Adapting Sources of Middle School Mathematics Self-Efficacy Scale to Turkish Culture

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Article Info	ABSTRACT
	The purpose of this study was to adapt the Sources of Middle School Mathematics Self-Efficacy Scale developed by Usher and Pajares to Turkish culture. This scale assesses Bandura's theorized sources of self-efficacy among mathematics students in middle school. After the Turkish version of the scale was formed, it was applied 6th, 7th and 8th grades 282 middle school students (157 girls and 125 boys). Results of Confirmatory Factor Analysis (CFA) showed good fit indeces; χ2/sd= 2.25, RMSEA= .06, CFI= .98, NNFI= .97 and SRMR= .05. These values indicated that the proposed four factor model was acceptable for this Turkish sampling. The reliability coefficient estimated by Cronbach alpha was found; mastery experience α= .86, vicarious experience α= .75, social persuasions α= .94, physiological state α= .91. Also the reliability coefficient estimated by split-half was found; mastery experience α= .81, vicarious experience α= .73, social persuasions α= .92, physiological state α= .89. Deciding on stability of the scale test-retest applied to 36 studens for 16 days interval. Results showed that mastery experience r= .67, vicarious experience r= .48, social persuasions r= .63, physiological state r= .41. These values indicated that this scale is a reliable instrument for Turkish sampling. In conlusion, Sources of Mathematics Self-Efficacy Scale is a valid and reliable instrument to meeasure sources of mathematics self-efficacy for middle school students in Turkish culture.

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1.   INTRODUCTION

Bandura's social cognitive theory [1] stated that if people believe they can produce desired outcomes they have more incentive to act. Although many researches attest to the predictive power of self-efficacy on academic achievement, there have been fewer efforts to investigate the sources underlying these self-beliefs [2]. Bandura A. [1] has drawn a distinction between the role of self-efficacy beliefs versus that of outcome expectations in influencing and predicting motivation and behavior. Self-efficacy beliefs and outcome expectations are often positively associated. The outcome expectations are generally dependent on their judgments of what they can accomplish. The relationship between self-efficacy and outcome expectations is not always consistent. For example, a student reasonably confident in his mathematics capabilities may choose not to take an advanced statistics course because the teacher's grading curve convinces him that getting the highest grade is unlikely. In the present study, we are concerned with the sources of self-efficacy beliefs.

Bandura [3] stated that self-efficacy beliefs are developed by individuals interpret information from four sources. First source, mastery experience, the most effective way of developing a strong sense of efficacy, include previous experience with on the task success have more confidence to complete similar

tasks (high self-efficacy) than those who do not (low self-efficacy). Indeed, successful performance in a domain can have lasting effects on one's self-efficacy. In addition to interpreting the results of their actions, students build their efficacy beliefs through the vicarious experience of observing others. Students compare themselves to particular individuals such as classmates, peers, and adults as they make judgments about their own academic capabilities. Individuals are also able to compare their current and past performances either cognitively or by recording and reviewing their performances. Third source of self-efficacy is social persuasions that students receive from others. Encouragement from parents, teachers, and peers whom students trust can boost students' confidence in their academic capabilities. Supportive messages can serve to bolster a student's effort and self-confidence, particularly when accompanied by conditions and instruction that help bring about success [3]. Finally, Bandura [3] hypothesized that self-efficacy beliefs are informed by emotional and physiological states such as anxiety, stress, fatigue and mood. Students learn to interpret their physiological arousal as an indicator of personal competence by evaluating their own performances under differing conditions. Strong emotional reactions to school-related tasks can provide cues to expected success or failure. High anxiety can undermine self-efficacy. A person who expects to fail at a task, or finds the task too demanding will experience a set of emotional cues: rapid heartbeat, blushing, sweating, headaches, etc. If these physiological cues are persistent and severe enough, they contribute to a sense of weak self-efficacy. It has been observed that that not reached consensus on how best to measure the sources of self-efficacy in academic settings. Most widely used scale was Sources of Mathematics Self-Efficacy Scale (SMES) developed by Lent, Lopez and Bieschke [4] to meausere sources of mathematics self-efficay of college syudents. This scale adapted for use in different context [5]-[8]. Also, Matsui, Matsui and Ohnishi [9] developed a scale to measure the sources of college students' mathematics self-efficacy. Hampton [10] developed the Sources of Academic Self-Efficacy scale.

Although the Sources of Mathematics Self-Efficacy scale is one of the most widely used instrument of explaining sources of self-efficacy beliefs, but there is no studies done on it to test four focatorial models for sources of mathematics self-afficacy. Moreover, results of international exams have shown that mathematics achievement of Turkish students has not been at the expected [11]. Self-efficacy belief effect a person's activity choosing, learning, goal orientations, achievement in various fields, learning, and effort and perseverance [12]. For that reasons, the purpose of the current study was to test four factor model for sources of self-efficacy in feild of mathematics [3],[4],[13]. In this study The Sources of Mathematics Self-Efficacy scale was adapted to Turkish culture via validity and reliability studies.

2. RESEARCH METHOD

Participants in this study were 282 students (157 girls, 125 boys) in Grade 6 (n = 122), Grade 7 (n = 70), and Grade 8 (n = 90) enrolled at a public middle school in city center of Adıyaman. According Büyüköztürk [14], and Kline [15] number of the participants is enough for Confirmatory Factor Analysis.

In this study, The Sources of Middle School Mathematics Self-Efficacy Scale [13], and for criterian validity Academic Self-efficacy Scale developed by Jinks and Morgan [16] and adapted to Turkish by Öncü [17] was used.

The Sources of Mathematics Self-Efficacy Scale: This scale devveloped by Usher and Pajares [13] to measure middle school students' four sources of mathematics self-efficacy beliefs. The purpose of this study was to adapt this scale to Turkish culture. There were 24 items on a 7-point Likert-type scale in the original scale. The scale items were ranking from 1 "completely disagree" to 7 "completely agree". In the scale seven negative items 3, 19, 20, 21, 22, 23, 24 are reversed scored. The scale consists of four subscales which were 6 items for mastery experience, 6 items for vicarious experience, 6 items for social persuasions and 6 items for physiological state. For each subscales the maximum score was 42 and minimum score was 6.

To decide about the criterion validity of the scale, scores of academic self-efficacy, ability, context, and educational quality of areas such as self-concept, math skills self-efficacy, math courses self-efficacy, self-regulatory self-efficacy, task-goals and Semester GPA were taken into consideration. The correlational values of those selected scores and four factors in the SMSMSEC ranged between .88 and -.65. The internal consistency of the original scale was tested via Cronbach alpha. The alpha values for four factors in the scale ranged between, .84 and .88 [13].

The Sources of Mathematics Self-Efficacy Scale translated by four researchers who native Turkish speaker and also fluent in English, and one translator. The translated versions were analyzed and writen the final version of translated scale. This last version was asked to five researchers to evaluate items linguistic fitnees to orginal scale and for their suggestions. This form of scale is applied to 20 students and asked them what they understand from items. After getting feedback from students, some items were clarified and rewritten.

Academic Self-Efficacy Scale: This instrument developed by Jinks and Morgan [16] and adapted to Turkish culture by Öncü [17] to obtain information about self-efficacy beliefs that influence students' success in threelevel; ability, environment and quality of education. EFA results showed that ability explained %23, environment explained %13 and quality of education explained%7 of total variances of %43. DFA results showed that the adjustment index was found as χ2/sd=4.28, RMSA= .09, CFl=.90 and SRMR=.07. In reliability studies Cronbach alpha was found that ability subscale α=.86,   environment subscale α=.71, equality of education subscale α=.71and total scores of scale academic self afficacy α=.81. In conclusion, findings of reliability and validity studies showed that the academic self-efficacy scale which is consist of 21 items that adapted to Turkish can be used by researchers.

3.   RESULTS AND ANALYSIS
3.1. Valididty Studies for the Sources of Mathematics Self-Efficacy Scale

As seen in Table 1, item factor correlation observed between r=.62 and r=.86 for mastery experience, between r=.65 and r=.72 for vicarious experience, between r=.83 and r=.91 for social persuasions and between r=.74 and r=.87 for phsilogical states. Item factor correlations were found significant in all factor and items.

Table 1. Item-Factor Scores Correlation Analysis (n=282)

Items	Mastery Experience (ME)	Vicarious Experience (VE)	Social Persuasions (SP)	Physiological State (PS)
ME1 (Item1)	.86**			
ME2 (Item2)	.85**			
ME3 (Item3)	.62**			
ME4 (Item4)	.79**			
ME5 (Item5)	.75**			
ME6 (Item6)	.76**			
VE1 (Item7)		.65**		
VE2 (Item8)		.67**		
VE3 (Item9)		.65**		
VE4 (Item10)		.66**		
VE5 (Item11)		.72**		
VE6 (Item12)		.67**		
SP1 (Item13)			.83**	
SP2 (Item14)			.91**	
SP3 (Item15)			.89**	
SP4 (Item16)			.88**	
SP5 (Item17)			.87**	
SP6 (Item18)			.84**	
PS1 (Item19)				.74**
PS2 (Item20)				.83**
PS3 (Item21)				.87**
PS4 (Item22)				.85**
PS5 (Item23)				.86**
PS6 (Item24)				.85**

** = p<.001.

As seen in Table 2, Usher and Pajares's [13] four factor of Sources of Middle School Mathematics Self-Efficacy Scale provided the best fit to the data (χ2/df= 2.5, CFI= .98, NNFI= .97, SRMR= .05, RMSEA = .06). The path diagram of Sources of Middle School Mathematics Self-Efficacy Scale was indicated in Figure 1.

Table 2 Fit Indexes of Sources of Middle School Mathematics Self-Efficacy Scale

Goodness fit indeces	Values
X^2/sd	2.25
CFI	.98
NNFI	.97
SRMR	.05
RMSEA	.06

Brown [18] suggested to report goodness fit indeces as Ki-kare, RMSEA, SRMR, CFI and NFI. Also Usher ve Pajares [13] used RMSEA, SRMR, CFI indexes to decide on goodness fit indexes for Sources of Middle School Mathematics Self-Efficacy Scale in scale development process. For that reasons in this study X^2/sd, RMSEA, SRMR, CFI values were reported in this study. CFA results showed that the proposed four factor model for Sources of Middle School Mathematics Self-Efficacy Scale was acceptable for this Turkish sampling. These values showed that good fit indexes [19],[15],[20]. Figure 1 shows factor structure and estimated parameters for the Sources of Mathematics Self-Efficacy Scale.
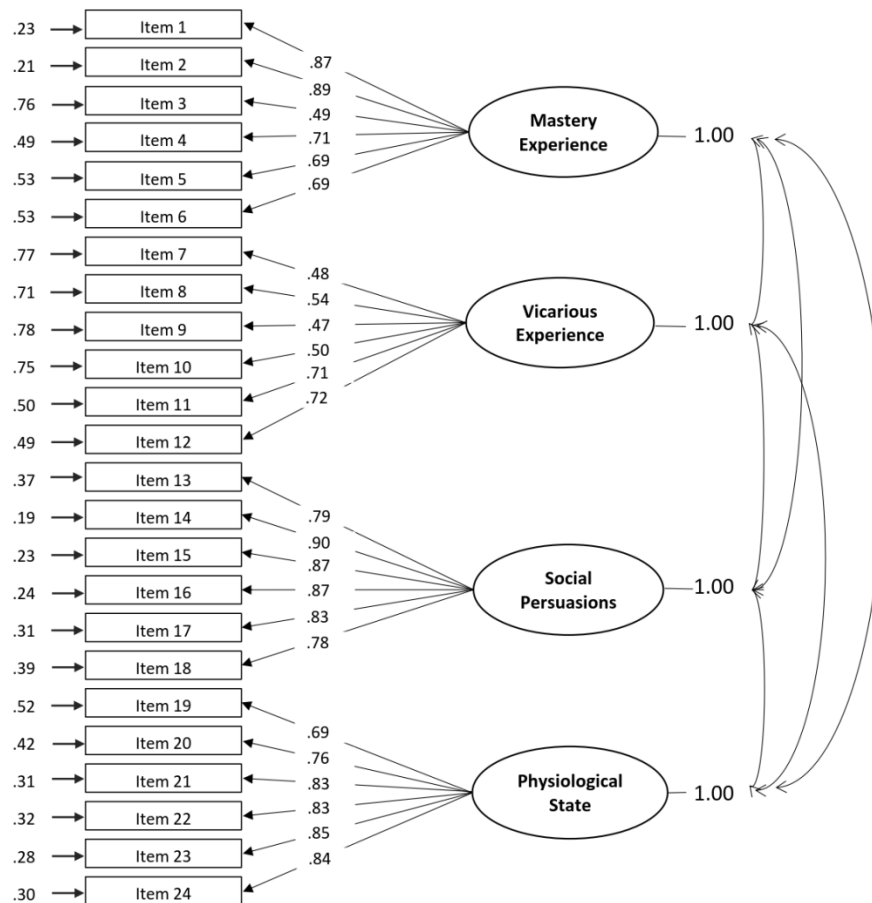

Figure 1 Factor structure and estimated parameters for the Sources of Mathematics Self-Efficacy Scale
(Chi-Square= 552.79, df=246, P-value= .000, RMSEA= .067)

To provide additional information for the validity of the Sources of Mathematics Self-Efficacy Scale, correlational analyses were conducted to test the correlations between sources of mathematics self afficacy and subscales of acedemic self efficacy that measured by Children' Percevied Academic Self-Efficacy, and mathematics achievement. As seen Table 3, mastery experience, vicarious experience, socail persuasion and physiological state was correlated pozitively with mathematics achievement (respectively; r= .66, r= .40, r= .55 and r= .28, p< .01). Also, mastery experience, vicarious experience, socail persuasion and physiological state was correlated positivelywith ability (respectively; r= .63, r= .46, r= .66 and r= .34, p< .01). Thirdly, mastery experience, vicarious experience, socail persuasion and physiological state was correlated positively with environment (respectively; r= .28, r= .20, r=.17 and r=.50, p< .01). Lastly, mastery experience, vicarious experience and socail persuasion was correlated positively with quality of education (respectively; r= .24, r= .29, and r= .25 p< .01).

Table 3 Correaltions for Sources of Mathematics Self-Efficacy, Acedemic Self Efficacy
and Mathematics Achievement (n=282)

Scale and subscales	Mastery Experience	Vicarious Experience	Social Persuasions	Physiological State
Mathematics achievement	.66**	.40**	.55**	.28**
Academic self-efficacy				
Ability	.63**	.46**	.66**	.34**
Environment	.28**	.20**	.17**	.50**
Quality of education	.24**	.29**	.25**	.07

** p<.01

3.2. Reliability Studies for the Sources of Mathematics Self-Efficacy Scale

The reliability coefficient calculated by Cronbach alpha were; α=.86 for mastery experience, α=.75 for vicarious experience, α=.94 for social persuasions, and α=.91for physiological state. Also reliability coefficient estimated by Spearman Brown were α=.81 for mastery experience, α=.73 for vicarious experience, α=.92 for social persuasions, and α=.89 for physiological state (Table 4).

Table 4. Reliability Analysis Results for Sources of Middle School
Mathematics Self-Efficacy Scale

Sources of mathematics self-efficacy	Cronbach's Alpha (n=282)	Spearman-Brown (n=282)	Test-retest coralations (n=36)
Mastery experience	.86	.81**	.67**
Vicarious experience	.75	.73**	.48**
Social persuasions	.94	.92**	.63**
Physiological state	.91	.89**	.41*

*** p<.01, * p<.05; Test-retest corelation calculated for 16 days.*

To decide on stability of scale, test-retest reliability was calculated on 36 studens and for 16 days interval by using Pearson's product–moment correlation. The coefficient values were r= .67 for mastery experience, r= .48 for vicarious experience, r= .63 for social persuasions, and r= .41 for physiological state (see Table 4). These results showed that that this instrument is a reliable scale for Turkish sampling.

4. DISCUSSION

This study examined the psychometric properties of the Sources of Mathematics Self-Efficacy Scale that is one of the most widely used instruments for the assessment of students' sources of self-efficacy biliefs [3],[13] in a middle school Turkish sample. The results of CFA for testing Usher and Pajares' [13] four factor model of sources of mathematics self efficacy provided the good fit to the data.

Usher and Pajares [13] four-factor model had good fit indices, the results of CFA supported to four model of sources of mathematics self-efficacy (see Table 2). Usher and Pajares' model tested on six group with CFI=95, SRMR= .04-.06, RMSEA= .04 fit indices, they concluded that four facor model for sources of mathematixcs self–efficcay good fit on six groups. The current study used a normal group of middl school students and not middle school students grouped acording to some quality. In this study Sources of Mathematics Self-Efficacy Scale studied on general group had good fit indices and supported to the results of Usher and Pajares [13]. In conclusion, this instrument can be used to measure middle school students' sources of self-efficacy by researhers.

Convergent validity was supported by the strong correlation between the sources of self efficacy and self-efficacy, and mathematics achievement (see Table 3). In fact, each source was related ability, environment, quality of education and mathematics achievement except quality of education did not related physiological state.

On the basis of Usher and Pajares' [13] correlational evidence between self-efficacy and achievement was showed strong correlations with mastery experience, vicarious experience, social persuasions and physiological state. Similar expected results were found within the current study that mathematics achievement was pozitively correlated with mastery experience, vicarious experience, socail persuasion and physiological state with, ability was pozitively correlated with mastery experience, vicarious experience, socail persuasion and physiological state, environment was positively correlated with mastery experience, vicarious experience, social persuasion and physiological state, and quality of education was positively correlated with mastery experience, vicarious experience and social persuasion.

      Reliability analyses with Cronbach alpha and Spearman Brown indicated that both results related to the reliability were high. The Cronbach alpha coefficient was above α=.85 except mastery experience (α=.75). Also, Spearman Brown reliability coefficient was above α=.81 except mastery experience (α=.73; see Table 4). Usher and Pajares [13] found that Cronbach alpha values for four factors in the scale ranged between .84 and .88 [13]. In the current study only mastery experience' a cronbach alpha value is below and other sources are above results of Usher and Pajares [13]. Test-retest reliability in a 16 day interval was also satisfactory with strong correlations between measurements suggested that that the temporal stability of the Sources of Mathematics Self-Efficacy Scale was good. The coefficient values were ranged beetwen r= .41 and r= .67. These results showed that this instrument is a reliable scale for Turkish sampling.

5. CONCLUSION

      In conclusion, Sources of Mathematics Self-Efficacy Scale is a reliable and valid instrument to assess the sources of mathematics self-efficacyf in middle school students. Sources of Mathematics Self-Efficacy Scale can be used to assess the sources of mathematics self-efficacy in four dimensions; mastery experience, vicarious experience, socail persuasion and physiological state. It can be used by researchers to understand middle school students' mathematics' self-efficacy beliefs and mathematics achievement.

REFERENCES

[1] Bandura A., "Social Foundations of Thought and Action: A Social Cognitive Theory," Englewood Cliffs, NJ, Prentice-Hall, 1986.
[2] Pajares F. and Urdan T., "Adolescence and education, Self-efficacy beliefs of adolescents," Greenwich, CT, Information Age Publishing, vol. 5, 2006.
[3] Bandura A., "Self-efficacy: The Exercise of Control," New York: Freeman, 1997.
[4] Lent R. W., *et al.*, "Mathematics self-efficacy: Sources and relation to science-based career choice," *Journal of Counseling Psychology*, vol/issue: 38(4), pp. 424-430, 1991.
[5] Anderson S. L. and Betz N. E., "Sources of social self-efficacy expectations: Their measurement and relation to career development," *Journal of Vocational Behavior,* vol/issue: 58(1), pp. 98-117, 2001.
[6] Britner S. L. and Pajares F., "Sources of science self-efficacy beliefs of middle school students," *Journal of Research in Science Teaching*, vol/issue: 43(5), pp. 485-499, 2006.
[7] Smith S. M., "The four sources of influence on computer self-efficacy," Delta Pi Epsilon, vol/issue: 43(1), pp. 27-39, 2001.
[8] Usher E. L. and Pajares F., "Inviting confidence in school: Invitations as a critical source of the academic self-efficacy beliefs of entering middle school students," *Journal of Invitational Theory and Practice,* vol. 12, pp. 7-16, 2006.
[9] Matsui T., *et al.*, "Mechanisms underlying math selfefficacy learning of college students," *Journal of Vocational Behavior*, vol/issue: 37(2), pp. 225-238, 1990.
[10] Hampton N. Z., "Sources of academic self-efficacy scale: An assessment tool for rehabilitation counsellors," *Rehabilitation Counseling Bulletin,* vol/issue: 44(1), pp. 260-277, 1998.
[11] National Ministry of Education, "PISA 2012 ulusal ön raporu," Ankara, MEB, 2013.
[12] Bandura A., "Self-efficacy: The foundation of agency," in W. J. Perrig and A. Grob, "Control of human behaviour, mental processes and consciousness," Mahwak, NJ, Erlbaum, pp. 17-33, 2000.
[13] Usher E. L. and Pajares F., "Sources of self-efficacy in mathematics: A validation study," *Contemporary Educational Psychology,* vol/issue: 34(1), pp. 89-101, 2009.
[14] Çokluk Ö., *et al.*, "Sosyal bilimler için çok değişkenli istatistik: SPSS ve LISREL uygulamaları," Ankara, Pegem Akademi, 2016.
[15] Kline R. B., "Principles and practice of structural equation modelling," New York, Guilford Press, 2010.
[16] Jinks J. and Morgan V., "Children's perceived academic self-efficacy: An inventory scale," *The Clearing House,* vol/issue: 72(4), pp. 224-230, 1999.
[17] Öncü H., "Akademik Özyeterlik Ölçeğinin Türkçe'ye Uyarlanması," *Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi Dergisi*, vol/issue: 13(1), pp. 183-206, 2012.
[18] Brown T. A., "Confirmatory factor analysis for applied research," New York, The Guilford Press, 2006.
[19] Hu L. and Bentler P. M., "Cutoff criteria for fit indices in covariance structure analysis: Conventional versus new alternatives," *Structural Equation Modeling: A Multidisciplinary Journal,* vol/issue: 6(1), pp. 1-55, 1999.
[20] Raykov T. and Marcoulides G. A., "On multilevel model reliability estimation from the perspective of structural equation modeling," *Structural Equation Modeling: A Multidisciplinary Journal*, vol/issue: 13(1), pp. 130-141, 2006.

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