: * Represents the nonsignificant paths

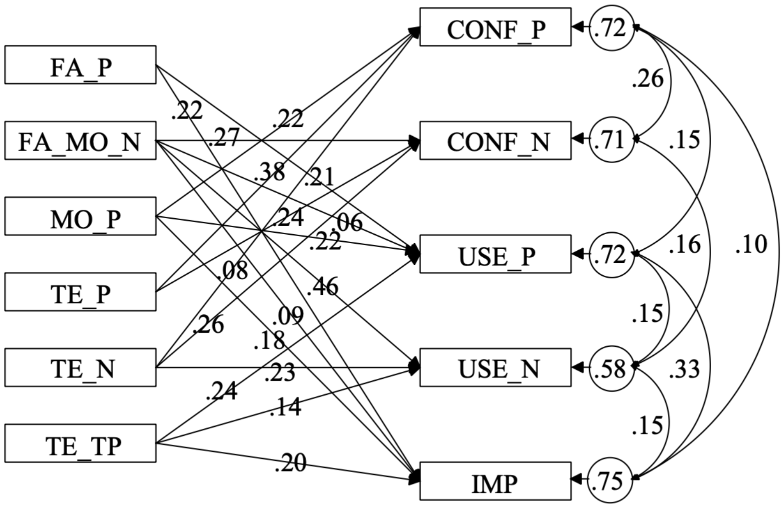

Figure 1. Path analytic model of attitude toward mathematics

From Table 5, Figure 1 displays the path model of the attitudes toward mathematics of the Turkish seventh graders. Notably, the standardized path coefficients changed between .46 and .06 in the fitted model. According to Cohen (1988), standardized path coefficients with absolute values less than 0.10, around 0.30, and above 0.50 indicate a small, medium, and large effect, respectively (as cited in Kline, 2016). Concerning these criteria, except for the path coefficients from FA_MO_N to USE_P and IMP, and from TE_N to CONF_P, all the other path coefficients indicated medium effects with various magnitudes. The path coefficients from FA_MO_N to USE_P and IMP and TE_N to CONF_P indicate small effect sizes.

In the model fitted, the greatest effect on CONF_P came from TE_P and MO_P. On the other hand, TE_N showed a rather smaller relationship with the CONF_P. In other words, in this study, students' positive confidence in learning mathematics is related to their positive perceptions of their teacher's and mother's attitudes toward them as learners of mathematics. Moreover, their positive confidence in learning mathematics is less related to their negative perceptions of their teacher's attitudes toward them as mathematics learners.

The observed variables FA_MO_N, TE_N, and TE_P are related to CONF_N. That is, students' negative confidence in learning mathematics is related to their negative perceptions of their father's, mother's, and teacher's attitudes toward them as mathematics learners and their positive perceptions of their teacher's attitudes toward them.

The observed variables TE_TP, MO_P, FA_P, and FA_MO_N are related to USE_P. However, the relationship between FA_MO_N and USE_P is very weak, as evidenced by a small path coefficient which is .06. In other words, students' positive beliefs about the usefulness of mathematics are related to their perceptions of their teacher's teaching profession and their positive perceptions of their mother's and father's attitudes toward them as learners of mathematics, and less related to their negative perceptions of their father's and mother's attitudes.

Like USE_P, the observed variables FA_MO_N, TE_N, and TE_TP are related to USE_N. Students' negative beliefs about the usefulness of mathematics are related to their negative perceptions of their mother's, father's, and teacher's attitudes toward them as mathematics learners, and their perceptions of their teacher's teaching profession.

Lastly, the observed variables FA_P, TE_TP, MO_P, and FA_MO_N are related to IMP. However, the relationship between FA_MO_N and USE_P is rather weak, as evidenced by a small path coefficient which is .09. That is, students' positive beliefs about the importance of mathematics are related to their positive perceptions of their mother's and father's attitudes toward them as mathematics learners, their perceptions of their teacher's teaching profession and less related to their negative perceptions of their father's and mother's attitudes.

Discussion

Previous research has emphasized that teachers and parents affect students' attitudes toward mathematics in several ways. In the present study, a path model was proposed to determine the relationships between students' perceptions of their teachers' and parents' attitudes toward them as mathematics learners and different dimensions of students' attitudes toward mathematics. Accepting the three-dimensional view of attitude toward mathematics, this study selected different mathematics attitudes that represent cognitive, affective, and behavioral dimensions of attitude toward mathematics. Before testing the proposed model, a principal components analysis and a confirmatory factor analysis were conducted to investigate whether the items measured the traits suggested by their placement on the scales and to identify the observed variables for the path model, respectively. According to the results of the PCA, positive and negative items loaded strongly on separate factors for each of the scales. Moreover, for only Father and Mother scales, the negative items loaded on a single factor. This can be supported by the results of the correlation analysis between the latent variables used in the path model. Accordingly, it was observed that the highest correlation was between the students' perceptions of their fathers' and mothers' positive attitudes toward students as mathematics learners. This can be interpreted that the students gave similar responses to corresponding statements in the questionnaire for both father and mother. This parallels Fennema and Sherman (1977)'s recognized correlation between the father and mother scales as one of the highest intercorrelations between the FSMAS variables.

Supported by recognizing the intersection of the domains of the FSMAS (Fennema & Sherman, 1976) and this study's CFA, a few observed and latent variables were removed from the model, and some error covariances were added between the observed variables. Specifically, many researchers hypothesize that mathematics anxiety is merely a lack of confidence in one's ability to learn mathematics. Therefore, they did not use the mathematics anxiety scale in their research (O'Neal et al., 1988). Similarly, in this study, it was observed that the liking of mathematics scale was correlated highly with the confidence in learning mathematics scale, and therefore, it was removed from the path model. In fact, the results of both analyses (i.e., PCA and CFA) empirically confirm what Triandis (1971) stated theoretically: the three components of attitude (i.e., cognitive, affective, and behavioral) are generally closely related. Therefore, the observed variables of confidence in learning mathematics, usefulness of mathematics, importance of mathematics, perceived father's, mother's, and teacher's attitudes toward students as learners of mathematics and teacher's teaching profession were used in the path model of the study. Thus, this study's selection of variables is consistent with Vandecandelaere et al.'s (2012) separation of the dimensions of mathematics self-confidence, perceived usefulness of mathematics, and enjoyment of mathematics.

After PCA and CFA, a specification search was employed to find a better fitting-model. This included additional parameters to arrive at a modified model. For this purpose, we added error covariances between variables, thus maintaining our hypothesized path model. This was an expected modification supported by the previous research on the FSMAS. Across a particular set of model fit indices, the best values indicated that the model fit is good. The results supported all of the hypothesized relationships.

The quantitative nature of the above statistical results can be further understood through a qualitative lens focussing more generally on the strength of associations and correlations without specifically considering precise numeric, statistical results. Thus, we consider associations of "moderate" strength rather than some specific value such as .26. Indeed, for this discussion, we consider variables with a medium effect size as having moderate associations.

It is important to continually remember that all investigated variables in this study are based on the students' perceptions of particular behaviors and opinions (explicit or implicit) of others. While these perceptions may or may not comport to reality, they are those of the students. This study began with the variables: students' perceptions of their mothers' (MO), fathers' (FA), and teachers' (TE) attitudes regarding the students as mathematical learned, and students' perception of their teachers' attitudes regarding their profession (TE_TP); students' intrinsic attitudes such as confidence in learning mathematics (CONF), usefulness of mathematics (USE), importance of mathematics (IMP), liking of mathematics (LIKE), and mathematics anxiety (ANX); and student behaviors such as learner behaviors toward mathematics (BEHA) and time spent on mathematics at home (TIME). Then LIKE, ANX, BEHA, and TIME were eliminated. However, of the remaining seven variables, two resulted in most affecting students' attitudes toward mathematical learning: perceptions of their mother's, father's, and teacher's attitudes toward the students as mathematical learners and the teacher's attitude towards teaching. From the students' perspective of each variable, this can be cryptically simplified into the following encapsulation:

- Students' positive confidence in learning mathematics was moderately associated with their mothers' and teachers' positive attitudes toward the respective children as mathematical learners.
- Students' negative confidence in learning mathematics was moderately associated with their fathers' and mothers' negative attitudes toward the respective children as mathematical learners and teachers' positive and negative attitudes toward the respective children as mathematical learners.
- Students' positive belief about the usefulness of mathematics was moderately associated with their fathers' and mothers' positive attitudes toward the respective children as mathematical learners, and their teachers' positive view of teaching.
- Students' negative belief about the usefulness of mathematics was moderately associated with their fathers', mothers', and teachers' negative attitudes toward the respective children as mathematical learners.

- Students’ positive belief about the importance of mathematics was moderately associated with their fathers’ and mothers’ positive attitudes toward the respective children as mathematical learners and their teachers’ positive view of teaching.

In general, it was observed that the positive variables were associated with the positive variables, and the negative variables were associated with the negative variables in the study. However, there were some exceptions where positive variables were associated with negative variables, the vice versa. In those cases, it was observed that the strength of the relationships is weak (except for the relationship between CONF_N and TE_P). If the variables are combined regarding their association with the students’ positive and negative attitudes, the following ideas emerge.

- When considering the strength and direction of relationships among variables, the associations were generally moderate and positive.
- Students’ confidence in learning mathematics was associated with their mothers’ and teachers’ attitudes toward the respective children as mathematical learners. Moreover, their negative confidence in learning mathematics was associated with their fathers’ negative and the teachers’ positive attitudes toward the respective children as mathematical learners.
- Students’ belief about the usefulness of mathematics was associated with their fathers’ and mothers’ attitudes toward the respective children as mathematical learners. While their positive belief about the usefulness of mathematics was associated with their teachers’ positive view of teaching, their negative belief about the usefulness of mathematics was associated with their teachers’ negative attitudes toward the respective children as mathematical learners.
- Students’ belief about the importance of mathematics was moderately associated with their fathers’ and mothers’ attitudes toward the respective children as mathematical learners and their teachers’ view of teaching.

In addition to the numerous variables which were initially omitted as having less effect on student attitudes, these findings lead to some supplementary observations from the perspectives of the mothers, fathers, and teachers.

- While the mothers’ and fathers’ attitudes towards their children as mathematical learners had some effects on their children’s attitudes and views, the teacher produced student attitudinal effects in two dimensions: through their perceived attitudes to the students as mathematics learners and through their perceived attitude to the teaching profession.
- While the fathers’ positive or negative perceived attitude toward their children as mathematical learners affected the children respectively regarding a negative attitude regarding confidence in learning mathematics, a positive or negative attitude regarding the usefulness of mathematics, and the importance of mathematics, the children’s perception of their fathers’ attitude seemed to have a minimal effect regarding the children’s confidence in learning mathematics. Thus, while the fathers’ negative view of their children as mathematical learners can always negatively affect the children, their positive view does not always elicit positive results.

- The mothers' positive or negative perceived attitudes toward their children as mathematical learners directly and respectively affected the children's attitudes in each of the final dimensions.
- The teachers' effect on the students' attitude is curious in several ways. First, the teachers' perceived positive or negative views of the students as mathematical learners directly and respectively affected the students' confidence in learning mathematics and negative view of the usefulness of mathematics. Second, the teachers' perceived positive attitude toward teaching positively affected the students' positive view of the usefulness of mathematics. Third, and very interestingly, the students' negative confidence in learning mathematics, negative view of the usefulness of mathematics, and positive view of the importance of mathematics were affected by the teachers' both positive and negative views of teaching. This third finding is curious and warrants further research.

While the associations recognized were only moderate, they were stronger than others. In other words, beyond the affective dimensions of liking mathematics (LIKE) and mathematics anxiety (ANX) and the behavioral dimensions of the learners' mathematics behaviors (BEHA) and time spent on mathematics at home (TIME), the external, extrinsic variables of the students' perceptions of their mothers' (MO), fathers' (FA), and teachers' (TE) attitudes regarding the students as mathematical learners, and students' perception of their teachers' attitudes regarding their profession (TE_TP) had stronger associations with students' intrinsic cognitive dimensions of confidence in learning mathematics (CONF) and perceived usefulness of mathematics (USE), and importance of mathematics (IMP).

Implication

It is important to remember that while these variables are associated with student attitudes, it is not implied that these are causal to the student attitudes. However, based on the findings of this and related studies in the literature, some implications can be drawn. First, future research must transcend simple positive-negative distinctions of affect. This study's consideration of cognitive, affective, and behavioral dimensions for assessing students' attitudes toward mathematics is notable. Many of the mathematics attitude scales that have been constructed or used in studies are generally intended to assess factors such as liking or disliking, usefulness, and confidence. They usually ignore the behavioral dimension of attitude—tacitly assuming that peoples' behaviors toward an object demonstrate limited insights about their attitude toward the object. However, a person's consistencies in thinking, feeling, and acting suggest the existence of attitude. Therefore, to assess students' attitudes, we have considered all three of these components.

Regarding attitude in mathematics, most researchers have investigated relationships between attitude and achievement, the causes of dramatic change in students' attitudes passing from elementary to high school, different gender groups, and students' socioeconomic status. They generally focus on measuring attitude instead of assessing it. Moreover, the instruments traditionally used in those studies do not vary according to differing definitions of attitude or even the complete absence of an explicit definition. Therefore, to get a refined picture of attitude, an obvious implication for any related research methodology is the necessity of explicitly defining which aspects of attitude are studied and for appropriate methods to investigate and address these aspects.

The findings of this study suggest a relationship between parents' and teachers' attitudes and those of the respective children. According to the self-determination theory (Deci & Ryan, 1985), parental behaviors can support students' feelings of competence, autonomy, and relatedness. Our final model demonstrates that, while mothers are more influential on middle school children's confidence in learning mathematics than fathers, both parents influence their children's beliefs about the usefulness and importance of mathematics. Wilkins and Ma (2003) also found that students who perceived that their parents thought mathematics was important were more likely to believe that mathematics was important and, overall, they seemed to maintain more positive feelings about the usefulness of mathematics throughout high school than did students who experienced more negative parental push. The contrast between the effects of mothers and fathers highlights that the effect of parental values on students' interests might be associated with the gender of parents.

This study found that parents and teachers can affect students' attitudes toward mathematics in both directions. For example, it was observed that students' positive or negative confidence in learning mathematics was affected by their teachers' both positive and negative attitudes toward them as learners of mathematics. Therefore, in addition to the parent's gender, as it affects students' attitudes toward mathematics, it is also important to consider the direction of their effects.

While it was observed that parents' and teachers' opinions and behaviors toward children are identified as crucial for their children's attitudes, research has suggested that the effect of parents' and teachers' opinions and behaviors on students' attitudes might depend on students' gender (Lazarides et al., 2015). Although the focus of the current study was not to explore the relationships between fathers' and mothers' beliefs and behaviors and their sons' and daughters' beliefs and behaviors, it is stressed that more research is needed in this area. This idea can also be adapted to the teachers, in the consideration of the relationships between male and female teachers' beliefs and behaviors and those of boy and girl students.

Altogether, the most pressing implication of this study may be that parents should be informed regarding how their perceived attitudes regarding their children as mathematical learners affect their children's attitudes toward the use and importance of mathematics and their confidence in learning mathematics. In essence, children seem to inherit attitudes regarding mathematics and themselves as they perceive from their parents. This warrants far more investigation and the development of materials to inform parents of these self-fulfilling effects.

Conclusion

Employing path analyses, this study explored the relationships between Turkish 7-th grade students' perceptions of their teachers' and parents' attitudes toward them as learners of mathematics and mathematics and the students' attitudes related to mathematics learning. After the analysis of numerous variables, the students' perceptions of the parents' and teachers' attitudes regarding the students as mathematical learners (and to a lesser degree the teachers' attitudes toward the teaching profession) were most strongly associated with students' attitudes regarding their confidence in learning mathematics and views of the usefulness and importance of mathematics. This was coupled with the recognition that students' perceptions of parents' and teachers' positive or negative attitudes were often associated with the respective students' positive and negative perspectives.

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Declarations

Conflict of interest. The authors declared that they have no conflict of interest.

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Appendix.

Table

Structure Matrix for PCA With Oblimin Rotation of the Fifteen-Factor Solution

Scale/ Item No.	Item	Component 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
C1+	Generally I have felt secure about attempting mathematics.	.281	-.067	.192	-.152	.198	.409	.111	.285	-.285	-.252	.246	.079	-.251	**.669**	.279
C2+	I am sure I could do advanced work in mathematics.	.272	-.051	.113	-.155	.148	.358	.088	.254	-.262	-.250	.249	.084	-.128	**.721**	.304
C3+	I am sure that I can learn mathematics.	.192	-.187	.171	-.216	.231	.266	.165	.141	-.325	-.235	.275	.168	-.241	**.724**	.289
C4+	I think I could handle more difficult mathematics.	.195	-.090	.183	-.211	.138	.345	.086	.153	-.253	-.292	.209	.096	-.047	**.754**	.178
C5+	I can get good grades in mathematics.	.103	-.191	.236	-.256	.181	.332	.193	.120	-.424	-.224	.216	.175	-.308	**.668**	.247
C6+	I have a lot of self-confidence when it comes to math.	.278	-.078	.208	-.199	.220	.502	.137	.262	-.335	-.333	.192	.113	-.218	**.712**	.258
C7-	I'm no good at math.	.172	-.242	.113	-.071	.148	.304	.292	.221	**-.767**	-.137	.128	.308	-.157	.343	.136
C8-	I don't think I could do advanced mathematics.	.152	-.277	.093	-.118	.158	.251	.246	.142	**-.670**	-.103	.110	.311	-.070	.293	.146
C9-	I'm not the type to do well in math.	.160	-.337	.115	-.157	.172	.260	.312	.121	**-.772**	-.106	.155	.401	-.181	.342	.137
C10-	For some reason even though I study, math seems unusually hard for me.	.200	-.101	.021	-.002	.066	.439	.287	.116	**-.587**	-.129	.016	.189	-.067	.204	.012
C11-	Most subjects I can handle OK, but I have a knack for mucking up math.	.246	-.295	.111	-.135	.159	.325	.377	.145	**-.799**	.112	.137	.369	-.157	.363	.108
C12-	Math has been my worst subject.	.289	-.247	.054	-.120	.125	.248	.336	.143	**-.758**	-.110	.094	.274	-.118	.269	.066
U1+	I'll need mathematics for my future work.	.115	-.072	.214	-.273	.230	.124	.017	.210	-.094	-.181	.161	.195	-.090	.207	**.724**

U2+	I study mathematics because I know how useful it is.	.280	-.154	.227	-.302	.227	.220	.089	.293	-.279	-.287	.250	.124	-.240	.416	**.592**
U3+	Knowing mathematics will help me earn a living.	.135	-.159	.227	-.495	.20	.139	.101	.162	-.147	-.260	.208	.216	-.181	.307	**.648**
U4+	Mathematics is a worthwhile and necessary subject.	.216	-.224	.188	-.479	.311	.147	.114	.110	-.144	-.194	.231	.313	-.242	.280	**.607**
U5+	I'll need a firm mastery of mathematics for my future work.	.189	-.141	.212	-.470	.212	.226	.055	.183	-.092	-.272	.212	.284	-.096	.267	**.685**
U6+	I will use mathematics in many ways as an adult.	.226	-.129	.224	-.346	.160	.274	.089	.142	-.174	-.332	.210	.119	-.134	.316	**.564**
U7-	Mathematics is of no relevance to my life.	.146	-.347	.112	-.228	.200	.062	.314	.090	-.323	-.040	.061	**.734**	-.156	.116	.176
U8-	Mathematics will not be important to me in my life's work.	.085	-.332	.103	-.179	.193	.061	.306	.052	-.276	-.005	.102	**.713**	-.149	.116	.180
U9-	I see mathematics as a subject I will rarely use in daily life as an adult.	-.071	-.300	.065	-.091	.098	.098	.353	.153	-.300	-.026	.083	**.616**	-.065	.092	.061
U10-	Taking mathematics is a waste of time.	.229	-.454	.087	-.231	.246	.053	.345	.086	-.343	-.010	.098	**.762**	-.182	.119	.135
U11-	In terms of my adult life it is not important for me to do well in math.	.185	-.468	.088	-.274	.238	-.012	.369	.022	-.355	.031	.092	**.744**	-.202	.126	.105
U12-	I expect to have little use for mathematics when I get out of school.	.237	-.421	.173	-.341	.215	.142	.330	.207	-.372	-.106	.143	**.687**	-.138	.211	.224
I1+	I would like a job that involved using mathematics.	.326	-.051	.215	**-.474**	.186	.303	.084	.330	-.199	-.289	.099	.042	-.052	.294	.387
I2+	I need to do well in mathematics to get the job I want.	.206	-.093	.241	**-.688**	.177	.198	.054	.257	-.113	-.262	.136	.185	-.089	.244	.394
I3+	I need to do well in mathematics to get into the secondary school or university I prefer.	.108	-.179	.194	**-.746**	.181	.114	.097	.142	-.136	-.162	.247	.232	-.198	.219	.251
I4+	Mathematics is important to everyone's life.	.172	-.152	.244	**-.703**	.232	.137	.061	.120	-.070	-.222	.186	.200	-.190	.143	.346
I5+	I think it is important to do well in mathematics at school.	.207	-.241	.157	**-.682**	.246	.140	.127	.123	-.174	-.215	.209	.287	-.161	.210	.371

L1+	I like mathematics.	**.651**	-.123	.197	-.291	.282	.396	.124	.364	-.386	-.330	.212	.143	-.332	.473	.395
L2+	I enjoy learning mathematics.	**.632**	-.181	.205	-.358	.290	.331	.157	.316	-.338	-.313	.267	.183	-.361	.438	.355
L3-	Mathematics is boring.	**.576**	-.308	.089	-.294	.244	.236	.258	.226	-.417	-.173	.047	.406	-.241	.226	.133
L4+	Mathematics is an easy subject.	.444	.012	.095	-.120	.111	**.510**	.066	.243	-.244	-.297	.163	-.054	-.120	.333	.287
L5+	I need to do well in mathematics to please myself.	.336	-.153	.206	**-.518**	.177	.131	.006	.127	-.069	-.276	.268	.070	-.288	.251	.363
A1+	Math doesn't scare me at all.	.319	.022	.138	-.041	.048	**.664**	.068	.213	-.204	-.264	.181	.001	-.053	.397	.268
A2+	It wouldn't bother me at all to take more math courses.	**.438**	-.142	.191	-.314	.184	.338	.111	.359	-.153	-.288	.155	.180	-.214	.338	.321
A3+	I haven't usually worried about being able to solve math problems.	.272	-.038	.197	-.181	.125	**.650**	.074	.256	-.259	-.357	.215	.017	-.138	.386	.257
A4+	I almost never have got nervous during a math test.	.152	.043	.092	-.052	.044	**.795**	.037	.095	-.175	-.200	.053	-.019	-.032	.236	.091
A5+	I usually have been at ease during math tests.	.133	.037	.120	-.090	.034	**.815**	.043	.105	-.213	-.271	.99	-.040	-.091	.297	.092
A6+	I usually have been at ease in math classes.	.121	-.122	.147	-.245	.136	**.678**	.119	.127	-.261	-.220	.189	.098	-.236	.322	.150
A7-	Mathematics usually makes me feel uncomfortable and nervous.	**.495**	-.388	.085	-.242	.271	.271	.404	.160	-.415	-.042	.071	.471	-.088	.261	.023
A8-	Mathematics makes me feel uncomfortable, restless, irritable, and impatient.	.167	-.261	.091	-.043	.183	.120	.375	.043	-.213	.042	.059	-.391	**.317**	-.359	-.048
A9-	I get a sinking feeling when I think of trying math problems.	.187	-.267	.159	-.108	.143	.190	**.515**	.085	-.306	-.005	.050	.300	.077	.213	-.083
A10-	My mind goes blank and I am unable to think clearly when working mathematics.	.317	-.319	.170	.105	.158	.257	**.543**	.149	-.436	-.037	.012	.343	.014	.283	.009
A11-	A math test would scare me.	.302	-.204	.089	-.019	.102	**.587**	.384	.075	-.408	-.037	-.001	.286	.120	.281	-.015
A12-	Mathematics makes me feel uneasy and confused.	**.488**	-.321	.124	-.198	.186	.396	.451	.162	-.486	-.100	.039	.401	.023	.338	.061
B1+	I always do my math homework.	.255	-.099	.203	-.228	.188	.181	.141	.387	-.179	-.171	.245	.130	**-.602**	.278	.171
B2+	I come to math classes on time.	.093	-.293	.222	-.247	.221	.113	.139	.112	-.174	-.053	.220	.314	**-.697**	.218	.154
B3-	I skip math classes.	.059	**-.500**	.070	-.129	.170	.070	.212	-.011	-.177	.049	.045	.437	-.342	.125	.001
B4+	I often raise my hand in math classes.	.232	-.150	.213	-.168	.163	.429	.229	.335	-.411	-.300	.294	.130	**-.452**	.430	.200

TI1-	I spend very little time on mathematics at home.	-.014	-.385	.117	-.082	.126	.130	.300	**.496**	-.313	-.022	-.013	.271	-.231	.218	.127
TI2+	I spend a lot of my study time on mathematics when compared to other subjects.	.246	-.028	.249	-.206	.149	.197	.008	**.728**	-.117	-.306	.273	.070	-.146	.220	.224
TI3-	Compared to other subjects, I spend the least time on mathematics at home.	.012	-.448	.113	-.134	.145	.142	.377	**.525**	-.400	-.078	.012	.351	-.221	.225	.112
TI4+	I spend a lot of my time at home on mathematics.	.216	.000	.249	-.229	.110	.216	.035	**.714**	-.088	-.297	.246	.012	-.076	.202	.193
F1+	My father thinks that mathematics is one of the most important subjects I have studied.	.107	-.120	**.715**	-.205	.130	.064	-.005	.241	.034	-.179	.287	.073	-.078	.130	.190
F2+	My father has always encouraged me to do well in mathematics.	.078	-.198	**.773**	-.216	.163	.102	-.001	.151	-.062	-.253	.336	.128	-.096	.195	.141
F3+	My father has always been interested in my progress in mathematics.	.101	-.181	**.741**	-.137	.104	.194	.022	.202	-.105	-.300	.310	.030	-.097	.183	.221
F4+	My father thinks I'll need mathematics for what I want to do after graduate.	-.016	-.154	**.677**	-.349	.111	.110	.038	.137	-.063	-.253	.325	.133	-.138	.165	.100
F5+	My father thinks I'm the kind of person who could do well in mathematics.	.094	-.243	**.638**	-.189	.142	.281	.138	.054	-.230	-.353	.502	.091	-.294	.277	.263
F6+	My father thinks I could be good in math.	.136	-.250	**.600**	-.171	.140	.303	.151	.085	-.275	-.312	.442	.100	-.386	.226	.277
F7-	My father wouldn't encourage me to plan a career which involves math.	-.132	-.228	-.133	.042	.056	-.002	**.337**	.030	-.157	.144	-.017	.093	.016	-.051	.113
F8-	My father hates to do math.	.214	**-.696**	.280	-.122	.147	.080	.276	.019	-.249	.003	.046	.377	-.157	.047	.076
F9-	As long as I have passed, my father hasn't cared how I have done in math.	.183	**-.753**	.361	-.065	.101	.072	.346	.021	-.257	-.018	.130	.326	-.181	.088	.090
F10-	My father thinks advanced math is a waste of time for me.	.100	**-.752**	.186	-.087	.141	.069	.392	-.001	-.269	.080	.119	.471	-.215	.097	.105

F11-	My father thinks I need to know just a minimum amount of math.	.057	**-.760**	.163	-.095	.100	.041	.398	.025	-.278	.077	.117	.455	-.205	.063	.052
F12-	My father has shown no interest in whether I take more math courses.	.176	**-.702**	.304	-.065	.081	.018	.278	.039	-.224	.000	.101	.313	-.039	.114	.114
M1+	My mother thinks I'm the kind of person who could do well in mathematics.	.179	-.165	.310	-.129	.128	.208	.098	.068	-.182	-.284	**.796**	.083	-.175	.301	.264
M2+	My mother thinks I could be good in math.	.152	-.249	.330	-.173	.140	.213	.139	.101	-.209	-.271	**.806**	.124	-.211	.301	.267
M3+	My mother has always been interested in my progress in mathematics.	.017	-.229	.352	-.233	.090	.152	.072	.226	-.127	-.195	**.732**	.119	-.211	.264	.121
M4+	My mother has always encouraged me to do well in mathematics.	-.020	-.212	.416	-.284	.166	.114	.005	.209	-.084	-.233	**.679**	.156	-.158	.215	.093
M5+	My mother thinks that mathematics is one of the most important subjects I have studied.	-.025	-.202	.422	-.374	.113	.059	.028	.304	-.018	-.180	**.571**	.142	-.086	.139	.112
M6+	My mother thinks I'll need mathematics for what I want to do after graduate.	-.065	-.132	.409	-.438	.088	.075	.043	.247	-.025	-.215	**.503**	.170	-.108	.148	.059
M7-	My mother thinks advanced math is a waste of time for me.	.014	**-.720**	.024	-.151	.170	.058	.432	.089	-.273	.035	.169	.402	-.193	.110	.061
M8-	As long as I have passed, my mother hasn't cared how I have done in math.	.034	**-.765**	.138	-.203	.169	.018	.326	.138	-.261	-.032	.281	.340	-.197	.109	.050
M9-	My mother wouldn't encourage me to plan a career which involves math.	.187	**-.452**	.010	-.089	.039	.046	.293	.101	-.256	.015	.056	.318	.167	.112	.025
M10-	My mother has shown no interest in whether I take more math courses.	.038	**-.729**	.177	-.216	.144	.026	.288	.177	-.237	-.069	.264	.332	-.085	.142	.056
M11-	My mother thinks I need to know just a minimum amount of math.	-.042	**-.716**	.067	-.191	.165	.031	.381	.154	-.275	.015	.182	.465	-.188	.152	.067
M12-	My mother hates to do math.	.054	**-.675**	.128	-.250	.209	.053	.215	.134	-.224	-.038	.183	.307	-.063	.142	.053

T1+	My teachers have encouraged me to study more mathematics.	.078	.113	.191	-.069	.110	.007	-.152	.114	.089	**-.575**	.117	-.047	.111	.084	.111
T2+	My teachers think I'm the kind of person who could do well in mathematics.	.137	-.098	.225	-.155	.136	.333	.112	.154	-.217	**-.680**	.319	.090	-.157	.361	.263
T3+	Math teachers have made me feel I have the ability to go on in mathematics.	.151	-.080	.209	-.207	.188	.338	.119	.140	-.230	**-.705**	.286	.099	-.208	.316	.219
T4+	My math teachers would encourage me to take all the math I can.	.107	.008	.212	-.167	.153	.194	-.057	.168	-.084	**-.758**	.191	.017	-.027	.175	.189
T5+	My math teachers have been interested in my progress in mathematics.	.089	-.035	.206	-.248	.276	.295	.055	.138	-.115	**-.703**	.199	-.001	-.188	.243	.162
T6+	I would talk to my math teachers about a career which uses math.	.147	.082	.196	-.216	.103	.219	-.100	.220	-.066	**-.591**	.052	-.148	-.066	.105	.132
T7-	When it comes to anything serious I have felt ignored when talking to math teachers.	.067	-.201	-.020	.015	.057	.067	**.571**	.007	-.168	.144	.028	.265	-.028	.046	-.045
T8-	I have found it hard to win the respect of math teachers.	-.018	-.157	-.020	.008	.094	.053	**.577**	.066	-.191	.093	-.062	.142	-.039	-.012	-.036
T9-	My teachers think advanced math is a waste of time for me.	.056	-.479	.047	-.124	.166	.022	**.640**	.088	-.314	.034	.070	.479	-.176	.165	.047
T10-	Getting a mathematics teacher to take me seriously usually been a problem.	.103	-.344	.011	-.075	.195	.093	**.729**	.060	-.278	-.032	.062	.339	-.114	.107	.030
T11-	My teachers would think I wasn't serious if I told them I was interested in a career in science and mathematics.	.093	-.344	.060	-.106	.100	.064	**.704**	.042	-.271	.013	.080	.350	-.146	.097	.055
T12-	I have had a hard time getting teachers to talk seriously with me about mathematics.	.073	-.296	.003	-.056	.094	.081	**.727**	.073	-.259	-.060	.025	.250	-.086	.078	.002
P1+	My math teacher likes mathematics.	.091	-.108	.108	-.154	**.735**	.080	.082	.084	-.098	-.155	.064	.092	-.083	.197	.183
P2+	My math teacher knows a lot about mathematics.	.070	-.101	.127	-.125	**.742**	.072	.025	.098	-.071	-.143	.086	.160	-.048	.146	.166

P3+	My math teacher values our work.	.207	-.124	.125	-.231	**.699**	.090	.138	.147	-.131	-.231	.156	.128	-.189	.136	.215
P4-	My math teacher makes everything worse when I have a problem.	.123	-.218	.032	-.166	**.555**	.041	.240	.033	-.385	-.074	-.016	.270	-.191	-.102	.113
P5+	My math teacher is very fair to me.	.107	-.095	.119	-.253	**.516**	.158	.216	.024	-.066	-.260	.077	.188	-.331	.214	.030
P6+	My math teacher tells me when I do a good job.	.144	-.113	.189	-.222	**.541**	.157	.154	.069	-.110	-.336	.194	.152	-.218	.227	.168
P7-	My math teacher treats boys and girls differently in the classroom.	.083	-.215	-.018	-.123	**.475**	.016	.273	.025	-.383	-.031	.025	.277	-.208	-.107	.017

[1]Note: C = confidence; U = usefulness; I = importance; L = liking; A = anxiety; B = behavior; TI = time; F = father; M = mother; T = teacher; P = profession. Negatively worded items are marked with a minus sign for item no.; positively worded items are marked with a plus sign for item no. Major loadings for each item are bolded.