AN ATTITUDE SCALE IMPROVING STUDY IN THE CONTEXT OF ELEMENTARY SCHOOL ALGEBRA COURSE*

(CEBİR KONUSUNA YÖNELİK BİR TUTUM ÖLÇEĞİ GELİŞTİRME ÇALIŞMASI)

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ABSTRACT

The aim of this study is to improve an attitude scale for algebraical subject in the scope of maths lesson. In order to test validity and reliability of developed scale, 488 students in sixth, seventh and eighth grades of secondary schools of Ministry of Education in Adana province that were chosen by disproportional cluster sampling method, were used. The scope validity, criterion validity, structure validity were tested by necessary analysis. The explanatory factor analysis done in this direction, it was found out that the scale was gathered in two factors as positive and negative attitude and the contribution of these factors to total variance as 53.91% and factor loads were changing between .65 and .83. Again, accordance index values ($\chi 2$/sd=2.8; RMSEA= .057; SRMR= .046; GFI= 0.92; AGFI= 0.90; CFI= 0.98) scale obtained at the end of confirmatory factor analysis was found to have a good accordence value. As it is understood from these analysis, it can be said that a valid and reliable quinary likert type with 25 items that are gathered on two factors as "Positive attitude" and "Negative attitude" was obtained.

Keywords: Mathematics, students, algebraical attitude, scale

ÖZET

Bu araştırmanın amacı, matematik dersi kapsamında cebir konusuna yönelik tutum ölçeği geliştirmektir. Geliştirilen ölçeğin geçerliği ve güvenirliğini test etmek amacıyla Adana ilinde Milli Eğitim Bakanlığı'na bağlı ortaokullarının altıncı, yedinci ve sekizinci sınıfına devam eden ve oransız küme örnekleme yöntemiyle belirlenen 488 öğrenciye uygulanmıştır. Ölçeğin kapsam geçerliği, ölçüt geçerliği, yapı geçerliliği ve güvenirliği için gerekli analizleri yapılmıştır. Yapılan açımlayıcı faktör analizi sonucu olumlu tutum ve olumsuz tutum olmak üzere iki faktörde toplandığı ve bu faktörlerin toplam varyansa yaptıkları katkı %53.91 olduğu ve faktör yüklerinin .65 ile .83 arasında değiştiği ortaya çıkmıştır. Doğrulayıcı faktör analizi sonucunda ise elde edilen uyum indeks değerleri ($\chi 2$/sd=2.8; RMSEA= .057; SRMR= .046; GFI= 0.92; AGFI= 0.90; CFI= 0.98) ölçeğinin iyi bir uyum değerine sahip olduğu ortaya çıkarmıştır. Buna göre "Olumlu tutum" ve "Olumsuz tutum" olmak üzere iki faktörde toplanan 25 maddelik 5'li likert tipi geçerli ve güvenilir bir ölçek elde edildiği sonucuna ulaşılmıştır.

Anahtar Sözcükler: Matematik, ortaokul öğrencileri, cebir sel tutum ölçeği, ölçek geliştirme

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INTRODUCTION

With general definition, algebra can be defined as symbolization of numeric relations and mathematical structures and analysis of these complex mathematical problems with these symbols (Taylor-Cox, 2003; Schoenfeld, 1995). Algebraical subject was addressed by many academician in various ways. For example according to Lacampagne, Blair and Kaput (1995) algebra is a mathematical language whereas for Vance (1998) it is a way of mathematical thinking rather than a series of rules that is formed by scheme of symbols. On the other hand, Lian and Idris (2006) define algebraical subject as an important tool that provides methods such as explaining and analysis of mathematical properties, patterns and relations in various problematic situations. Again according to (NCTM, 2000) algebra is emphasized as presenting simple solution ways by using symbols instead of numbers in arithmetic calculations. Yackel (1997) ve Kieran (1992) defined algebra as an important scientific branch that involves the usage of real and complex numbers, forming and solving first and second degree equations, simplifying polinoms and rational expressions, symbolic representations of linear, quadric, power, logarithmic and trigonometric functions with graphics as wella as usage of sequences and series.

Some studies done in literature has taken algebra in different classifications (Usiskin, 1988; Kaput, 1995). In this scope, according to Usiskin algebra was classified as generalized arithmetics, solution periods of some certain problems, relations between quantities and structural studies, according to Kaput algebraic subject was classified as generalization, systemmatic structures, structural study field, algebra as functional and language of modelling. Algebraic subject that has an important place in mathematics programmes of our country (MEB, 2009, 2013) attracts attention as an important fact in terms of exploring patterns, making generalizations between these patterns, transforming patterns into different representation types, understanding mathematical relations and generalizing arithmetic skills in students starting from primary school (Schoenfeld, 1995; Van De Walle 2012). However the sudies done on algebraic teaching in literature show that it is perceived as a field disconnected from daily life, difficult and abstract formed of symbols and this plays an important role in their success and attitudes towards algebra (Atnafu, 2010; Bell, 1995; Çağdaşer, 2008; Das & Wilkinson, 2011; Hodges & Kim, 2013; Jacobs, Franke, Carpenter, Levi & Battery, 2007; Kaput, 1998; Kieran, 1992; Kulpa, 2007; Leong & Alexander, 2013; McCoy, 2005; Norton & Irvin, 2007; Roberts & Bilderback, 1980; Stephens, 2007; Williams & Molina, 1997). In this scope, McCoy (2005) found out that the success of students showing positive attitude towards algebra increase than the ones showing negative attitude and teacher quality is also an important factor in success. Similarly Hodges and Kim (2013) in their studies reached a conclusion that the motivations of students have increased when they show positive attitude towards algebra. Again, Çağdaşer (2008) in his study found out algebraic teaching done suitable to constructivist attitude increases attitude of students in positive way. Atnafu (2010) also examined the relation between components that formed attitudes towards

algebra and algebraic success in his study. At the end of study Atnafu reached a conclusion that there is a significant relation between attitudes towards algebraic subject and success. However, when the studies mentioned above are examined in scope of method, since there is not an exact scale that adresses the relation between algebra and attitude, the researchers used mathematical lesson attitude scale that involves a general frame or they adapted these scale items to algebraic subject (Atnafu 2010; McCoy, 2005; Öner, 2009; SattarGasim, 2012) . Starting from this fact, with this study it was aimed to contribute to literature by forming a definite attitude scale towards algebraic subject that its validity and reliability were proved.

METHOD

The Model of Research

This study is a study of developing a valid and reliable scale in order to identify the attitudes of students towards algebra. It was figured according to survey model. A survey model is a research figure that properties, behaviours, attitudes and tendencies of population are determined by quantitative method and questionnaire or scales are determined by using sampling (Creswell, 2008).

Population and Sampling

Algebraic subject is thought in secondary school mathematics teaching programme of sixth, seventh and eighth grades (MEB, 2013). In this scope, as the students of sixth, seventh and eighth grades of 2013-2014 academic year in Adana province formed the population of study, 488 students that were determined by disproportional cluster sampling method formed the sampling of this study. 45.5% of participant students are female students whereas 54.5% of them are male. 38.9% of them are in 6th grades, 31.8% of them are in 7th grades and 29.3% of them are in 8th grades. In the scope of maths lesson success grades 9.1% of them are unsuccessful (1), 24.9% of them are passing (2), 26.2% of them are average (3), 24% of them are good (4) and 15.8% of them are very good (5).

The Preperation Period of Algeabric Attitude Scale

The measurement scale that was developed to measure the attitudes of students towards algebra, was prepared by following the steps below (Balcı, 2005; Devellis, 2003).

Item Pool: In development period of Algeabric Attitude Scale, from 120 students in sixth, seventh and eighth grades their thoughts and views regarding algebra were asked to write down. Among these views the sentences that can be attitude expression were determined and 76 item pools were formed.

Expert Opinion: Item pool was presented to two experts of mathematic education, assessment and evaluation and programme developing fields, to be examined. In the direction of feedbacks from experts, which items has to be in pilot scheme were decided. Also, eight items were decided to be taken out from sample scale since they had the same meaning and did not involve "attitude" expression and the expressions of four of them were decided to be changed. In the scale that had its

last form, totally 68 items which 36 had positive and 32 had negative expression, took place.

Pilot Scheme: Totally 68 items of sampling scale was applied to 38 people formed by sixth grade students in terms of language and comprehensibility. In application period, the views of teachers about the suitability of scale items to the level of students, were asked. In the direction of opinions taken either from teachers and students, in the 64th item the expession "complicated" was written instead of "complex".

The Analysis of Data

In testing period of validity and reliability of scale, scope, criterion and structure validity analysis were done respectively; also Cronbach alpha and Guttman Split Half values were calculated. In this scope, exploratory factor analysis done to obtain construct validity of scale was calculated with the help of SPSS 17.0 programme, the suitability of datas to factor analysis were compared to the results of Kaiser-Meyer-Olkin (KMO) test and Barlett Sphericity test (Kalaycı, 2005; Tavşancıl, 2010). Also, as item discrimination power was calculated by independent sample t-test analysis with examination of arithmetic means, standard deviation values and item-total point correlation, varimax technique was used in obtaining of factors. Again in the scope of structure validity, Lisrel 8.71 programme was used for Confirmatory Factor Analysis and the suitability of model that was obtained in exploratory factor analysis was tested. For Confirmatory Factor Analysis done in this scope, Chi- Square Goodness, χ^2, Goodness of Fit Index, Adjustment Goodness of Fit Index, Comparative Fit Index, Root Mean Square Error of Approximation, Standardized Root Mean Square Residual were examined. With this generally for χ^2/sd, the values below 2 shows perfect accordance whereas the values between 2 and 4 shows acceptable accordance (Kline, 2011; Schermelleh-Engel, Moosbrugger & Müller, 2003). For GFI and CFI index .90 value points accepatable accordance and .95 value poins perfect accordance (Marsh, Hau, Artelt, Baumert & Peschar, 2006). For AGFI .85 value defines acceptable accordance and .90 value defines perfect accordance (Schermelleh-Engel & Moosbrugger, 2003). For RMSEA .08 value is taken as acceptable accordance and .05 value is taken as perfect accordance (Byrne & Campbell, 1999). For SRMR .10 value shows acceptable accordance whereas .05 value shows perfect accordance (Hu & Bentler, 1999; Kline, 2011).

RESULTS

In this section the findings regarding the validity and reliability applied in development period of "Algebraic Attitude Scale" takes place.

Findings Regarding the Validity of Scale

Validity is a measurement degree of a test or a scale to measure a property (Altunışık, Coşkun, Bayraktaroğlu & Yıldırım, 2005; Balcı, 2005). Content, criterion-related and construct validities have to be provided to consider a scale as valid (Creswell 2003; Devellis, 2003). According to this, the datas regarding the content, criterion-related scale and construct validities are given in details below.

Findings Regarding Content Validity: Content validity is related with sufficiency of items in the scale tool (Devellis, 2003). Punch (2005) also expresses that in content validity all elements of content has to take part or to be represented in the measurement. In order to obtain the content validity of measured scale tool, the opinion of expert (Balcı, 2005; Büyüköztürk, 2006; Büyüköztürk, Çakmak, Akgün, Karadeniz & Demirel, 2008; Karasar, 2009; Tavşancıl, 2010) was asked. With this aim, the content validity of scale that contaın 68 items in quinary likert type was presented to opinions of six expert.

Findings Regarding Criterion-Related Validity: As an indicator in this kind of validity, the same concept is compared to other scale that the researcher trusts in (Punch, 2005). In this contend in order to examine criterion-related validity of Algebraic Attitude Scale, "Mathematical Attitude Scale" that was developed by Baykul (1990) and is consisted of 30 items was used with this. According to this, the findings regarding correlations between the points obtained from algebraic attitude scale with mathematical attitude scale, were given in Table 1.

Table 1. The Correlation Matrix Regarding Algebraic Attitude Scale with Mathematical Attitude Scale

Algebraic Attitude Scale	Mathematical Attitude Scale
Positive Attitude	.19*
Negative Attitude	.32*

n= 115, *p<0.05

When Table 1 is examined, the points obtained from Algebraic Attitude Scale and the points obtained from Mathematical Attitude Scale are considered to be statistically significant (p<0.01).

Findings Regarding Construct Validity: Construct validity is teorically related with the relation of a variable with other variables (Devellis, 2003) as well as determination of which concept or property the prepared scale measures. The most used method in examination of construct validity is factor analysis (Balcı, 2005). As factor analysis depends on correlation between items measuring same property, it also aims to explain with less number of factor by gathering these variables together (Tabachnick & Fidell, 2001). In this scope, both explatory and confirmatory factor analyses were used in this study.

Explatory factor analysis is defining of items within relation with each other by gathering them in a group (Tabachnick & Fidell, 2001). In explatory factor analysis for the suitability of datas regarding algebraic attitude scale to factor analysis, Kaiser-Mayer-Olkin (KMO) sampling sufficiency test and the results of Barlett globosity test. At the end of this analysis KMO value was .96 and at the end of Barlett test chi square value was found statistically significant ($\chi2 = 7123,870$, p<0.01). The obtained findings shows that data set is suitable for factor analysis. In

analysis firstly the difference between the factor loads of items in the scope of algebraic attitude scale (minimum .40) and the factor loads of items loaded on more than one factor (minimum .30) was examined and as a result of this thirty four items were excluded from aims (Kline, 2011). These processes were done by using principal components factor method and varimax vertical turning process that is frequently used in social sciences (Büyüköztürk, 2006).

It is clearly seen in Figure 1 that 25 items that principal components analysis was used, were gathered under two factors which their eigenvalue is bigger than 1.00.
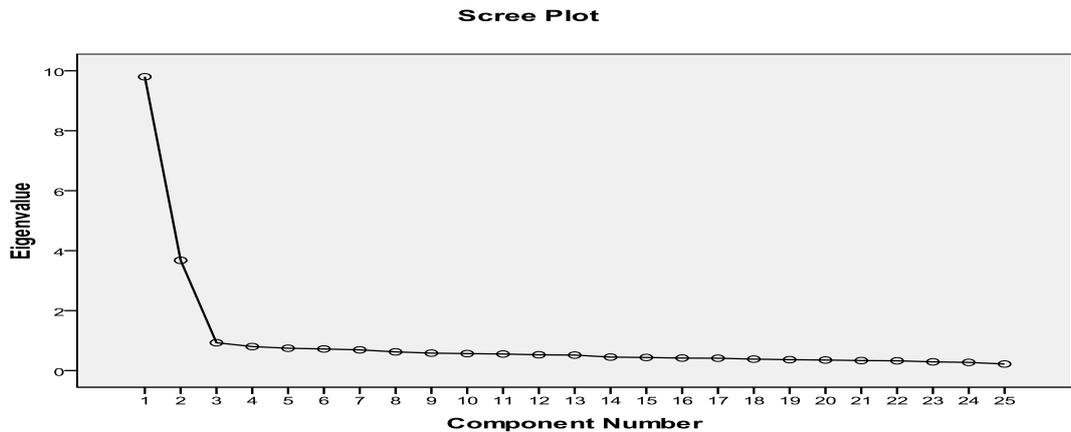
Figure 1.Scree plot graphic

When Figure 1 is examined, it is seen that scree plot graphic was gathered under two factors. In this scope, two factored structure that was reached in three iteration and explains 53.91% of total variance, was obtained. The factor loads that belong to each factor is given in Table 2.

When Table 2 is examined, as a result of applied analysis it is seen that eigenvalue of "Positive attitude" subfactor is 9.80 and variance value is 39.20% whereas eigenvalue of "Negative attitude" subfactor is 3.68 and variance value is 14.71%. As a result of factor analysis total variance that was explained by two factors is 53.91%. It is seen that the factor loads are changing between .65 and .83. In obtaining the items that are measuring the same structure, it was watched out that load values of factors are high and the items are high in one value and low load value in other factors and item factor loads are at least .65 (Büyüköztürk, 2006).

Table 2. The Factor Analysis Results of Algebraic Attitude Scale

Item Number	F1	F2	r*	t	$\overline{X}$	S
18	.83		.87	-11.90**	3.12	1.35
34	.80		.81	-8.60**	2.81	1.27
16	.76		.82	-10.41**	2.80	1.26
17	.76		.85	-9.65**	2.99	1.27
21	.74		.82	-10.64**	3.23	1.30
33	.74		.73	-7.76**	2.86	1.25
25	.74		.77	-9.26**	2.71	1.21

13	.73		.73	-8.10**	2.80	1.33
19	.72		.72	-8.20**	2.62	1.17
15	.72		.75	-7.75**	3.00	1.23
26	.71		.77	-10.36**	3.22	1.19
35	.70		.76	-9.47**	3.03	1.33
48	.70		.80	-10.1**	3.16	1.32
58	.69		.80	-13.24**	3.17	1.36
12	.66		.75	-7.90**	2.85	1.42
27	.66		.78	-9.41**	3.01	1.22
5		.79	.77	-15.53**	2.75	1.30
66		.77	.81	-16.69**	2.98	1.34
65		.74	.77	-14.96**	3.07	1.34
20		.72	.79	-14.63**	3.11	1.39
45		.69	.73	-13.17**	3.04	1.21
46		.68	.72	-12.18**	2.86	1.33
64		.66	.71	-14.69**	3.04	1.36
55		.65	.74	-13.25**	2.94	1.36
3		.65	.71	-13.99**	2.46	1.32
Eigenvalue	9.80	3.68	**Total**			
Variance Percentage	39.20	14.71	53.91			
Cronbach Alpha	.93	.80	.92			
Ranj	.66-.83	.65-.79	. 65-.83			
Item Number	16	9	25			

Note: Inscope of easy observation the factor loadsunder .30valuewere not written.

*r: Item – total point correlations; **p<0.01

F1: Positive Attitude; F2: Negative Attitude

Again in Table 2, according to the results of item analysis applied to evaluate item discrimination, it is seen that item total correlation parameter changes between .71 and .87. Also, the total points of students were ordered for each sub scale. In this order by forming sub 27% and upper 27% groups, the condition of items to seperate those two groups was examined and it was seen that all items can seperate groups significantly (p<0.01). It is seen in Table 2 that the arithmetic means forming algebraic attitude scale changes between 2.46 and 3.23.

On the other hand confirmatory factor analysis is a kind of scale model that is used in advance researches basis on measuring on factor numbers and their variables (Kline, 2011; Tabachnick & Fidell, 2001). In this scope, in order to evaluate the validity of two factored structure of algebraic attitude scale as a result of explatory factor analysis, confirmatory factor analysis was calculated by using LISREL (Linear Structural Relations) 8.71 programme. In the direction of datas of this study, the accordance index values of algebraic attitude scale is given in Table 3.

Table 3. Confirmatory Factor Analysis (CFA) Accordance Indexes of Algebraic Attitude Scale

CFA Accordance Indexes	χ^2	sd	χ^2/sd	RMSEA	SRMR	GFI	AGFI	CFI
Model Values	528.99	188	2.8	.057	.046	.92	.90	.98

When Table 3 is examined the obtained accordance indexes of analysis applied to algebraic attitude scale are like this: As Chi-square value $\chi 2(550)=528.99$ p<.01, $\chi 2/sd$ value is 2.8; Root Mean Square Error of Approximation is (RMSEA)= .057; Standardized Root Mean Square Residual is (SRMR)= .046; Goodness of Fit Index is (GFI)= 0.92; Adjustment Goodness of Fit Index is (AGFI)= 0.90; Comparative Fit Index is (CFI)= 0.98. According to this, it was found out that algebraic attitude scale has a good accordance value and in quality of confirming factor structure (Çokluk, Şekercioğlu & Büyüköztürk, 2010; Bayram, 2013; Schermelleh-Engel, Moosbrugger & Müller, 2003; Tabachnick & Fidell, 2001). In Figure 2 coefficients of item factor relations regarding confirmatory factor analysis are given.
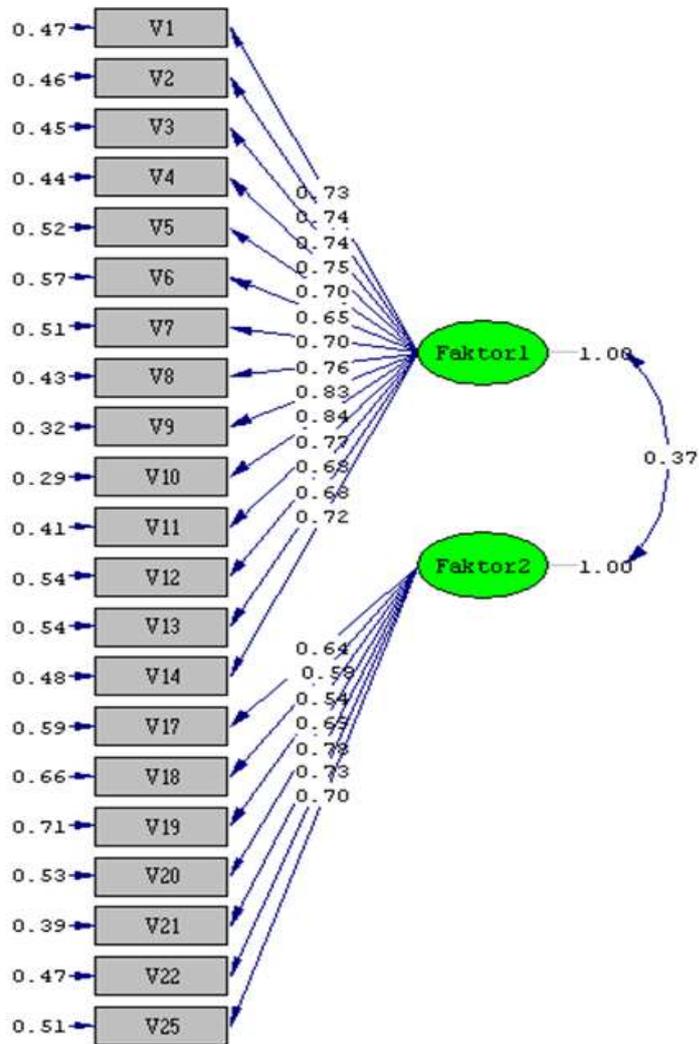
Chi-Square=528.99, df=188, P-value=0.00000, RMSEA=0.057

Figure 2. The Values Regarding Item Factor Relations of Confirmatory Factor Analysis

In Figure 2 when the findings obtained as a result of confirmatory factor analysis are examined, error variance and factor load values of 25 items forming

algebraic attitude scale, are given. According to this, factor load values of scale items are changing between 0.54 and 0.84 and all load values are statistically significant (p<0.01).

The Reliability of Scale

Reliability is stable and consistent results of a measuring tool (Creswell, 2008). Consistency is two ways in a period as inner and outer consistency. Consistency in period is obtaining similar results from measuring tool to same people at different times (Creswell, 2008; Punch, 2005). Inner consistency analysis is done by looking at correlation values between items that form a likert type scale (Altunışık, Coşkun, Bayraktaroğlu & Yıldırım, 2005). In this study, in the measurement of inner consistency of scale Cronbach Alfa coefficient was calculated. As Cronbach Alpha value is .92 regarding the total of scale, inner consistency coefficients in each sub factors are calculated as .93 and .80 respectively. Since these values are higher than .70 show that the scale is reliable. Also Guttman Split Half values were calculated in order to obtain reliability or consistency between two halfs. This value is .94 for "positive attitude" sub value, .80 for "negative attitude" sub value and for the total of scale is .72.

Grading of Scale

In this scale that was prepared to identify attitudes of students towards algebraic subject, quinary likert type grading scale (1. Completely disagree; 5. Completely agree) was used. In directive of scale the aim of this study and the points to take into account in filling of this scale was clearly expressed. The items in the scale are consisted of seventeen positive and nine negative expressions. The negative expressions in the scale were evaluated by reversing. The possible lowest grade that can be taken from scale is 25 whereas the highest grade is 125. In order to make interpretation easy, the total points taken from each sub factor was divided into item number in each sub factor and average value of each factor was calculated between 1 and 5.

DISCUSSION, CONCLUSION AND SUGGESTIONS

This study was done to develop a definite attitude scale which its validity and reliability was tested, towards algebra in the scope of mathematics. As a result of applied analysis two dimensional quinary likert type of scale that is consisted of 25 items was obtained. The obtained algebraic attitude scale involves two sub dimensions as "positive attitude" and "negative attitude". Those two dimensions in the scale largely shows similarity in the literature (Aiken, 1996; Tavşancıl, 2010) to the properties that has to be in attitude scale. Accordingly, it can be said that Algebraic Attitude Scale obtained from this study has rather high validity in terms of other attitude items in the literature.

The values obtained as a result of statistical analysis of validity and reliability for algebraic attitude scale also present strong evidences in suitability of scale for usage. The two dimensions in the scale explain 53.91% of total variance. This value is accepted as sufficient in terms of variance rates in social sciences that

is changing between 40% and 60% (Tavşancıl, 2010). As a result of explatory factor analysis the factor loads gathered in factors were found as .65 and higher. As a general rule Tabachnick and Fidell (2001), express .32 and higher factor loads can be used. In the direction of confirmatory analysis, the obtained accordance index values ($χ2/sd=2.8$; RMSEA= .057; SRMR= .046; GFI= 0.92; AGFI= 0.90; CFI= 0.98) show that the scale has good accordance value (Çokluk, Şekercioğlu & Büyüköztürk, 2010; Bayram, 2013; Schermelleh-Engel, Moosbrugger & Müller, 2003; Tabachnick & Fidell, 2001;).

In the scope of reliability of scale Cronbach Alpha (.92) and Guttman Split Half (.72) values were calculated. In literature it is known that the reliability coefficient for psychological test .70 or higher is enough for the reliability of test points (Büyüköztürk, 2006). According to this, it can be said that Algebraic Attitude Scale is rather a reliable measuring tool. On the other hand, the points obtained from items of scale were ordered from high to low by forming sub and upper 27% groups and independent groups were analysed by t-test. As a result of this analysis, it was found out that all items can identify groups significantly ($p<0.01$).

As a result the applied explatory and confirmatory analysis, according to the values obtained from content and scale validity with reliability analysis, it is seen that Algebraic Attitude Scale is a reliable and valid tool for secondary school students. In future similar studies, by reordering the validity and reliability values of algebraic attitude scale can be used for different class levels in secondary school. This study was only done for algebraic subject. Similar studies can also be done for different subjects.

REFERENCES

Aiken, L. R. (1996). *Rating scales and checklists: Evaluating behavior, personality, and attitudes*. New York: John Wiley & Sons.

Altunışık, R., Coşkun, R., Bayraktaroğlu, S. & Yıldırım, E. (2005). *Sosyal bilimlerde araştırma yöntemleri SPSS uygulamalı* (4. Baskı). Sakarya: Sakarya Kitapevi

Atnafu, M. (2010). Relation between Tenth Grade Students' Attitude and Components of Attitude in Algebra with Algebra Achievement of Addis Ababa Secondary Schools, Ethiopia. AddisAbabaUniversity, Ethiopia, Retrieved 2 December, 2013, from http://www.cimt.plymouth.ac.uk/journal/atnafu.pdf

Balcı, A. (2005). *Sosyal bilimlerde araştırma yöntem, teknik ve ilkeler*. Ankara: PegemA Yayıncılık.

Baykul, Y. (1990). *İlkokul beşinci sınıftan lise ve dengi okulların son sınıflarına kadar matematik ve fen derslerine karşı tutumda görülen değişmeler ve öğrenci yerleştirme sınavındaki başarı ve ilişkili olduğu düşünülen bazı faktörler*. Ankara: ÖSYM Yayınları.

Bayram, N. (2013). *Yapısal eşitlik modellemesine giriş AMOS uygulamaları* (2. Baskı). Bursa: Ezgi Kitabevi.

Bell, A. (1995). Purpose in school algebra. *Journal Of Mathematıcal Behavior*, 14, 41-73.

Büyüköztürk, Ş. (2006). *Sosyal bilimler için veri analiz el kitabı* (2. baskı). Ankara: Pegem A Yayıncılık.

Büyüköztürk, Ş., Çakmak, E., Akgün, Ö.E., Karadeniz, Ş. & Demirel, F. (2008). *Bilimsel araştırma yöntemleri*. Ankara: Pegem A Yayınları

Byrne; B. M. & Campbell, L. T. (1999). Cross-Cultural Comparisons and the Presumption of Equivalent Measurement and Theoretical Structure. *Journal of Cross-Cultural Psychology*, 30(5). 555-574.

Creswell, J. W. (2003). *Research design qualitative and quantitave and mixed methods approaches.*Thousand Oaks: Sage Publications.

Creswell, J. W. (2008). *Educational research planning, conducting, and evaluating qualitative and inquiry and research* (3rd ed.). New Jersey: Pearson International Edition.

Çağdaşer, B. T. (2008). *Cebir öğrenme alanının yapılandırmacı yaklaşımla öğretiminin 6. Sınıf öğrencilerinin cebirsel düşünme düzeyleri üzerindeki etkisi*. Unpublished master thesis, Uludağ Üniversity,Bursa.

Çokluk, Ö., Şekercioğlu, G. & Büyüköztürk, Ş. (2010). *Sosyal bilimler için çok değişkenli istatistik*. Ankara: Pegem Akademi.

Das, P. K. & Wilkinson, M. (2011). The effects of gender, class level and ethnicity on attitude and learning environment in college algebra course. *Journal of Mathematical Sciences & Mathematics Education,* 6(2), 44- 55. Retrieved 5 December, 2013, fomhttp://msme.us/2011-2-6.pdf .

DeVellis, R. F. (2003). *Scale development: Theory and applications* (2th ed.). Thousand Oaks: Sage Publications.

Hodges, C. B. & Kim, C. (2013). Improving college students' attitudes toward mathematics. *TechTrends*, 57(4), 59-66.

Hu L.T. & 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), 1-55.

Jacobs, V. R., Franke, M. L., Carpenter, T. P., Levi, L. & Battery, D. (2007). Professional development focused on children's algebraic reasoning in elementary school. *Journal For Research in Mathematics Education*, 38(3), 258-288.

Kalaycı, Ş. (2005). *SPSS uygulamalı çok değişkenli istatistik teknikleri*. Ankara: Asil Yayın Dağıtım.

Kaput, J. J. (1995). A research base supporting long term algebra reform? In D. T. Owens, M. K. Reed, & G. M. Millsaps (Eds.), Proceedings of the 17th Annual Meeting of PME-NA (Vol. 1, pp. 71-94). Columbus, OH: ERIC Clearinghouse for Science, Mathematics, and Environmental Education. Retrieved 5 December, 2013, from http://files.eric.ed.gov/fulltext/ED389539.pdf

Karasar, N. (1999). *Bilimsel araştırma yöntemleri* (9. baskı). Ankara: Nobel Dağıtım.

Kieran, C. (1992). The learning and teaching of school algebra. D. A. Grouws (Ed.), *Handbook of Research on Mathematics Teaching and Learning*, ss. 334-370, New York: Macmillan Library.

Kline, R. B. (2011). *Principles and practice of structural equation modeling* (3rd ed.). New York: Guilford Press.

Kulpa, C. S. (2007). *Algebra and the elementary school: Teacher math anxiety and its impact on student achievement.* Unpublished doctoral thesis. Walden University, Minnesota.

Lacampagne, C.,Blair, W. & Kaput, J. (1995). The Algebra Initiative Colloquium, Washington, DC: US Department of education. Retrived 5 December, 2013, fromhttp://files.eric.ed.gov/fulltext/ED385436.pdf

Leong, E. K. & Alexander, N. (2013). Exploring attitudes and achievement of web-based homework in developmental algebra. *The Turkish Online Journal of Educational Technology*, 12(4), 75-79.

Lian, L: N. & Idris, N. (2006). Assessing algebraic solving ability of form four students. *International Electronic Journal of Mathematics Education*, 1(1), 55-76.

Marsh, H. W., Hau, K., Artelt, C. Baumert, J. & Peschar, J. L. (2006). OECD's brief self report measure of educational psyhology's most useful affective construct: Cross-cultural, psychometric comparisons across 25 countries. *International Journal of Testing*, 6(4), 311-360.

McCoy, L. P. (2005). Effect of demographic and personal variables on achievement in eighth-grade algebra. *The Journal of Educational Research*, 98(3), 131-135

MEB, (2009). *İlköğretim matematik dersi 6-8. sınıflar öğretim programı ve kılavuzu*. Ankara: Devlet Kitapları Müdürlüğü Basımevi.

MEB, (2013). *Ortaokul matematik dersi (5,6,7 ve 8. Sınıflar) öğretim programı*. Ankara: Milli Eğitim Bakanlığı Talim Terbiye Kurulu Başkanlığı.

Myers, D. G. (2010). *Social psychology.* New York NY: Mcgraw Hill

NCTM, (2000). *Principles and standards for school mathematics*. Reston, VA: National Council of Teachers of Mathematics.

Norton, S. & Irvin, J. (2007). Developing positive attitudes towards algebra. *Mathematics: Essential research, essential practice*, 561-570.

Öner, A. T. (2009). *İlköğretim 7. sınıf cebir öğretiminde teknoloji destekli öğretimin öğrencilerin erişi düzeyine, tutumlarına ve kalıcılığa etkisi.* Yayınlanmamış yüksek lisans tezi, Dokuz Eylül Üniversitesi, İzmir.

Punch, K. P. (2005). *Sosyal araştırmalara giriş nicel ve nitel yaklaşımlar* (D. Bayrak, H. B. Arslan & Z. Akyüz, Çev.). Ankara: Siyasal Kitapevi.

Roberts, D. M. & Bilderback, E. W. (1980). Reliability and validity of a statistics attitude survey. *Educational And Psychological Measurement,* 40, 235-238.

SattarGasim, A. (2012). Eighth grade students attitude towards algebra in Maldivian schools. Retrieved from 2 December, 2013, from, http://www.villacollege.edu.mv/iri/images/eighth-grade.pdf

Schermelleh-Engel, K., Moosbrugger, H., & Müller, H. (2003). Evaluating the Fit of Structural Equation Models: Tests of Significance and Descriptive Goodness-of-Fit Measures. Methods of Psychological Research Online 2003, Vol.8, No.2, pp. 23-74. Retrieved from 2 December, 2013, from, http://www.dgps.de/fachgruppen/methoden/mpr-online/issue20/.

Schoenfeld, A. (1995). Report of Working Group 1 (In C. LaCampagne, W. Blair & J. Kaput), The Algebra Initiative Colloquium (pp. 11-18). Washington, DC. Retrieved from 5 December, 2013, from http://files.eric.ed.gov/fulltext/ED385436.pdf.

Stephens, A. C. (2007). What "counts" as algebra in the eyes of preservice elementary teachers?. *Journal of Mathematical Behavior*, 27, 33–47.

Tabachnick, B. G.& Fidell, L. S. (2001). *Using multivariate statistics* (4th ed.). Boston: Allyn and Bacon.

Tavşancıl, E. (2010). *Tutumların ölçülmesi ve SPSS ile veri analizi* (4. Baskı). Ankara: Nobel Yayın Dağıtım.

Taylor-Cox, J. (2003). Algebra in the early years establishes the necessary groundwork for ongoing and future mathematics learning. *Young Children*, 14-21.

Usiskin, Z. (1988). Conceptions of school algebra usses of variables. Defining algebraic thinking and an algebra cirruculum. Retrieved from 2 December, 2013, from, http://qrc.depaul.edu/algebrainitiative/Articles/Usiskin_Conceptions_of_School_Algebra.pdf.

Van De Walle, J. A. (2012). *Elementary and middle school mathematics: Teaching developmentally.* Boston: Allyn and Bacon.

Vance, J. (1998). Number operations from an algebraic perspective. *Teaching Children Mathematics,* 4, 282-285.

Williams, S. E. & Molina, D. (1997). Algebra: What All Students Can Learn 41-44. The nature and role of algebra in the K-14 curriculum. Proceedings of a National Symposium (Washington, DC, May27-28, 1997). ED 429 801SE.

Yackel, E. (1997). A foundation for algebraic reasoning in the early grades. *Teaching Children Mathematics,* 3 (1997), 276-280.