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The Development of a Mathematics Self-Report Inventory for Turkish Elementary Students

Ayça Akın
Anadolu University, TURKEY
Cem Oktay Güzeller
Hacettepe University, TURKEY
Sinem Sezer Evcan
Akdeniz University, TURKEY

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The purpose of the current study is to develop a mathematics self-report inventory (MSRI) to measure Turkish elementary students' mathematics expectancy beliefs and task values based on the expectancy-value theory of achievement motivation. In Study-1 (n = 1,315), exploratory factor analysis (EFA) and reliability analysis are used to evaluate the MSRI. EFA results suggest a five-factor model that consists of interest value, extrinsic-utility value, importance value, personal cost, and expectancy beliefs. In Study-2 (n = 1,343), confirmatory factor analysis (CFA) and convergent, discriminant, and subgroup validity results are also used to examine construct validity for the MSRI. The results indicate that (a) elementary students' scores on the MSRI did not significantly differ by gender; (b) elementary students' scores on the MSRI were significantly influenced by grade level; and (c) a significant, positive, and strong relationship existed between students' scores on the MSRI and students' achievement scores from the Level Determination Exam. The findings of this study showed that, with a few exceptions, the MSRI is a reliable and valid psychological tool for use with the elementary students in Turkey and may be regarded as beneficial in guiding subsequent study goals by explaining students' achievement-related beliefs grounded in the expectancy value theory.

Keywords: elementary students, expectancy-value theory of achievement motivation, expectancy beliefs, task values

INTRODUCTION

Student performance in mathematics originates in multiple sources. Research has shown that psychological constructs are key factors in mathematics performance,

Correspondence: Ayça Akın,
Department of Elementary Education, Faculty of Education, Anadolu University, Yunusemre Campus, Tepebaşı, Eskişehir, Turkey.
E-mail: aycaakin07@gmail.com

the learning process, and the learning environment (e.g., Eccles & Wigfield, 2002; Yıldırım, 2011). However, school mathematics education's attention seems to be
paid mainly to mathematics achievement rather than to students' self-constructs about mathematics. If students' self-constructs about mathematics are underestimated by educators, the mathematics curriculum into which educators have put significant effort will not have a powerful and lifelong affect (Luttrell et al., 2010).

The present study aims to develop a mathematics self-report inventory (MSRI) to measure Turkish elementary students' mathematics expectancy beliefs and task values. The MSRI is based on the expectancy-value theory of achievement motivation (Eccles et al., 1983; Eccles & Wigfield, 1995; Wigfield & Eccles, 2000) which suggests that students' choices and performance of the task and persistence on the task are predicted by expectancy beliefs and subjective task values (Zhu, 2009).

State of the literature

- The expectancy-value theory of achievement motivation is a motivation theory that has been used to examine students' perceptions of mathematics.
- Literature findings indicate that expectancy beliefs and task values are key factors in mathematics achievement. In other respects, many studies indicated that middle school mathematics mainly focuses on mathematics achievement rather than students' expectancy beliefs and task values.
- In Turkey, many measures have been developed to assess middle school students' mathematics attitudes, but these have failed to evaluate all factors of mathematics values and expectancy beliefs. There is a need for instruments evaluating students' expectancy beliefs and task values.

Contribution of this paper to the literature

- The EFA and CFA indicated that the five-factor structure of the MSRI demonstrated an adequate-to-good fit to the acceptance criteria. Convergent and discriminant validity was provided for the MSRI.
- The results revealed that there was not any significant difference between the MSRI scores of girls and boys that there was a strong and positive relationship between expectancy beliefs and task values.
- The findings of this study indicate that, with a few exceptions, the MSRI is a reliable and valid instrument for use with elementary students in Turkey.

THEORETICAL BACKGROUND

The expectancy-value theory of achievement motivation has been used to investigate academic motivations underlying students' perceptions of subject areas (Cruz, 2005). This model gives an opportunity to understand an individual's achievement and motivation (Zhu, 2009). Eccles et al. (1983) suggest a theoretical model which is grounded on the hypothesis that "it is not reality itself (past successes or failures) that most directly determines children's expectancies, values, and behavior, but the interpretation of that reality"(p. 81). This theoretical model proposed that expectancy beliefs and task values are presumed to affect achievement-related choices, students' performance of the task, and persistence and effort on the task. Expectancy beliefs and task values are also presumed to be affected by task-specific beliefs including short-term goals, long-terms goals, self-schema, ideal self, self-concept of one's abilities, affective memories, and perceptions of task. All of these variables are successively affected by previous achievement-related experiences and their interpretation, and socializers' beliefs and behaviors (Wigfield & Eccles, 2000).

Definition of important terms

Expectancy beliefs

In the earlier version of the expectancy-value theory of achievement motivation, expectancy beliefs are comprised of both expectancies for success and beliefs about ability. Expectancies of success are defined as "individuals' beliefs about how well they will do on upcoming tasks, either in the short- or longer-term future" (Eccles & Wigfield, 2002, p. 119), whereas beliefs about ability are defined as "the assessment of one's own competency to perform specific tasks or to role-appropriate behaviors"

(Eccles et al., 1983, p. 82). However, empirical research (e.g., Eccles et al., 1983; Eccles & Wigfield, 1995) has indicated that adolescents and children's expectancies for success and beliefs about ability are closely associated and empirically indistinguishable (Eccles & Wigfield, 2002). According to the literature and definitions, we can also say that expectancy beliefs and self-efficacy are similar self-constructs and are measured by analogous psychological measures (Eccles & Wigfield, 2002).

Task values

Task values refer to "a psychological construct rather than an objective property of the object or task" (Wigfield & Eccles, 1992, p. 272). In the expectancy-value theory of achievement motivation, task values consist of four major values in a subjective task: interest/intrinsic value, attainment value, utility value, and cost.

Interest/intrinsic value is defined as "the inherent enjoyment or pleasure one gets from engaging in an activity" (Eccles & Wigfield, 1995, p.216). Students with higher mathematics interest spend more time doing math tasks and show higher mathematics achievement than students with lower mathematics interest (Hidi, 1990; Schiefele, 1991). When the mathematics tasks are regarded as enjoyable, academic motivation and expectancy beliefs for that these tasks are mostly high (Anderson, 1998).

Attainment value refers to the student's level of perceived importance in the doing well on the task (Luttrell et al., 2010). For example, students who think of themselves as mathematicians and believe that proving a theorem or solving a mathematical problem is crucial for their mathematics career will actively participate in a mathematics competitions or workshops, and feel that excellent performance in the competition or workshop will be of high attainment value.

Utility value is defined as "the importance of the task for some future goal that might itself be somewhat unrelated to the process nature of the task at hand" (Eccles et al., 1983, pp. 89-90). According to this definition, utility value is pertinent to the student's internalized long- and short-range goals (Zhu, 2009). The perception of the necessity of doing well on the task predicts the level of utility value. For example, engineering students will have a high utility value for mathematics because they will be able to get into an engineering department, if they get a high score on the university entrance exam in mathematics.

Cost is conceptualized as a separate critical component of task values and includes loss of energy and time for other activities; choices and life-defining roles such as personal aspiration, gender and social role; beliefs about effort exerted on task; negative feelings about performing a task; and an inevitable ending of failure (Eccles et al., 1983). Students whose cost is high may generally avoid the mathematics-related activities, courses, and tasks (Eccles et al., 1983).

The expectancy-value theory of achievement motivation is used as a theoretical perspective to reply to the individual motivation questions, "can I do this task?", "why do I want to this task?" and "do I want to do this?" (Wigfield et al. 2006, p. 236). For any specific issue, these questions are clarified by an individual's expectancy beliefs, task values involving interest, attainment, and utility value; and cost.

The earlier version of the expectancy-value theory proposed that expectancy beliefs and task values are assumed to be inversely correlated (Atkinson, 1957). According to Atkinson and a few other researchers, students' expectancy beliefs are high and if the task is easy task values are low. On the other hand, Feather (1988) and Wigfield (1994) claim that a positive relationship exists between expectancy beliefs and task values, and students tend to place more value on the activities which they do well them, and in which they feel they are talented. Many studies' findings (e.g., Wigfield et al., 1997) related to the expectancy-value theory of achievement motivation indicate that expectancy beliefs and task values are positively correlated to each other.

Existing measures of expectancy beliefs and task values

Eccles et al. (1983) developed the first measure for evaluating expectancy beliefs (involving expectancies for success and beliefs about ability), task values (including interest, attainment and utility), and perceived task difficulty (comprising perceptions of effort and perceptions of the difficulty required to perform well in the subject) in English and mathematics for elementary students. The findings from a similar study of adolescents resulted in a six-factor model that differentiated between achievement-related beliefs generated by (1) interest value, (2) attainment value, (3) utility value, (4) expectancy beliefs (including beliefs about ability, performance perceptions, and expectancy of success), (5) perceptions of the effort required to perform well in the subject, and (6) perceptions of the difficulty of performing well in the subject (Eccles & Wigfield, 1995). According to these studies' results, task values are separated into three factors (interest, attainment, and utility value), cost is the original fourth factor (not involving task values and including perceptions of effort and perceptions of the difficulty of performing well in the subject), and expectancy beliefs are the fifth factor, with different components of expectancy beliefs being indistinguishable. The differential factors of task values were recognized by students in 5th grade and above, whereas several components of expectancy beliefs' were not identified by the same students (Wigfield & Eccles, 2000). Students' expectancy beliefs and task values in mathematics became progressively more negative as they grew older. Because students got older, their beliefs became more realistic about mathematics (Wigfield & Eccles, 2000). Past studies' results showed gender norms, with girls having more negative expectancy beliefs and task values in mathematics than boys although they did equally well on the mathematics tasks (e.g., Eccles, Wigfield, Harold, & Blumenfeld, 1993; Wigfield et al., 1997), while current studies' results (e.g., Chouinard, Karsenti, & Roy, 2007; Luttrell et al., 2010) indicate that students' expectancy beliefs and task values in mathematics did not significantly differ by gender. Luttrell et al. (2010) developed the Math Value Inventory for general education students to evaluate interest, general utility, need for high achievement, and personal cost value of mathematics based on the expectancy-value theory of achievement motivation.

In Turkey, there were number of measures (e.g., Bindak, 2005; Nazlıçiçek & Erktin, 2002) that had been developed for elementary students to assess mathematics anxiety or mathematics attitudes. However, these failed to evaluate all factors of mathematics values and expectancies beliefs and were not grounded in the expectancy-value theory of achievement motivation and thus cannot accurately provide educators and researchers a means to assess mathematics curricula, their efforts and reform in mathematics education, and students' beliefs about mathematics (Luttrell et al., 2010).

METHOD

Instrument

Item development and content validation of the MSRI

Based on the review of literature related to the expectancy-value theory of achievement motivation (e.g., Eccles et al., 1983; Eccles & Wigfield, 1995; Luttrell et al., 2010; Wigfield & Eccles, 2000), initial items of the MSRI, which consisted of 54 draft items underlying the five-factor structure (interest value, extrinsic utility value, importance value, personal cost and expectancy beliefs in mathematics), were developed by the researchers. The content of these draft items was validated by being sent to 10 content experts in the fields of mathematics education, measurement evaluation, psychological counselling and guidance, and Turkish philology who identified unclear items, items with the similar content and proposed deletion of items. According to suggestions made by the content experts, 18 draft items were removed and the necessary corrections were made for unclear items. Following the content validation process, the MSRI was comprised of 36 items that reflected interest value, extrinsic utility value, importance value, personal cost, and expectancy beliefs in mathematics. All items of the MSRI were measured with a five-point Likert-type scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*).

Level Determination Exam (LDE)

The Level Determination Exam (LDE) is a national central exam which is carried out by the Ministry of Education (MNE) to sixth, seventh and eight-grade elementary students for placing them into secondary school types. The LDE comprises in all multiple-choice questions covering six sections which are Mathematics, Turkish, Science, Social Science, Foreign Language, and Religious Culture and Moral Knowledge. The participating students' achievement scores from the LDE have been taken from e-school system of Group Head of Information Technology of Ministry of Education.

Participants and sampling

The participants were 1,315 (Study 1) and 1,343 (Study 2) Grade 6 to Grade 8 students ($n_{female1}$ = 614; n_{male1} = 701; mean age_1 = 13.07; SD_1 = .98; $n_{female2}$ = 657; n_{male2} = 686; mean age_2 = 13.23; SD_2 = 1.05) from 10 public elementary schools on the southern coast of Turkey. Before the analyses, the outliers, which were defined as having values with standardized scores exceeding 3.29, $p < .001$, were examined and 57 (Study 1) and 60 (Study 2) cases were deleted (Tabachnick & Fidel, 2007). Therefore, the first sample group was comprised of 1,258 elementary students ($n_{female1}$ = 614; n_{male1} = 644; mean age_1 = 13.12; SD_1 = .96) and the second sample group was comprised of 1,283 elementary students ($n_{female2}$ = 648; n_{male2} = 635; mean age_2 = 13.49; SD_2 = 1.21). All students in the both studies are aged between 11 and 16 years of age.

Statistical analysis

In the current research, EFA and CFA are used to determine the factor structure of the MSRI. Before the analyses were carried out, the assumptions of factor analysis (i.e., data with a univariate normal distribution and without multiple correlation problems) were held (Muthen & Kaplan, 1985; Tabachnick & Fidell, 2007). In both study groups, the kurtosis and skewness values were ranged between -1 and 1 and the values of correlation coefficients were under or equal to .90. The findings showed that the data of both study groups demonstrated a univariate normal distribution and there were not any multiple correlation problems, so the data of both study groups were suitable for factor analyses. Convergent and discriminant validity were assessed by average variance extracted (AVE), construct (composite) reliability and item reliability, and subgroup validity was evaluated by gender and grade level. In order to evaluate the internal consistency and reliability of the MSRI and each factor, the Chronbach's alpha coefficients were computed. Pearson product-moment correlations were also calculated to ascertain the relationships among each factor of the MSRI.

RESULTS

EFA of the MSRI (n =1,258)

In order to evaluate the factorial structure of the 36 items in the MSRI, EFA was used. Before EFA was conducted, we checked the assumptions (i.e., sample size, linearity, outliers, and factorability of the correlation matrix) of the EFA (Pallant, 2007). According to Comrey and Lee (1992), "the adequacy of sample size might be evaluated very roughly on the following scale: 50 – very poor; 100 – poor; 200 – fair; 300 – good; 500 – very good; 1000 or more – excellent" (p. 217). We determined that the assumption of linearity was not needed to control for the sample size of Study 1 (n= 1,258) because this sample size was sufficient (Pallant, 2007). Furthermore, in Study 1, we excluded 57 cases as outliers from the EFA. Bartlett's test of sphericity and the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy were used to evaluate the factorability of the correlation matrix. Findings indicated that Bartlett's test of sphericity was significant (x^2= 20310.569; *SD*= 528; p = .001) and the KMO value of .96 was considered superb by Kaiser's criteria (Field, 2005), therefore the data set was suitable for the EFA.

The principal component analysis performed with the MSRI data for 36 items indicated five factors with eigenvalues greater than one, and these five factors were rotated using the varimax procedure. According to acceptance criteria for factor intercorrelations in the literature (e.g., Stevens, 1996), the items with a factor loading less than or equal to .40 were discarded from the instrument; therefore, three items were eliminated from the MSRI, leaving 33 items. Factor intercorrelations ranged between .422 and .762. Altogether, these five factors explained 57.304% of the total variance of the 33 items. Factor 1 (eigenvalue =

Table 1. Factor loading, eigenvalue, descriptive statistics and Cronbach Alphas for the five-factor solution of the MSRI, and intercorrelations among factors

	Items	Factor					
		I	II	III	IV	V	Communality or Total Scale
IV1	Learning mathematics is enjoyable.	.743	.195	.173	-.197	.231	.722
IV2	If I see an article about math in a newspaper or magazine, I want to read it immediately.	.714	.202	.114	-.088	.115	.585
IV3	I am interested to learn new topics in mathematics.	.713	.229	.201	-.157	.223	.675
IV4	I look forward to mathematics lessons.	.745	.211	.156	-.178	.166	.683
IV5	Mathematics makes me a sensation.	.728	.225	.184	-.160	.233	.694
IV6	Working with numbers makes me feel glad.	.708	.138	.192	-.102	.199	.606
IV7	I take pleasure in solving mathematics problems.	.664	.180	.191	-.159	.307	.629
EUV1	Learning new skills in mathematics improves creative thinking ability.	.391	.497	.170	-.112	.242	.503
EUV2	Mathematics enhances individual intelligence.	.304	.567	.205	-.061	.242	.518
EUV3	Mathematics helps me to solve everyday problems.	.229	.726	.024	-.003	.083	.588
EUV4	Mathematics is worth the effort to learn because it helps me to get a job in whatever field I want.	.199	.551	.269	-.134	.219	.481
EUV5	I need mathematics in every step of my life.	.228	.674	.229	-.073	.168	.592
IMV1	I study hard in order to be a success in mathematics.	.286	.320	.422	-.105	.240	.435
IMV2	If I do not receive at least 85 out of 100 points, I feel disappointed in myself.	.313	.206	.458	-.140	.302	.461

IMV3	I would be unhappy to perform at the level of an average student in mathematics.	.250	.146	.565	-.007	.201	.443
IMV4	Getting high marks in mathematics exams is of top importance to me.	.120	.165	.762	-.074	.259	.694
IMV5	I want to be the most successful student in math class.	.178	.058	.747	-.040	.137	.614
IMV6	Understanding the solution of difficult mathematical problems is important to me.	.204	.279	.543	-.143	.310	.531
PC1	No matter how much I study, I cannot be successful in mathematics.	-.115	-.029	-.127	.731	-.254	.629
PC2	All the symbols of mathematics confuse me.	-.098	-.058	-.023	.729	-.136	.563
PC3	Mathematics is boring.	-.411	-.157	-.125	.658	-.076	.648
PC4	I feel helpless and nervous when I try to do my math homework.	-.211	-.090	-.051	.751	-.136	.637
PC5	I have a lower level of mathematical understanding than other friends in my class.	-.048	-.184	-.067	.738	-.002	.586
EB1	I am confident in calculating how much cheaper a book would be after a 40% discount.	.260	.066	.078	-.008	.561	.493
EB2	I am confident in calculating the arithmetic mean of marks I obtained from the mathematics exams.	.111	.104	.305	-.091	.640	.533
EB3	I am confident in converting a given length in meters to millimeters.	.139	.089	.105	-.100	.692	.527
EB4	I am confident in finding the unknown angle of a triangle.	.144	.089	.153	-.177	.736	.625
EB5	I am confident in finding the perimeter of a square or equilateral triangle when given an equilateral triangle with the same perimeter as the square.	.150	.091	.203	-.192	.733	.647
EB6	I am confident in calculating the surface area and volume of a prism.	.243	.125	.061	-.114	.633	.492
EB7	I am confident in describing which integer represents the depth of a scuba diver's dive.	.197	.151	.121	-.150	.681	.563
EB8	I am confident to solve an equation such as "5x + 3 =13, x=?"	.193	.154	.115	-.167	.715	.613
EB9	I am confident in determining what fraction of the day is spent at school.	.093	.137	.184	-.128	.628	.473
EB10	I am confident to show numbers such as 7, $\lvert -5 \rvert$, 0, 3 and 9 on number line.	.073	.168	.188	-.132	.671	.537
	Eigenvalue	4.848	2.595	2.867	3.052	5.548	
	% of variance explained	14.691	7.864	8.687	9.250	16.811	57.306
	Cronbach's α	.912	.773	.797	.825	.900	.877
	Mean	3.653	4.002	4.171	2.724	4.092	3.791
	Standard deviation	.965	.804	.717	1.111	.829	.529

F1, Interest value; F2, extrinsic utility value; F3, importance value; F4, personal cost; F5, expectancy beliefs

4.848; % of variance explained = 14.691), interest value (IV), included seven items. Factor 2 (eigenvalue = 2.595; % of variance explained = 7.864), extrinsic utility value (EUV) included five items. Factor 3 (eigenvalue = 2.867; % of variance explained = 8.687), importance value (IMV), included six items. Factor 4 (eigenvalue = 3.052 ; % of variance explained = 9.250), personal cost, included five items. Factor 5 (eigenvalue = 5.548; % of variance explained = 16.811), expectancy beliefs, included 10 items (see Table 1).

The item-total correlations with each item of the MSRI ranged from.377 to .773. Chronbach's alpha coefficient of the MSRI was .877 and Chronbach's alpha coefficients for the factors were range between .773 and .912. The analysis showed that the MSRI possessed sufficient internal consistency and reliability because all

Cronbach's alpha coefficients were above .70 and all item-total correlations were higher than .30 (Büyüköztürk, 2007).

CFA of the MSRI (n =1,283)

In order to assess the model fit of the MSRI, the ratio of chi-square to the degrees of freedom (χ^2/df), goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), comparative fit index (CFI), and root-mean-square error of approximation (RMSEA) were calculated (e.g., Kline, 2005). The goodness-of-fit indexes for the five-factor model were χ^2= 1639.24, d*f*= 481, p < .001, χ^2/d*f*= 3.407, RMSEA= .039, GFI= .92, AGFI= .91, CFI= .98. Although the ratios of chi-square to degrees of freedom were higher than expected, all other fit indices indicated a good fit. In order to improve the fit indices, we decided to modify items IV6 and IV7, EUV1 and EUV2, IMV2 and IMV3, and IMV4 and IMV5. Findings for the modified model showed an adequate-to-good fit (χ^2= 1424.55, d*f*= 477, χ^2/d*f*= 2.99, p= .001, RMSEA= .039, GFI= .93, AGFI= .92, CFI= .99). Because the values of GFI, AGFI and CFI were greater than .90, the value of RMSEA was smaller than .08 and the value of chi-square ratio was less than 3 (e.g., Byrne, 1989). Table 2 also shows the item-factor loading estimates (λ), t values, estimated error variances (SE), and variance explained ratio (R^2) of the MSRI. The t values of all items were significant. The item-factor loadings ranged between .54 and .83. According to Cohen's criteria, absolute values less than .10 may show a "small effect," while values around .30 show a "medium effect" and values above .50 shows a "large effect", (cited in Kline, 2005). All items' factor loading demonstrated a large effect size.

Convergent and discriminant validity

To assess convergent validity, the AVE, construct (composite) reliability, and item reliability were computed based on the Fornell and Larcker's (1981) formula. Acceptable item reliability value should be at least .50 with a significant *t*-value (Hulland, 1999). Table 2 shows that all item reliability values were above .50 with a

Table 2. CFA: Maximum likelihood estimates

Items	λ	t	SE	R²	Items	λ	t	SE	R²
IV1	.83	35.95	.31	.69	IMV6	.74	29.16	.45	.55
IV2	.71	28.72	.49	.51	PC1	.71	27.50	.49	.51
IV3	.80	34.05	.35	.65	PC2	.67	25.24	.56	.44
IV4	.80	33.71	.36	.64	PC3	.74	29.25	.45	.55
IV5	.81	34.40	.35	.65	PC4	.78	31.07	.39	.61
IV6	.70	27.80	.51	.49	PC5	.70	26.74	.51	.49
IV7	.77	32.12	.40	.60	EB1	.57	21.34	.68	.32
EUV1	.66	24.81	.56	.44	EB2	.68	26.84	.54	.46
EUV2	.69	26.36	.52	.48	EB3	.68	26.76	.54	.46
EUV3	.55	19.92	.70	.30	EB4	.77	31.59	.41	.59
EUV4	.67	25.44	.55	.45	EB5	.79	33.09	.37	.63
EUV5	.68	26.07	.54	.46	EB6	.66	25.60	.57	.43
IMV1	.69	26.66	.52	.48	EB7	.68	26.82	.54	.46
IMV2	.59	21.42	.66	.34	EB8	.69	27.37	.52	.48
IMV3	.55	19.74	.70	.30	EB9	.63	24.09	.61	.39
IMV4	.54	25.96	.54	.46	EB10	.68	26.69	.54	.46
IMV5	.58	21.01	.67	.33					

Table 3. Construct reliabilities, AVE and squared correlations, and correlations between factors

Factors	Construct reliability	AVE	IV	EUV	IMV	PC	EB
Interest value (IV)		.61	-	**.40**	**.38**	**.21**	**.30**
Extrinsic utility value (EUV)		.43	.63	-	**.38**	**.11**	**.28**
Importance value (IMV)		.42	.62	.62	-	**.13**	**.38**
Personal cost (PC)		.52	-.46	-.33	-.36	-	**.19**
Expectancy beliefs (EB)		.48	.55	.53	.62	-.44	-

significant *t*-value. All construct reliability values range from .74 to .79, were higher than the suggested value of .70 (e.g., Nunnally, 1978). Table 3 shows that AVE for expectancy beliefs, extrinsic utility value, and importance value were .48, .43, and .42 respectively, which is slightly lower than acceptable criteria for AVE. Although the AVE for each construct should be greater than .50 (Fornell & Larcker, 1981), an AVE of .40 or greater is considered acceptable in social sciences (Scherer, Wiebe, Luther, & Adams, 1988). Therefore the convergent validity has been provided. In addition to Fornell and Larcker's (1981) formula, the Pearson product-moment correlations were calculated between students' scores on MSRI and students' achievement scores from the LDE. Results indicated statistically significant, positive, and strong correlation between students' MSRI scores and students' achievement scores from the LDE (r= .504; p< .01). The results of the study support the researchers' hypothesis (e.g., Luttrell et. al., 2010) that students whose expectancy beliefs and task values in mathematics are higher are more likely to earn high scores on the math tests and complete more math classes in university. Thus, our results also provided support for the convergent validity. Fornell and Larcker (1981) proposed that the AVE for each construct is greater than the squared correlations with the other factors, which indicates adequate discriminant validity. The results in Table 3 show that the discriminant validity was also supported.

Subgroup validity

Subgroup validity is used to demonstrate hypothesized differences between groups' scores based on the scale or inventory based on the hypothesized direction (Hinkin, 1995). In this study, gender and grade level had been hypothesized to differentiate students on the MSRI. Group differences in gender and grade level were examined using independent *t*-test and ANOVA. The sample group was comprised of 648 girls and 635 boys. There were 393 sixth-graders, 458 seventh-graders and 432 eight-graders.

Past research on the gender-related differences in expectancy beliefs and task values in mathematics indicated that boys would demonstrate more positive views toward these psychological constructs than girls (e.g., Eccles et al., 1993; Wigfield et al., 1997), whereas current research (e.g., Chouinard et al., 2007; Luttrell et al., 2010) shows that expectancy beliefs and task values in mathematics are becoming more gender neutral. Therefore, it was predicted that differences between genders in students' expectancy beliefs and task values in mathematics would be either generally significant in favoring boys or not significant. Findings of independent *t*-test analysis indicated that there was not any significant difference between the MSRI scores of girls and boys ($\bar{x}_{\text{girl}} = 3,819$; $\bar{x}_{\text{boy}} = 3,811$; t = .321; p = .748), and this result is consistent with the findings of current studies.

Many of the studies' results (e.g., Eccles et. al., 1993) reveal that older children's expectancy beliefs and task values in mathematics are more negative than these beliefs in younger children. Therefore, it was predicted that differences in expectancy beliefs and task values in mathematics would be different in terms of grade level, favoring students at lower grade levels. The result of ANOVA indicated that there was a significant difference in students' MSRI mean scores compared with grade level ($F_{(2-1280)}$ = 32.581; p< .01), and the partial eta squared of .05 is defined by Cohen (1988) as a small impact (see Table 4). Thus, these results bear out the predictions.

Table 4. Students' MSRI mean scores and grade level one-way analysis of variance results

Grade	N	$\bar{X}$	SD		Sum of square	Df	Mean square	F	p
6	393	3.96	.51	W.G.	17.20	2	8.60	32.58	.001**
7	458	3.82	.49	B.G.	337.79	1280	.26		
8	432	3.67	.27	Total	354.99	1282			
Total	1283	3.79	.28						

**$p < .01$

DISCUSSION AND CONCLUSION

The purpose of the current study was to develop the MSRI, which measures elementary students' expectancy beliefs and task values in mathematics based on the Eccles et al. model of the expectancy-value theory of achievement motivation and also to investigate the psychometric properties of the MSRI for Turkish elementary students.

In order to provide the construct validity of the MSRI, EFA was performed with the first sample group, and then the second sample group was used to assess the factor structure of MSRI using CFA. After EFA of the MSRI, a five-factor structure with 33 items was found, accounting for 57.304% of the variance explained. The five factors were labeled interest value, extrinsic utility value, importance value, personal cost, and expectancy beliefs. CFA indicated that the five-factor structure of the MSRI demonstrated an adequate-to-good fit to the acceptance criteria. The findings of the EFA and CFA of the current study confirmed the results from the literature findings (Eccles et al., 1983; Eccles et al., 1993; Eccles & Wigfield, 1995): elementary students' expectancy beliefs and task values in mathematics comprised distinct factors. Earlier works on expectancy-value theory of achievement motivation (Eccles et al., 1983; Eccles et al., 1993; Eccles & Wigfield, 1995; Wigfield & Eccles, 1992) indicated that different factors of math values were empirically distinguishable and definable in both factor analyses, particularly in students in 5th grade and higher levels. Similar finding were found in this study, where math values which were consisted of four different components in the 6th grade and above.

To assure construct validity, further validation techniques such as convergent, discriminant, and subgroup validity were used in the study. The item reliability and construct reliability values for convergent validity were acceptable for all factors. The AVE for expectancy beliefs, extrinsic utility value and importance value were a little lower than the acceptable criteria. However, these values were adequate for social sciences studies. Results of the discriminant validity analysis satisfied the required criteria for all factors. ANOVA and t-test analysis results were in line with the predictions for gender and grade-level differences in students' expectancy beliefs and task values in mathematics and thus provided the subgroup validity. These results also supported construct validity. The internal consistency and reliability of the MSRI was computed by Chronbach's alpha coefficients. The results indicated that the MSRI and its each factor had a good internal consistency and reliability, and item reliability values of the MSRI were also considerably satisfactory.

The subgroup validity findings indicate that students' scores on MSRI were not significantly affected by gender. The result is line with the assertion that "mathematics is getting more gender neutral" (e.g., Chouinard et al., 2007; Luttrell et al., 2011), whereas the findings were inconsistent with idea that "mathematics is a male domain" (Eccles et al., 1983; Eccles et al., 1993; Greene et al., 1999). Earlier studies findings (e.g., Eccles et al., 1983; Rathbone, 1989) showed that girls' expectancy beliefs and task values in mathematics were significantly more negative than boys. The earlier view was that the jobs of mathematician, scientist, and engineer are more suitable for boys than girls, but now many girls study mathematics, engineering, and computer science, and this belief is losing its importance. As a consequence, our result was not astonishing for today's individuals and current research findings. Another subgroup validity finding was that students' scores on the MSRI were significantly influenced by grade level, favoring students at lower grade levels. This result was consistent with previous studies (Eccles et al., 1983; Eccles et al., 1993; Wigfield, 1984), revealing that older students' expectancy beliefs and task values in mathematics were more negative than the beliefs of the younger students. This result can be explained by researchers claims that students' expectancy beliefs and task values in mathematics become more realistic and accurate as they grow older (e.g., Wigfield & Eccles, 2000) and that younger children have optimistic expectancy beliefs and task values because they always believe that they can do well in all academic areas (Xiang et al., 2003).

As hypothesized, the finding showed that a significant, positive, and strong relationship existed between students' scores on the MSRI and students' achievement scores from the LDE, which is in line with claims that academic achievement and course participation are closely associated with students' beliefs such as expectancy beliefs or task values in mathematics (Chouinard et al., 2007; Luttrell et al., 2010; Wigfield & Eccles, 2000; Xiang et al., 2007).

In this study, the intercorrelations between students' expectancy beliefs and task values in mathematics ranged between -.33 and .63. The strongest relationships were observed between interest value and the four other factors of MSRI, with the most powerful relationship existing between interest value and extrinsic utility value. Students' interest value in mathematics is a key element for intrinsic motivation and mathematical beliefs (e.g., Hidi, 1990), and it is related to students' choices of mathematics courses, mathematical self-concept, mathematical self-efficacy, and mathematics achievement (e.g., Schiefele, 1991). An example of the association between interest value and extrinsic utility value is students who have a higher utility value might be more interested in mathematics courses because mathematics helps them get into engineering or sciences school. Previous studies' results (Hidi, 1990; Schiefele, 1991) also proposed that a student who has higher mathematics interest value might spend more time doing math tasks and exhibit greater mathematics performance than students with lower interest values.

The present study shows a strong and positive relationship observed between expectancy beliefs and task values (r= .46, p= .001) in the present study. This finding provides support for the contention of Eccles et al. (1983) and Wigfield (1994) that individuals are inclined to place more value on the mathematics activities which they felt they were good at. The findings also confirm that the strong and positive correlational relationships existed among interest value, extrinsic utility value, importance value, and expectancy beliefs; however, these factors negatively correlated to personal cost (e.g., Feather, 1988; Luttrell et al., 2010).

The findings show that, with a few exceptions, the MSRI is a reliable and valid psychological tool for use with Turkish elementary students and may be regarded as beneficial in guiding subsequent study goals and explaining students' achievement-related beliefs based on the expectancy-value theory of achievement motivation. Future studies should focus on examining the relationship among students' expectancy beliefs, task values in mathematics, mathematics achievement, course participation, etc., using structural models or multivariate analysis.

Implications of the study

Elementary students' mathematics expectancy beliefs and task values are needed to be assessed by mathematics teachers in cooperation with the school counseling and guidance services which assist them in the assessment and development of students' self-constructs about mathematics, and in that assessing students' self-constructs about mathematics can ensure mathamatics teachers with additional inner vision about their students' subsequent mathematics achievement (Schunk, 1991). Therefore, self-constructs (i.e. expectancy beliefs and task values about mathematics) assessment should be begun at primary school level because students' negative perceptions of self-constructs can be recognized and changed early (Pajares & Miller, 1994). For this purpose, the MSRI is developed for the teachers, school practitioners and researchers to examine mathematics expectancy beliefs and task values of elementary students based on the expectancy-value theory of achievement motivation. In educational/classroom practices, the mathematics teachers may give deep insight into elementary students' attitudes toward mathematics by using the MSRI. The MSRI can also be used to examine cultural, social and gender differences of different groups of students with regards to evaluating whether expectancy beliefs and task values indicate differences or not. The results of this study provide a better understanding of Turkish elementary students' mathematics expectancy beliefs and task values by developing the MSRI.

Limitations of the study

This study has several limitations. Students' self-constructs (i.e. elementary students' mathematics expectancy beliefs and task values) about mathematics are examined using the limited number of items in the mathematics self-report inventory (MSRI). Another limitation of the study is that this study is carried out in 10 public elementary schools on the southern coast of Turkey and it is also possible that the elementary students' expectancy beliefs and task value may differ from those in other regions.

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