ARAŞTIRMA Açık Erişim

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Turkish Adaptation of Mathematics Achievement Emotions Questionnaire (AEQ-M): Reliability and Validity Study[1]

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Öz. Bu çalışmanın amacı, Matematik Başarı Duyguları Ölçeği'ni (BDÖ-M) Türkçe'ye çevirmek ve ölçeğin psikometrik özellikleri hakkında kanıt ortaya koymaktır. Ölçek önce Türkçe'ye, ardından İngilizce'ye geri çevrilmiştir. Ölçeğe son şeklini vermeden önce üç ortaokul öğrencisi ile bilişsel görüşme yapılmış ve iki alan uzmanından görüş alınmıştır. Çalışma grubunu, Ankara'da devlet ortaokullarında öğrenim görmekte olan altıncı, yedinci ve sekizinci sınıf öğrencileri oluşturmaktadır. Ölçek sırasıyla 746 ve 2250 kişiden oluşan iki ayrı çalışma grubuna uygulanmıştır. Doğrulayıcı Faktör Analizi, BDÖ-M'nin orijinal modele uygun olarak yedi ayrı duygu boyutunu ölçtüğünü göstermiştir. Ek olarak birinci çalışma grubu için her bir duygu boyutunun test kaygısı ile ilişkisi incelenmiştir. Sınav kaygısı ile BDÖ-M ölçeğindeki negatif duygular (öfke, kaygı, umutsuzluk, bıkkınlık, ve utanç) arasında pozitif anlamlı bir ilişki bulunmuştur. Her bir duygu boyutunun güvenirliği hakkında bilgi sağlamak için ise Cronbach alfa katsayıları incelenmiş ve değerlerin .82 ve .93 arasında değiştiği görülmüştür. Sonuç olarak, Türkçe'ye uyarlaması yapılan BDÖ-M'nin ortaokul öğrencilerinin matematik başarı duygularını ölçmede geçerli ve güvenilir bir ölçek olduğu söylenebilir.

Anahtar Kelimeler. Başarı duyguları, denetim(kontrol)-değer kuramı, matematik eğitimi, geçerlik, güvenirlik

Abstract. This study aimed to adapt Mathematics Achievement Emotions Questionnaire (AEQ-M) to Turkish language and provide evidence for the psychometric characteristics of the instrument. The scale was first translated to the Turkish and back translated to the English. Before finalizing the instrument, cognitive interviews were done with three middle school students and expert opinions were obtained from two experts in the field. Participants were sixth, seventh, and eighth grade middle school students in Ankara, Turkey. The scale was administered first to 746 and then to 2250 students, in Study 1 and 2 respectively. Confirmatory factor analysis suggested the seven-factor emotion model consistent with the original model. Besides, the relationships between each emotion and test anxiety were examined in Study 1 as further validity evidence. Positive and significant relationship appeared with negative emotions (i.e., anxiety, anger, shame, hopelessness, and boredom) of the AEQ-M. Cronbach alpha coefficients were high and ranged from .82 to .93. Overall, the Turkish adaptation of AEQ-M yielded valid and reliable scores to assess different mathematics achievement emotions of middle school students.

Keywords. Achievement emotions, control-value theory, mathematics education, validity, reliability

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Affect as a general term addresses many constructs such as feelings, emotions, and moods (Boekaerts, 2007) and is contended to be the predictors of a variety of learning outcomes and the academic success of students in different subject domains. In this regard, mathematics is portrayed to be highly influenced by many affective variables due to its abstract nature (Kleine, Goetz, Pekrun, & Hall, 2005). Among these affective variables, emotions or feeling states of people are described to be more intense and unstable compared to beliefs and attitudes in mathematics education.

Particularly, emotions are defined as "multi-component, coordinated processes of psychological subsystems including affective, cognitive, motivational, expressive, and peripheral physiological processes" (Pekrun, 2006, p.316). Besides, emotions are highly related to metacognitive learning strategies (King & Areepattamannil, 2014; Op't Eynde, 2004), self-regulated learning (Pekrun, Goetz, Frenzel, Barchfeld, & Perry, 2011; Villavicencio & Bernardo; 2016) and academic achievement (Goetz, Pekrun, Hall, & Haag; 2006; Pekrun, Elliot, & Maier, 2009; Pekrun, Hall, Goetz, & Perry, 2014; Villavicencio & Bernardo; 2016). However, they cannot be studied by traditional methods in education because of methodological problems, ethical reasons, and their unstable nature (Schutz & De Cuir, 2002). Indeed, a variety of emotions are experienced by people on different academic settings. For example, a student might be anxious before entering a difficult examination, but he/she might be proud of himself/herself if he/she gets a high score in this exam. However, he/she might be hopeless if he/she does not get the desired score. Furthermore, a student might be highly interested in a science course, so he/she might enjoy during a laboratory session, yet he/she might get bored while doing homework. Such differences confirm the fact that people experience a variety of emotions during their academic lives.

Taken the multiplicity of emotions in consideration, achievement emotions are defined as "emotions that are tied directly to achievement activities or achievement outcomes" (Pekrun, 2006, p.317). Coming from Pekrun (2006)'s control value-theory, this definition, calls for studies examining the role of emotions on academic learning and achievement of students. Indeed, there is no agreement on the number of basic emotions. Yet test anxiety has been studied for a long period of time (Zeidner, 2007). Regarding the subject domain, mathematics anxiety has been extensively studied in the literature as well (i.e.,

Baloğlu & Koçak; 2006; Birgin, Baloğlu, Çatlıoğlu & Gürbüz; 2010; Dede & Dursun; 2008; Goetz, Bieg, Lüdtke, Pekrun, & Hall, 2013; Keshavarzi & Ahmedi, 2013; Ma, 1999; Yüksel-Şahin; 2008; Wigfield & Meece, 1988). However, anger, frustration, confusion, boredom, shame, hopelessness, enjoyment, hope, relief, pride are some other examples of emotions which are neglected for a period of time although they are viewed substantially important for behaviour and academic success of students (Frenzel, Thrash, Pekrun, & Goetz, 2007a; Goetz, Frenzel, Pekrun, Hall, & Ludtke, 2007; Spangler, Pekrun, Kramer, & Hofmann, 2002; Mega, Ronconi,& De Beni, 2014; Valiente, Swanson, & Eisenberg, 2012).

Theoretical Background of Achievement Emotions

Pekrun (2006) presents a three-dimensional taxonomy while explaining the structure of emotions. In this taxonomy, valence (positive and negative), activation degree (activating and deactivating), and object focus (activity and outcome emotions) are three dimensions of achievement emotions. Accordingly, emotions are considered as bipolar; that is, classified as positive or negative according to valence dimension. For instance, enjoyment, pride, hope, and relief are some examples of positive emotions; while anger, anxiety, shame, hopelessness, and boredom are the examples of negative emotions. However, activation degree refers the multipolar nature of emotions. Enjoyment, hope, pride, joy, and gratitude might be classified as positive activating, whereas relaxation, relief, and contentment are positive deactivating emotions. On the other hand, anger, anxiety, shame, and frustration are classified as negative activating, while boredom, hopelessness, disappointment, and sadness are negative deactivating emotions (Pekrun, Goetz, Titz & Perry, 2002). In this sense, positive activating emotions help learners to manage their learning process, while positive deactivating emotions play as an indicator to take a break during learning process. On the other hand, students try to overcome with the problems or keep themselves from the failure with the help of negative activating emotions whereas negative sense and feelings about their abilities might be developed because of the experience of negative deactivating emotions (Chiang & Liu, 2014).

Except the valence dimension and activation degree, object focus is another dimension for the three-dimensional taxonomy of emotions. According to

object focus, emotions might be classified as "activity emotions" or "outcome emotions." For activity emotions, if the on-going achievement activities are perceived to be controllable and positively valued, enjoyment might arise but if they are negatively valued, anger might be experienced. However, if the on-going activities are valued but there is a shortfall on the perceived control over the activities, frustration might appear (Pekrun, 2006; Pekrun, Frenzel, Goetz, & Perry, 2007). Outcome emotions, which focus on the outcomes of activities, are classified as prospective and retrospective emotions. In this category, time is taken as a reference point. If a possible success or the failure is expected on an activity, the emotions will be called as prospective emotions. More specifically, if the level of the control over the activities is high and the focus is on the success, anticipatory joy is sensed. Yet, when students try to avoid themselves from the failure with a high level of control, relief is experienced. Furthermore, if the partial control exists regarding the focus on success or failure, hope or anxiety might appear. Hopelessness is also inevitable under the possibility of the failure (Pekrun, 2006; Pekrun et al., 2007). Retrospective emotions, on the other hand, are experienced shortly after potential success and failure states. The causes of the outcomes that might be because of the self, others, or external situations are also considered for such emotions. To illustrate this, pride and shame might arouse due to the attribution of the success or the failure to the self, while anger and gratitude might be expressed due to the attribution of the abovementioned acts to others (Pekrun, 2006; Pekrun et al., 2007).

Measurement of Achievement Emotions

The original version of Achievement Emotions Questionnaire (AEQ) was constructed by Pekrun et al. (2011) based on the control-value theory to measure students' distinct achievement emotions for different age groups. Enjoyment, hope, pride, relief, anger, anxiety, hopelessness, shame, and boredom were selected emotions to be included in the scale. There are three sections in AEQ regarding three different academic settings: class-related (80 items), learning-related (75 items) and test-related (77 items) emotions. Within each section, there are also three parts as before, during, and after which address the emotions in the related sections. Although the instrument measures trait-like emotions, state or course-specific emotions of students might be also assessed if the instructions were adapted in this respect (Pekrun et al., 2011). During the validation process, several models (i.e., one-emotion factor model, eight emotions-factors model,

three settings-factors model and emotion x setting factors model) were tested. According to the confirmatory factor analysis results, emotion x setting factors model was seen to fit better than the other models when the modification indices were compared. Besides, the reliability estimates of the instrument did not fall below .75.

As control-value theory suggested, emotions are deemed as domain-specific (Goetz, et al., 2007; Goetz, Frenzel, Hall, & Pekrun, 2008). Therefore, many studies focused on the domain specificity of emotions in different academic domains (Goetz et al., 2006; Frenzel et al., 2007a; Goetz, Cronjaeger, Frenzel, Lüdtke, & Hall, 2010). In this regard, AEQ was also adapted to measure students' achievement emotions on specific subject domains like mathematics (AEQ-M; Pekrun, Goetz, & Frenzel, 2005). The present study aims to adapt the Achievement Emotion Questionnaire – Mathematics (AEQ-M) to Turkish language and provide evidence regarding the psychometric characteristics of this instrument.

METHOD

Participants

Two different samples of middle school students were used in this study. Cluster sampling as a probabilistic sampling strategy was applied in both. In Study 1, three public middle schools were initially chosen in a central district of a big city in Turkey. The questionnaire was administered to totally 746 middle school students. Among the students, 18.2% was from the sixth graders (n= 136), 37% were from the seventh graders (n = 276), and 44.8% were from the eighth graders (n = 334). Furthermore, 52.1% of the participants were female (n = 389) and 47.5% were male (n = 354). Three students did not mention their gender.

In Study 2, fourteen schools were selected from four central districts of the same city in Turkey. Among the selected schools, 2,250 middle school students from sixth, seventh, and eighth grades took part in the study. Regarding the grade levels, 690 students were from the sixth (30.7%), 772 students were from the seventh (34.3%), and 784 of them were from the eighth grade (34.8%). Four students did not indicate their grades. Besides, 51.7% of the participants were

female (*n* = 1,164) and 48.2% were male (*n* = 1,085). One student did not provide gender information.

Adaptation Process of AEQ-M

As a multidimensional self-report instrument, AEQ-M is accessible in German, Chinese, and English languages (Pekrun et al., 2005). Besides, sub-scales of this instrument have been extensively used to measure students' mathematics achievement emotions across different grade levels (e.g., Frenzel, Goetz, Lüdtke, Pekrun, & Sutton, 2009; Frenzel, Pekrun, & Goetz, 2007b, 2007c; Frenzel, et al., 2007a; Goetz et al., 2010; Villavicencio & Bernardo; 2013a, 2013b, 2016). The instrument includes 60 items on a five-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5). The questionnaire assesses seven different emotions in mathematics: *enjoyment* (10 items; e.g., "I am happy that I understand the material."), *pride* (6 items; e.g., "After a math test, I am proud of myself."), *anger* (9 items; e.g. "I get angry because my math homework occupies so much of my time."), *anxiety* (15 items; e.g., "I start sweating because I am worried I cannot complete my assignments in time."), *shame* (8 items; e.g., "I am ashamed that I cannot answer my math teacher's questions well."), *hopelessness* (6 items; e.g., "During the math test, I feel hopeless."), and *boredom* (6 items; e.g., "I'm so bored that I don't feel like studying anymore.") (Pekrun et al., 2005).

AEQ-M consists of three sections, which are class-related emotions (18 items), learning-related emotions (19 items), and test- or exam-related emotions (23 items). Those sections focus on the emotional experiences of students while attending class, studying and doing homework, and taking tests or exams, respectively. There are also three parts within each section that assess emotions of students regarding particular time intervals such as before, during, and after. During part refers the activity emotions corresponding to the related section, before represents the prospective outcome emotions, and after part is about the retrospective outcome emotions.

Within the scope of the current study, AEQ-M was translated to Turkish language by the first author and three bilingual translators. Afterwards, the back translation was done by three different translators, as well. In the end, two versions were reviewed to ascertain if the content of the items matched the original questionnaire. During the translation process, the method of

decentering was used to provide equivalence. Then, expert opinion was taken from two experts in the field of guidance and psychological counselling and one expert in the field of measurement and evaluation to provide evidence for face validity. Before finalizing the instrument, cognitive interviews were done with three students from sixth, seventh, and eighth grades to identify the items that may cause possible response errors. Students also commented on the format and the design of the instrument. Accordingly, there was no problematic item in terms of the length or cultural sensitivity. However, five items including the word of "material" made confusion since this word has two meanings in English. It might be the subject or the related documents, textbooks, the worksheets, and manipulatives used in the lesson. In order to clarify those items, experts in different fields (e.g., curriculum and instruction, educational psychology) were consulted. Finally, it was agreed that the "subject" meaning should be considered in translation.

Data Analysis

The factorial structure of the Turkish AEQ-M was examined with Analysis of Moment Structures (AMOS 20; Arbuckle, 2011). Model selection was based on research on AEQ in different countries. Four models were planned to be tested in both studies: one emotion-factor model (1A), two-factor (correlated) model including positive and negative emotions (1B), three-settings factor model consisting of class-related, learning-related and test-related emotions (1C), and seven emotion-factors model with enjoyment, pride, anxiety, anger, boredom, hopelessness, and shame (1D) (See Figure 1). As chi-square statistics is highly sensitive to sample size (Kline, 2011), other goodness of fit indices (i.e., Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), Non-Normed Fit Index (NNFI), and Standard Root Mean Square Residual (SRMR) were used to evaluate model fit. According to Hu and Bentler (1999), values of CFI and NNFI should be greater than .95 for a good model fit and as low as .90 for a moderate model fit. On the other side, the rule of thumb for RMSEA for a good model fit is the value less than .05 and .08; while, values between .05 and .08 indicate mediocre model fit (Browne & Cudeck, 1993). The values for SRMR should be less than .08 for a good model fit (Hu & Bentler, 1999).
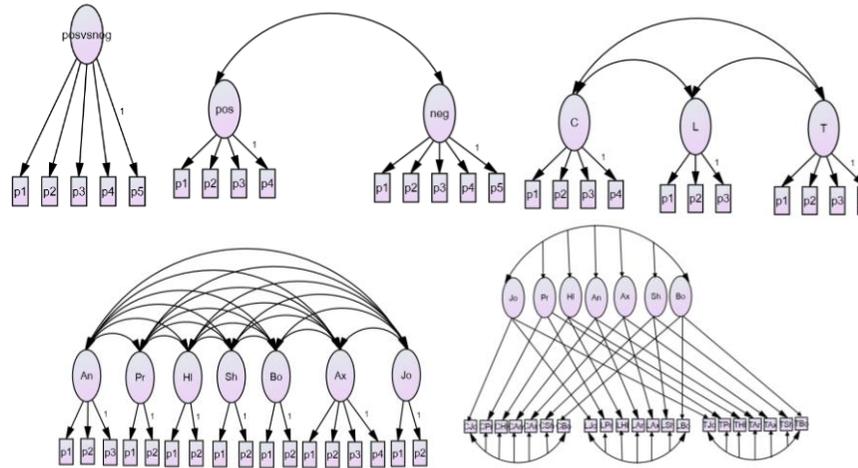
Figure 1. CFA models for mathematics achievement emotions questionnaire. Upper left part: Model 1A (one emotion-factor model), Upper middle part: Model 1B (positive vs negative emotions-factor model), and Upper left part: Model 1C (three settings model). Lower left part: Model 1D (seven emotions-factor model) and Lower right part: Model 1E (emotions x settings model). p represents parcel, pos = positive, neg = negative, Jo = enjoyment, Pr = pride, Hl = hopelessness, An = anger, Ax = anxiety, Sh = shame, Bo = boredom. C., L., and T denote class-related, learning-related, and test-related emotions, respectively. In Model 1E, parcelling cannot be used.

Before conducting CFA, the assumptions of sample size, normality, linearity, and absence of outliers were evaluated for both datasets (Tabachnick & Fidell, 2013). The sample size assumption was met, as the number of participants in both samples was more than ten times of the number of items in the scale (Hair, Black, Babin, & Anderson, 2010). In Sample 1, there was no standardized score above or below the critical point of 3.29 as a univariate outlier (Tabachnick & Fidell, 2013) except one case and this case was excluded from the sample. Besides, multivariate outliers were examined through Mahalanobis Distance (D^2). Accordingly, in Sample 1, twenty cases out of 745 participants showed evidence of being a multivariate outlier toward the critical value of 99.607 (107.38, df = 60, p = .001). These cases were excluded, producing a final data of 725 participants. In Sample 2, no value below or above the standardized score of 3.29 was inspected. However, 208 cases went beyond the critical value of 99.607 (df = 60, p = .001), and hence they were eliminated from the sample, leading to 2042 participants in Study 2.

Besides, the univariate normality assumption was inspected through skewness and kurtosis values, Kolmogorov-Smirnov and Shapiro-Wilk tests, histogram and Q-Q plots. Regarding the univariate normality, the absolute values of skewness and kurtosis results for each item were not greater than 3 and 10 (Kline, 2011). Kolmogorov-Smirnov and Shapiro-Wilk results were significant which indicates non-normality in the data, although histograms and Q-Q plots did not display serious evidence of non-normality in the data. As Mardia's tests show multivariate non-normality, item parcelling method was applied in this study (Bandalos, 2002; Marsh, Hau, Balla, & Grayson, 1998; Matsunaga, 2008).

Item parcelling is preferred when non-normality, sample size, sample size to variable ratio, and parameter estimates are of the concern (Bandalos & Finney, 2001). In other words, non-normal distributions tend to approximate more normal distributions within parcelled data (Holt, 2004; Matsunaga, 2008). Further, the number of parameter estimates and the number of the sample size to variable ratio are reduced, leading to a decrease in the amount of measurement error (Matsunaga, 2008). Since the number of items per parcel is suggested to be higher than three (Bollen, 1989), model 1E cannot be tested (see Figure 1). On the other hand, the number of parcels was preserved at a fewer level (2 or 3), while the number of items on each parcel was at maximum level to improve the model fit (Holt, 2004; Rogers & Schmitt, 2004).

Furthermore, internal consistency estimates were estimated through Cronbach alpha coefficients for all emotion dimensions for Study 1 and 2. These analyses were performed with IBM SPSS 22 for windows.

RESULTS

The CFA revealed a significant chi-square statistics results for each model in Study 1. As this statistic is sensitive to sample size (Kline, 2011), so other fit indices were examined: CFI, NNFI, RMSEA, and SRMR. Findings indicated that model 1B (positive vs negative factor-model) and model 1D (seven-emotions factor model) seemed to be good fitting models than the other models with the following fit indices, respectively: RMSEA= .06 and .05, CFI = .99 and .98, NNFI= .99 and .98 and SRMR= .02 and .02 (see Table 1). Based on CFA results, the factor loadings of the item parcels for model 1B (positive versus negative emotions-factor model) and model 1D (seven-emotions factor model) were greater than .80 (see Table 2).

Table 1. Confirmatory Factor Analysis of AEQ-M across Models (with Sample 1, n =725)

Model	X^2	df	CFI	NNFI	RMSEA	SRMR
1A	38.787	5	.986	.972	.095	.0222
1B	95.994	26	.991	.988	.060	.0186
1C	578.44	41	.846	.794	.133	.079
1D	294.736	98	.983	.976	.052	.0222

Table 2. Factor Loadings of Item Parcels of AEQ-M for Model 1B &1D (Study 1)

Model 1B			Model 1D		
Dimension	Item parcels	Standardized estimates	Dimension	Item Parcels	Standardized estimates
Positive	Parcel1	.86	Enjoyment	P1	.86
				P2	.94
	Parcel2	.91	Pride	P1	.91
				P2	.92
	Parcel3	.88	Anger	P1	.83
				P2	.87
	Parcel4	.94		P3	.85
			Anxiety	P1	.83
Negative	Parcel1	.94		P2	.80
				P3	.85
	Parcel2	.93		P4	.83
			Boredom	P1	.84
	Parcel3	.91		P2	.93
			Shame	P1	.83
	Parcel4	.93		P2	.83
			Hopelessness	P1	.86
	Parcel5	.90		P2	.89

In Study 2, the CFA was conducted with maximum likelihood (ML) estimation as it is recommended as a better alternative for medium to large samples (Tabachnick & Fidell, 2013). After performing CFA, chi square statistics were found to be significant, so CFI, NNFI, RMSEA and SRMR modification indices were compared. According to the results, model 1B seemed to fit well except for RMSEA value of .086 whereas model 1D is a good fitting model with the following fit indices: RMSEA= .069, CFI = .99, NNFI= .98 and SRMR= .02 (Table 3).

Table 3. *Confirmatory Factor Analysis of AEQ-M across Models (with Sample 2, n =2042)*

Model	X^2	df	CFI	NNFI	RMSEA	SRMR
1A	245.25	5	.967	.935	.153	.0306
1B	418.593	24	.984	.977	.086	.0237
1C	921.703	41	.925	.899	.103	.0582
1D	664.137	98	.985	.979	.053	.0171

The findings were in parallel with the findings of the first study. In this regard, the factor loading of the item parcels for model 1D is presented in Table 4. The factor loading of each parcel ranges from .78 to .93.

Table 4. Factor Loadings of Item Parcels for AEQ-M (Study 2)

Dimension	Item Parcels	Standardized estimates		Item Parcels	Standardized estimates
Enjoyment	P1	.93	Anxiety	P1	.84
	P2	.93		P2	.91
Pride	P1	.91		P3	.85
	P2	.93		P4	.89
Anger	P1	.87	Boredom	P1	.91
	P2	.88		P2	.88
	P3	.90	Shame	P1	.78
Anxiety	P1	.84		P2	.89
	P2	.91	Hopelessness	P1	.89
	P3	.85		P2	.91
	P4	.89			

As the model 1D appears to be the best fitting model while considering these two studies, descriptive statistics results and reliability coefficients regarding the model 1D for the first and second study is presented in Table 5. Cronbach alpha estimates did not change noticeably between two studies. They were deemed to be acceptable as they were all above .80 (Knapp & Mueller, 2010).

Table 5. Descriptive Statistics and Reliability Estimates of Emotion Dimensions (Study 1 and 2)

	M	SD	a
Study 1			
Enjoyment	3.50	1.06	.89
Pride	3.50	1.10	.91
Anxiety	2.45	0.91	.90
Anger	2.04	1.01	.89
Hopelessness	2.51	1.14	.86
Boredom	2.06	1.07	.88
Shame	2.44	.95	.82

Table 5. Descriptive Statistics and Reliability Estimates of Emotion Dimensions (Study 1 and 2)-cont

	M	*SD*	*a*
Study 2			
Enjoyment	3.31	1.09	.93
Pride	3.41	1.14	.92
Anxiety	2.55	1.01	.91
Anger	2.16	1.08	.91
Hopelessness	2.60	1.26	.89
Boredom	2.30	1.17	.87
Shame	2.35	0.98	.82

To provide further validation of AEQ-M, the participants in Study 1 were also administered the Turkish version of test anxiety (5 items) subscale of Motivated Strategies for Learning Questionnaire (Sungur, 2004). It was expected that test anxiety would be positively correlated with anxiety, anger, shame, hopelessness, and boredom, while negatively correlated with enjoyment and pride. Bivariate correlations were performed between the scores of test anxiety subscale of MSLQ and factor scores of AEQ-M. As displayed in Table 6, the relationships between factor scores of AEQ-M and test anxiety subscale of MSLQ were significant except enjoyment and pride. All the relationships appeared in the expected direction. The strength of the relationship between anxiety and test anxiety subscale was moderate ($r = .44$) (Cohen, 1988) but stronger than other emotions.

Table 6. Correlations between Emotions and Test Anxiety Subscale of MSLQ

	1	2	3	4	5	6	7	8
1.Enjoyment	-							
2.Pride	.82*	-						
3.Anger	-.50*	-.54*	-					
4.Anxiety	-.50*	-.54*	.54*	-				
5.Shame	-.41*	-.46*	.54*	.73*	-			
6.Hopelessness	-.57*	-.59*	.62*	.84*	.71*	-		
7.Boredom	-.70*	-.59*	.85*	.60*	.53*	.65*	-	
8.MSLQ (Test anxiety)	-.08	-.05	.12**	.44*	.33*	.36*	.14*	-

*$p<.01$, **$p<.05$

CONCLUSION AND DISCUSSION

This study aimed to adapt AEQ-M to Turkish language and check the psychometric characteristics of the scale. Psychometric properties of AEQ-M yielded satisfactory fit indices and reliability estimates. Although model 1B (positive versus negative emotions-factor model) and model 1D (seven-emotions factor model) both seemed to fit the data, model 1D represents the best considering the fit indices for Study 1 (CFI=.983, NNFI=.976, RMSEA=.052 SRMR=.0222) and for Study 2 (CFI=.985, NNFI=.979, RMSEA=.053, SRMR=.0171). Besides the internal consistency estimates for each emotion dimension ranged from .82 to .91 for Study 1 and from .82 to .93 for Study 2. In this regard, Cronbach alpha coefficients were deemed to be high for both studies. These findings were in line with Pekrun et al. (2011)'s study which examined the structure of academic emotions in different learning environments. Besides, the positive moderate correlations of the anxiety scale items with the items on test anxiety scale of MSLQ provided further evidence of validity for AEQ-M.

The studies that make cross-cultural comparisons of AEQ-M also confirmed the factorial structure of the instrument. In Frenzel et al. (2007a)'s study, the Chinese and German version of the instrument were administered to the middle school students to assess their mathematics enjoyment, mathematics pride, mathematics anxiety, mathematics anger, and mathematics shame, and measurement invariance across two languages were checked as well. The corresponding nature of both Chinese and German version of the questionnaire might encourage researchers to adapt the original instrument to some other languages as in the current study to gain more information about students' achievement emotions in mathematics. In this perspective, researchers in Turkey might also contribute to the related literature by using the Turkish version of AEQ-M.

Except from the cross-cultural studies, AEQ-M has been used in a number of studies which considered the discrete nature of emotions in learning environments for different subject domains including mathematics as well (Frenzel et al., 2007b; Frenzel et al., 2007c; Lichtenfeld, Pekrun, Stupnisky, Reiss, & Murayama, 2012; Peixoto, Mata, Monteiro, Sanchas, Pekrun, 2015; Villavicencio & Bernardo, 2013a). Having compared the fit indices and the

reliability estimates of the studies with the proposed model in the current study, there was a remarkable consistency among the findings. Therefore, AEQ-M could be considered to have a full potential to measure students' academic or achievement emotions in mathematics. However, there might be some other emotions that the current study did not focus on. Future studies might include those other than the targeted emotions. As this study underlined middle school students' mathematics achievement emotions, the questionnaire might also be tested with elementary and secondary school students.

All in all, the proposed model based on Pekrun (2006)'s control-value theory, the current literature, and the original version of the scale was verified by the data. The factor loadings of item parcels and the results of fit indices provided construct-related validity evidence. Therefore, the Turkish version of AEQ-M could be used to measure mathematics achievement emotions of middle school students in Turkish educational contexts.

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Yazar Katkıları / **Author Contributions**

Bu çalışma aynı zamanda Master tez çalışmasının bir bölümü olduğu için çalışmanın veri toplama, verilerin analizi ve bulguların raporlanması bölümleri YÇA'nın danışmanlığında BÇ ile ortak bir şekilde yürütülmüştür.

As this study was a part of Master's thesis, the data collection, data analysis and the reporting parts were carried out by BÇ under the supervision of YÇA.

Çıkar Çatışması / **Conflict of Interest**

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REFERENCES

Arbuckle, J. L. (2011). *Amos 20 [Computer software]*. Chicago: SPSS.

Baloğlu, M. & Koçak, R. (2006). A multivariate investigation of the differences in mathematics anxiety. *Personality and Individual Differences*, *40*, 1325-1335.

Bandalos, D. L. (2002). The effects of item parceling on goodness-of-fit and parameter estimate bias in structural equation modeling. *Structural Equation Modeling, 9*, 78–102.

Bandalos, D. L., & Finney, S. J. (2001). Item parceling issues in structural equation modeling. In G. A. Marcoulides & R. E. Schumacker (Eds.), *New developments and techniques in structural equation modeling* (pp. 269–296). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Birgin, O. , Baloğlu, M. , Çatlıoğlu, H. & Gürbüz, H. (2010). An investigation of mathematics anxiety among sixth through eighth grade students in Turkey. *Learning and Individual Differences*, *20*, 654-658.

Boekaerts, M. (2007). Understanding students' affective processes in the classroom.In P.A. Schutz & R. Pekrun (Eds.), *Emotions in education* (pp. 37–56). San Diego:Academic Press.

Bollen, K. A. (1989). *Structural equations with latent variables*. New York: Wiley.

Browne, M. W., & Cudeck, R. (1993). Alternative ways of assessing model fit. In K. A. Bollen & J. S. Long (Eds.), *Testing structural equation models* (pp. 136-162). Thousand Oaks, CA: Sage.

Chiang, W. & Liu, C. (2014). Scale of academic emotion in science education: Development and validation. *International Journal of Science Education*, *36* (6), 908-928.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd eds). Lawrence Erlbaum Associates, Publishers.

Dede, Y. & Dursun, Ş. (2008). İlköğretim II. kademe öğrencilerinin matematik kaygı düzeylerinin incelenmesi [The investigation of math anxiety levels of middle school students]. *Journal of Uludag University Faculty of Education*, *21*(2), 295-312.

Frenzel, A. C., Goetz, T. , Lüdtke, O. , Pekrun, R. & Sutton, R. E. (2009). Emotional transmission in the classroom: Exploring the relationship between teacher and student enjoyment. *Journal of Educational Psychology*, *101*(3), 705-716.

Frenzel, A. C., Thrash, T. M., Pekrun, R., & Goetz, T. (2007a). Achievement emotions in Germany and China: A cross-cultural validation of the Academic Emotions Questionnaire-Mathematics (AEQ-M). *Journal of Cross-Cultural Psychology*, *38*, 302–309.

Frenzel, A. C., Pekrun, R., & Goetz, T. (2007b). Girls and mathematics – a "hopeless" issue? A control- value approach to gender differences in emotions towards mathematics. *European Journal of Psychology of Education*, *22*, 497–514.

Frenzel, A. C., Pekrun, R., & Goetz, T. (2007c). Perceived learning environment and students' emotional experiences: A multilevel analysis of math classrooms. *Learning and Instruction*, *27*(5), 472-493.

Goetz, T., Bieg, M., Lüdtke, O., Pekrun, R., & Hall, N. (2013). Do girls really experience more anxiety in mathematics? *Psychological Science*, *20*, 1-9.

Goetz, T. Cronjaeger, H. , Frenzel, A. C., Lüdtke, O. & Hall, N. C. (2010). Academic self concept and emotion relations: Domain specificity and age effects. *Contemporary Educational Psychology*, *35*, 44-58.

Goetz, T. ,Frenzel, A. C. , Hall, N. & Pekrun, N. (2008). Antecedents of academic emotions: Testing the internal / external frame of reference model for academic enjoyment. *Contemporary Educational Psychology*, *33*, 9-33.

Goetz, T. , Frenzel, A. C. Pekrun, N. , Hall, N. & Lüdtke, O. (2007). Between and within domain relations of students' academic emotions. *Journal of Educational Psychology*, *99* (4), 715-733.

Goetz, T. , Pekrun, R. , Hall, N. & Haag, L. (2006). Academic emotions from a social-cognitive perspective: Antecedents and domain specificity of students' affect in the context of Latin instruction. *British Journal of Educational Psychology*, *76*, 289-308.

Hair, J. F. , Anderson, R. E., Tatham, R. L. & Black, W. C. (2010). *Multivariate Data Analysis* (7th ed.). Prentice Hall, Inc.

Holt, J. K. (2004, October). *Item parceling in structural equation models for optimum solutions.* Paper presented at the 2004 Annual Meeting of the Mid-Western Research Association, Columbus, OH.

Hu, L. H. & Bentler, P. M. (1999). Cut off criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, *6* (1), 1-15.

Keshavarzi, A. & Ahmadi, S. (2013). Ahmadi, S. (2013). A comparison of mathematics anxiety among students by gender. *Procedia- Social and Behavioural Sciences*, *83*, 542-546.

King, R. B. & Areepathamannil, S. (2014). What students feel in school influences the strategies tjhey use for learning: Academic emotions and cognitive / metacognitive strategies. *Journal of Pacific Rim Psychology*, *8*, 18-27.

Kleine, M., Goetz, M., Pekrun, R. & Hall, N. (2005). The structure of students' emotions experienced during a mathematical achievement test. *The International Journal on Mathematics Education*, *37*(3), 221-225.

Kline, R. B. (2011). *Principles and Practice of Structural Equation Modeling* (3rd ed.). The Guilford Press.

Knapp, T.R., & Mueller, R.O. (2010). Reliability and validity of instruments. In Hancock, G.R. & Mueller, R.O. (Eds.), *The Reviewer's Guide to Quantitative Methods in the Social Sciences* (337–342). London: Routledge.

Lihtenfeld, S. , Pekrun, R. , Stupnisky, R. H. , Reiss, K. & Murayama, K. (2012). Measuring students' emotions in the early years. The achievement emotions questionnaire-elementary school (AEQ-ES). *Learning and Individual Differences*, *22*, 190-201.

Ma, X. (1999). A meta-analysis of the relationship between anxiety toward mathematics and achievement in mathematics. *Journal for Research in Mathematics Education*, *30* (5), 520-540.

Marsh, H. W., Hau, K.-T., Balla, J. R., & Grayson, D. (1998). Is more ever too much? The number of indicators per factor in confirmatory factor analysis. *Multivariate Behavioral Research*, *33*, 181–220.

Matsunaga, M. (2008). Item parceling in structural equation modeling: A primer. *Communication Methods and Measures*, *2*(4), 260-293.

Mega, C. , Ronconi, L. & De Beni, R. (2012). What makes a good students? How emotions, self-regulated learning, and motivation contribute to academic achievement. *Journal of Educational Psychology*, *106* (1), 121-131.

Op 't Eynde, P. (2004). A socio-constructivist perspective on the study of affect in mathematics education. *Proceedings of the 28th Conference of the International Group for the Psychology of Mathematics Education 1*, 118–122.

Peixoto, F., Mata, L., Monteiro, V., Sanches, C. & Pekrun, R. (2015). The achievement emotions questionnaire: Validation for pre-adolescent students. *European Journal of Developmental Psychology*, *12*(4), 472-481.

Pekrun, R. (2006). The control-value theory of achievement emotions: Assumptions, corollaries, and implications for educational research and practice. *Educational Psychology Review*, *18*, 315–341.

Pekrun, R., Elliot, A. J., & Maier, M. A. (2009). Achievement goals and achievement emotions: Testing a model of their joint relations with academic performance. *Journal of Educational Psychology*,*101*, 115– 597.

Pekrun, R., Frenzel, A., Goetz, T., & Perry, R. P. (2007). The control-value theory of achievement emotions: An integrative approach to emotions in education. In P.A. Schutz & R. Pekrun (Eds.),   *Emotions in education* (pp. 13–36). San Diego: Academic Press.

Pekrun, R. , Goetz, T. & Frenzel, A. C. (2005). *Achievement emotions questionnaire- mathematics (AEQ-M). User's manual.* Department of Psychology, University of Munich.

Pekrun, R.,Goetz, T., Frenzel, A. C., Barchfeld, P., & Perry, R. P. (2011). Measuring emotions in students' learning and performance: The Achievement Emotions Questionnaire (AEQ). *Contemporary Educational Psychology, 36,* 36–48.

Pekrun , R , Goetz, T . , Titz, W . , & Perry, R P . (2002). Academic emotions in students' self-regulated learning and achievement: A program of quantitative and qualitative research. *Educational Psychologist*, *37*, 91-106.

Pekrun, R., Hall, N. C., Goetz, T.,& Perry, R. P. (2014). Boredom and academic achievement: Testing a model of reciprocal causation. *Journal of Educational Psychology*, *106*, 696–710.

Rogers, W. M., & Schmitt, N. (2004). Parameter recovery and model fit using multidimensional composites: A comparison of four empirical parcelling algorithms. *Multivariate Behavioral Research*, *39*, 379−412.

Schutz, P. A. & De Cuir, J. T. (2002). Inquiry on emotions in education. *Educational Psychologist*, *37*(2), 125-134.

Spangler, G., Pekrun, R., Kramer, K., & Hofmann, H. (2002). Students' emotions, physiological reactions, and coping in academic exams. *Anxiety, Stress and Coping, 15*, 383–400.

Sungur, S. (2004). *The implementation of problem-based learning in secondary school biology courses*. Unpublished Dissertation, Middle East Technical University, Ankara, Turkey.

Tabachnick, B. G., & Fidell, L. S. (2013). *Using multivariate statistics*. Needham Heights, MA: Allyn and Bacon.

Valiente, C. Swanson, J. & Eisenberg, N. (2012). Linking students' emotions and academic achievement: when and why emotions matter. *Child Development Perspectives*, *6*(2), 129-135.

Villavicencio, F. T., & Bernardo, A. B. I. (2013a). Negative emotions moderate the relationship between self-efficacy and achievement of Filipino students. *Psychological Studie*s, *58*(3), 225–232.

Villavicencio, F. T., & Bernardo, A. B. I. (2013b). Positive academic emotions moderate the relationship between self-regulation and academic achievement. *British Journal of Educational Psychology*, *83*, 329–340.

Villavicencio, F. T., & Bernardo, A. B. I. (2016). Beyond math anxiety: Positive emotions predict mathematics achievement, self-regulation, and self-efficacy. *The Asia-Pasific Education Research*, *25*(3), 415-422.

Wigfield, A., & Meece, J. L. (1988). Math anxiety in elementary and secondary school students. *Journal of Educational Psychology, 80,* 210 –216.

Yüksel-Şahin, F. (2008). Mathematics anxiety among 4th and 5th grade Turkish elementary school students. *International Electronic Journal of Mathematics Education*, *3*(3), 179-192.

Zeidner, M. (2007). Test anxiety in educational contexts: Concepts, findings, and future directions. In P.A. Schutz & R. Pekrun (Eds.), *Emotion in education* (pp. 165–184). San Diego, CA: Academic Press.

Genişletilmiş Özet

Giriş: Duygu, "çok boyutlu, duyuşsal, bilişsel, motivasyonel, dışavurumsal ve fizyolojik süreçleri içeren eş-güdümlü psikolojik alt sistemler" (Pekrun, 2006, sf. 316) olarak tanımlanmaktadır. Duyguların oluşumunda etkili olan temel bileşenler göz önünde bulundurularak Pekrun (2006) tarafından "akademik faaliyet ya da çıktılarla doğrudan ilişkili duygular" (sf. 317) olarak tanımlanan "başarı duyguları" kavramı ise öğrencilerin bir dersi dinlerken ve çalışırken, ödev yaparken, sınav olurken ya da bahsedilen tüm bu akademik faaliyetler kapsamında başarılı ya da başarısız olma hallerinde deneyimledikleri duygular olarak kabul görmektedir.

Öğrencilerin öğrenme ortamlarında deneyimleyecekleri akademik duyguları doğru bir şekilde tanımlamak ve ayırt edici geçerliği sağlama açısından alanyazında çeşitli duyguları bir arada ölçen ölçeklere ihtiyaç vardır. Bu kapsamda, Pekrun ve arkadaşları (2011) tarafından farklı yaş gruplarındaki bireylerin pozitif ve negatif başarı duygularını ölçmek için geliştirilen Başarı Duyguları Ölçeğinin (Achievement Emotions Questionnaire; AEQ) alanyazına katkıda bulunduğu düşünülebilir. Denetim-Değer kuramına göre denetim ve değer değerlendirmelerinin konu alanına bağlı olarak değişmesinden dolayı alanyazında bu öncüllerin bir ürünü olan akademik duyguların da konu alanına bağlı olarak değiştiğini ortaya koyan birçok araştırma bulunmaktadır (Goetz, Frenzel, Pekrun, Hall ve Lüdtke, 2007; Goetz, Frenzel, Hall ve Pekrun, 2008; Goetz, Pekrun, Hall ve Haag, 2006; Frenzel, Thrash, Pekrun ve Goetz, 2007). Bu kapsamda, farklı yaş gruplarındaki öğrencilerin matematiğe yönelik başarı duygularını ölçmek amacıyla Pekrun, Goetz ve Frenzel (2005) tarafından Matematik Başarı Duyguları Ölçeği (Achievement Emotions Questionnaire; AEQ-M) geliştirilmiştir. Bu çalışmanın amacı, Matematik Başarı Duyguları Ölçeği'ni (BDÖ-M) Türkçe'ye çevirmek ve ölçeğin psikometrik özellikleri hakkında kanıt ortaya koymaktır.

Yöntem: BDÖ-M, toplam 60 madde ve üç bölümden oluşmaktadır. Bu bölümler, sırasıyla sınıf ortamı (18 madde), öğrenme ortamı (19 madde) ve sınav ortamı (23 madde) ilgili duygu durumlarını içermektedir. Her bir bölüm kendi içerisinde önce, sırasında ve sonra olmak üzere üç alt bölüme ayrılmakta ve her bir alt bölüm ilgili bölümle ilgili duygu durumlarını incelemektedir. Zevk (10 madde), gurur (6 madde), kaygı (15 madde), öfke (9 madde), bıkkınlık (6 madde), umutsuzluk (6 madde) ve utanç (8 madde) gibi yedi farklı duygu durumunu içeren ölçek maddeleri 5'li Likert tipinde "kesinlikle katılmıyorum" (1) dan "kesinlikle katılıyorum" (5)'a doğru cevaplandırılmaktadır. Çalışma grubu, Ankara'da devlet ortaokullarında öğrenim görmekte olan altıncı, yedinci ve sekizinci sınıf öğrencilerinden oluşmaktadır. Ölçek, sırasıyla 746 ve 2250 kişiden oluşan iki ayrı çalışma grubuna uygulanmıştır. Ölçeğin yapı

geçerliğini sağlamak amacıyla Doğrulayıcı Faktör Analizi (DFA) yapılmış; güvenirliği hakkında bilgi sağlamak amacıyla Cronbach Alpha değerlerine bakılmıştır.

Bulgular: Birinci çalışma kapsamında yapılan DFA ile elde edilen uyum iyiliği indeksi (goodness of fit index; GFI), karşılaştırmalı uyum indeksi (comparative fit index; CFI) ve yaklaşık hataların ortalama karekökü (root mean square error of approximation; RMSEA) sonuçlarına göre pozitif-negatif duygu modeli (RMSEA= .06 , CFI = .99, NNFI= .99, SRMR= .02) ve yedi duygu boyutu modelinin (RMSEA= .05, CFI = .98, NNFI= .98 and SRMR= .02), diğer modellere göre daha yüksek uyum indeks değerlerine sahip olduğu görülmektedir. İkinci çalışma kapsamında yapılan DFA sonuçlarına göre ise yedi-boyutlu duygu modelinin en iyi uyum indeks değerlerine sahip olduğu görülmektedir (RMSEA= .069, CFI = .99, NNFI= .98 and SRMR= .02).

BDÖ-M'nin yapı geçerliğine ilişkin farklı kanıtlar sağlamak amacıyla birinci çalışma grubuna ayrıca Öğrenmede Güdüsel Stratejiler Anketi (Sungur, 2004)'nin sınav kaygısı alt ölçeği uygulanmıştır. BDÖ-M içerisinde yer alan her bir duygu boyutu ve sınav kaygısı arasındaki ilişki analizi sonuçları zevk ve gurur boyutları haricinde sınav kaygısının diğer duygu boyutları ile anlamlı ve pozitif bir ilişki içerisinde olduğunu göstermektedir.

Ölçeğin güvenirliği hakkında bilgi sağlamak için her bir boyutun Cronbach alfa değerlerine bakılmıştır. İç tutarlık katsayıları her bir duygu boyutu için birinci çalışmada .82 ve .91; ikinci çalışmada ise .82 ve .93 değerleri arasında değişmektedir.

Tartışma & Sonuç: Bu çalışmada önerilen modeller iki çalışma grubu için de Doğrulayıcı Faktör Analizi ile test edilmiş ve her modelin uyum indeksi sonuçları birbiriyle karşılaştırıldığında yedi-duygu boyutu modelinin doğrulandığı gözlenmiştir. Eldeki bulgular, mevcut alanyazın ile de uyum içerisindedir. Ayrıca, iki çalışma grubu için de yedi-duygu boyutu modeline göre iç tutarlık katsayıları hesaplanmıştır. Her bir duygu durumunun iç tutarlık katsayıları .80'nin üzerindedir. Bu kapsamda, BDÖ-M'nin ortaokul öğrencilerinin matematik başarı duygularını ölçmek için kullanılabilecek geçerli ve güvenilir bir ölçek olduğu sonucuna varılmaktadır.