International Electronic Journal of Elementary Education, 9(3), 627-644, March 2017

Developing the Irrational Beliefs in Mathematics Scale (IBIMS): A Validity and Reliability Study

Deniz KAYA [a] *

[a] *Ministry of National Education, Turkey*

Received: 11 September 2016 / Revised: 12 October 2016 / Accepted: 10 January 2017

Abstract

The purpose of this study is developing a valid and reliable scale intended to determine the irrational beliefs of students in mathematics. The study was conducted with a study group consisting of 700 students in 2015-2016 academic year. Expert opinions were received for the content and face validity of the scale, and the Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) were applied. After the EFA was applied a structure was obtained consisting of 20 items, which explained 53.86% of the total variance and the four factors. The findings obtained from the CFA showed that the structure consisting of 20 items and the four factors related to the Irrational Beliefs in Mathematics Scale (IBIMS) had adequate consistency indices (x^2/df=2.50, RMSEA=.056, SRMR=.056, GFI=.92, AGFI=.90, CFI=.92, IFI=.90, PNFI=.76). The total internal consistency coefficient of the scale was calculated as .81, and the internal consistency coefficients of the items of *Finding Reasons, Perfection, Being Conditioned* and *Inclinations for Being Accepted* were calculated as .85, .78, .71 and .66 respectively. The test-retest measurement reliability was found to be .75. The discrimination of the items in the scale was made with the total corrected item correlation by comparing the 27% lower-upper group comparisons.

Keywords: Developing scale, Irrational belief, Mathematics, Reliability, Validity

Introduction

Today, with the increasing importance of basic mathematical skills and competencies, many countries have felt the necessity of re-designing their educational policies, and have performed profound changes for this purpose. Especially, the research results of the Program for International Student Assessment [PISA], Trends in International Mathematics and Science Study, [TIMSS], International Association for the Evaluation of Educational Achievement [IEA], Progress in International Reading Literacy Study [PIRLS], National Council of Teachers of Mathematics [NCTM] and similar research institutions and programs that assess the knowledge and skills of students provide us with important clues for this purpose. In this context, the reports prepared by research institutions, and the widespread belief suggesting that the individuals and societies that can use mathematics in an efficient manner will have a voice in increasing the opportunities that will shape their futures made many educationalists to understand the factors that influence

* Address for correspondence: Deniz Kaya, Ministry of National Education, Izmir, Turkey. Phone: +90 507 9465098, E-Mail:denizkaya38@gmail.com

ISSN:1307-9298

mathematical success better (NCTM, 2000). No doubt, understanding the relations of these factors with each other in a better manner contributes greatly to the development of a desired and qualified mathematics teaching. However, the results of international tests show that the students of many countries are not at the desired level in terms of mathematical success (Martin, Mullis & Kennedy, 2007; Ministry of National Education, [MNE], 2014; Mullis, Martin, Robitaille & Foy, 2009; Organization for Economic Co-operation and Development, [OECD], 2014; Yalcin & Tavsancil, 2014). This situation has made the social, cognitive and affective characteristics that influence mathematical success become the focal point of many studies (Bandura, 1997; Bloom, 1998; Bruner, 1977; Campbell & Ramey, 1994; De Villiers, 1994; Piaget, 2013; Schunk & Zimmerman, 1998; Senemoglu, 2009; Wynn, 1992). It has been expressed in hypothetical expressions that cognitive characteristics (reasoning, problem solving, perception, memory, attention, imitation, and creativity) are important factors influencing success (Bandura, 1997; Bloom, 1998; Schunk & Zimmerman, 1998). As a matter of fact, the results of many studies conducted on mathematics support these hypothetical opinions (Arslan & Altun, 2007; Byron, 1995; Cai, 2003; Eurydice, 2012; Higgins, 1997; Isik & Kar, 2011; Ozsoy, 2005; Schonfeld, 1992; Van de Walle, 2004).

As it is already known, the majority of the behavioural characteristics that are supposed to be included in the educational needs of a student are defined as the cognitive characteristics (Ozcelik, 1998). In this context, cognitive characteristics have had their place among the important study topics of the literature researchers. In recent years, we can conclude that many academic studies, the majority of which are conducted on psychoanalytic hypotheses, have focused in the cognitive structures of students (Corey, 2005; Çivitci, 2006; Ellis & Dryden, 1997; Turkum, 1996; White, 2003; Wong, 2008). The concept of irrational beliefs in which the cognitive structure and processes are determined with various assessment methods and which is one of the study areas of the Rational Emotive Behaviour Therapy (REBT) is one of these concepts.

The idea of irrational beliefs is based on the REBT philosophy led by Albert Ellis in 1955. The most distinctive characteristics of this approach is that it associates the events, emotions, beliefs, evaluations and reactions of individuals with the influence of the psychological difficulties they undergo. In other words, ideas, emotions and behaviours influence each other at a major scale and act in a mutual cause and effect relationship. In this context, he defends the notion that humans are born with strong inclinations that are rational and irrational, beneficial and destructive (Ellis, 1999). According to this understanding, the reason that influence the spiritual health of humans in a negative manner is not bad environmental conditions, but the individuals' turning themselves into dysfunctional beings in emotional and behavioural terms. Ellis (1993) stated that individuals felt disappointment and being prevented when they failed or when they were not approved, and increased their discomfort by misconceptions, deductions and interpretations in the direction of their irrational desires. In this context, the REBT, which is one of the Cognitive Behavioural Therapy models, tried to explain its main idea on psychological problems with the concept of irrational beliefs. With the broadest meaning, irrational beliefs are defined as the cognition that lack empirical reality, which includes the expressions like "strict, dogmatic, unhealthy, and inharmonious", and which prevent the behaviour of reaching life goals and include compulsion and desire, and are not considered to be correct in logical terms (Can, 2009; Dryden & Neenan, 1996; Ellis, 1999; Ellis & Dryden, 1997; Ellis & Harper, 1997; Walen, DiGuiseppe & Dryden, 1992). Irrational beliefs generally develop when individuals convert the events and their desires about themselves into compulsory desires/demands (Corey, 2005; Nelson-Jones, 1982). The typical characteristics of these beliefs is that although they are dysfunctional, and do not have a logical and empirical validity, they are accepted as if they were real, and have selfdefeating patterns (Corey, 2005). For this reason, these thoughts trigger absolustic expectations about humans and events, awfulizing the negative results of an event in an excessive manner, and being vulnerable to any discomfort at a significant level (Abrams & Ellis, 1994; Corey, 2005).

When the literature is scanned, it is observed that there have been conducted studies reporting that there are positive and significant relations between irrational thinking and faulty thinking (Webber & Coleman, 1988), problem-solving skills (Bilge & Arslan, 2000), low self-respect (Daly & Burton, 1983), anxiety level (Çivitci, 2006; Lorcher, 2003), failure in classes (Bozkurt, 1998; Dilmac, Aydogan, Koruklu & Deniz, 2009), depression (Mclennan, 1987; Nelson, 1977), stress (Amutio & Smith, 2008), anxiety to establish communication (Altintas, 2006; Ambler & Elkins, 1985), anger (Ford, 1991), cancelling academic work (Bridges & Roig, 1997), gender (Bozkurt, 1998; Yurtal-Dinc, 1999), avoidant and postponing decision-making style (Can, 2009), aggressiveness (Kilicarslan, 2009), exam anxiety (Boyacioglu, 2010; Guler, 2012) and self-efficacy (Alcay, 2015). For example, Bilge and Arslan (2000) conducted a study by using different variables and examined the relation between problem solving skills and irrational thinking on 767 students whose irrational thinking levels varied. At the end of the study, it was observed that as the income levels of the families of the university students and their perceived academic success levels increased, and as their satisfaction on the educational medium they were studying at increased, and as the irrational belief levels in the residential units decreased, this situation influenced the problem-solving skills of the students in a positive manner. Çivitci (2006) conducted another study and examined the irrational belief levels of 405 students according to some socio-demographical characteristics. The findings of the study showed that the irrational belief levels of the students varied according to the educational status of their parents, perceived parent attitudes, perceived academic success and to the number of the siblings; however, it did not vary according to the grade, age, gender, employment status of the mother, and the structure of the family. Bridges and Roig (1997) examined the relation between irrational beliefs and delaying academic tasks in 195 university students. According to the study results, there is a significant relation between the "avoiding problems" sub-dimension, which is one of the sub-scales of the irrational beliefs, and the delaying academic tasks and duties variable. In another study conducted by Altintas (2006) on 395 secondary education students, it was reported that there is a significant relation between the communication skills of the teenagers from high schools and their irrational beliefs. When the gender variable is considered, it was determined that the irrational belief levels of female students were significantly higher than those of male students. On the other hand, Yurtal-Dinc (1999) conducted a study on 560 university students and examined their irrational beliefs (the need for approval, high expectations, the inclination of blaming someone, emotional irresponsibility, excessive anxiety, being addict, helplessness, and perfectionism) according variables like parents' attitudes (democratic, protective-demanding and authoritarian), gender, and the department they studied at. According to the data obtained in the study, the mean scores of the general irrational beliefs and high expectations sub-scale differed in favour of those with authoritative parent attitudes; and the helplessness sub-scale mean scores differed in favour of those with protective-demanding parent attitudes. The mean scores of the sub-scale of the inclination of blaming someone were observed to be higher in males than in females; and in the need for approval sub-scale, the mean scores of the students who were at the social sciences department, were found to be higher than those studying at science education departments. Daly and Burton (1983) conducted a study in which they examined the relation between irrational beliefs and self-respect and included 251 university students in their study. According to the data obtained, a negative and significant relation was found between the irrational beliefs and self-respect variables. In addition, it was reported that the irrational beliefs that predicted the low self-respect were the desire for being approved, high expectations, excessive anxiety and avoiding problems. The findings of the study conducted by Boyacioglu (2010) on 557 students indicate that there are positive and significant relations between the illogical beliefs of the students and exam anxiety. In this context, it was determined in previous studies that as the illogical belief levels of the students increased, so did their exam anxiety levels. Nelson (1977) examined the relation between irrational beliefs and depression in 156 university students. The correlation analyses revealed that depression had a significant relation with high expectations, excessive anxiety, helplessness and irrational beliefs, and there were low-level gender differences between the female and male students. Ford (1991) conducted a study with 110 subjects and investigated the relation between anger and irrational beliefs. At the end of the study it was determined that there is a significant relation between constant anger, angry nature, perception of injustice, the provocation factor among individuals and the irrational beliefs. Can (2009) conducted another study with 750 students and reported that there was a negative relation in the postponing, panic and avoidant sub-scales in the decision-making scale of the students whose irrational belief scale scores were low; and there was a positive relation between the self-respect sub-dimensions. Amutio and Smith (2008) conducted a study on 480 university students to determine the relation between the irrational beliefs and stress, and the results of this study revealed that there was a positive and significant relation between stress and irrational beliefs.

When the studies in the literature are examined in general terms, it is observed that the irrational beliefs were examined by considering them together with many variables (grade, gender, attitudes, residential areas, monthly income levels, etc.). When the field of mathematics education is considered, it is observed that there are limited studies conducted on the irrational beliefs of students. In addition to this, there are no scales that are specific to the irrational beliefs in mathematics education/teaching field. In this context, it is expected that this scale will bring a new insight to the studies that will be conducted on mathematics education. As a matter of fact, mathematics classes are considered as being boring and abstract subjects by many students and are not loved much (Aksu, 1985). On the other hand, it is also known that irrational beliefs have the quality of preventing individuals from reaching their goals and their happiness by influencing their emotions and thoughts in a negative manner. In this context, it is considered that examining many factor groups that influence the mathematical success of students together with the irrational beliefs in order to understand this issue better and to contribute to the solution of problems.

Method

The Model of the Study

The general scanning model was adopted in the study. The scanning models imply a research approach that aims to define an existing or past situation as is (Karasar, 2005). The study was designed in the descriptive scanning model and was conducted in two steps. In the first step, the IBIMS was developed; and in the second step; the scale, which was developed, was applied to another group to obtain evidence on the functionality of the scale.

The Study Group

The Study Group consisted of 700 students who were studying at the 6th, 7th, and 8th grades of a state secondary school in the city centre of Izmir in 2015-2016 academic year. 331 of the students were female (47.3%), and 369 were male (52.7%). In determining the number of the students that would constitute the study group, the criteria, which was recommended by Tabachnick and Fidell (2001) for factor analyses as 300 people *"good",* 500 people *"very good"* and 1000 people *"perfect"* was applied. In addition to this, classes from various grades were also included in the study group to increase the representation power of the scale for similar groups and to obtain a wide variance in terms of age.

Table 1. *The frequency table of the study group*

	6th Grade		7th Grade		8th Grade		Total	
	N	%	*N*	%	*N*	%	*N*	%
Female	129	48.1	112	48.5	90	44.8	331	47.3
Male	139	51.9	119	51.5	111	55.2	369	52.7
Total	268	38.3	231	33	201	28.7	700	100

Data Collection Tool

The hypothetical data on the research/studies conducted on irrational beliefs within our country and abroad were examined with literature scanning method. As a result of this scan, it was determined that the studies conducted for the purpose of measuring the irrational beliefs of students in mathematics were inadequate, and there were no scales to measure the irrational beliefs of secondary school students. In this context, an item pool consisting of 33 expressions was formed by considering the REBT hypothetical structure suggested by Albert Ellis in mid-1950s, and the irrational beliefs scale, which was developed by Jones (1969). The initial form, which consisted of 33 items, was presented to 5 experts (2 academicians, 1 mathematics teacher, and 2 psychology education) who had knowledge on this field and who were informed about the study to receive their viewpoints and to ensure the content and face validity. In order to receive the expert viewpoints, an assessment tool consisting of three items was used. In this assessment tool, the experts were asked to choose one of the options *"suitable", "must be corrected"* and *"not suitable".* By combining all the assessment tools as one assessment tool, the issue of how many experts approved each possible option of the items was determined. In this context, the content validity of the items was determined with the *"(The number of the experts who answered positively/The number of total experts)-1"* formula for each item (Veneziano & Hooper, 1997). After this calculation, four items whose content validity ratios were below 0.80 were excluded from the study. In addition to this, three items which were considered to have similar meanings, and another two items which were considered to cause misconceptions were determined and excluded from the scale. After the necessary changes were made in accordance with the expert viewpoints, a grammar teacher was consulted in order to ensure the understand ability of the scale in terms of language and typos. As a result, the draft scale, which had 24 items, was designed in a 5-point structure, which consisted of statements *"I definitely do not agree (1), I do not agree (2), I am indecisive (3), I agree (4) and I definitely agree (5)".* The possible highest score that could be received from the scale is 120, and the lowest score is 24. The scores' being high shows that the irrational beliefs of the student are at higher levels, and the scores' being low indicates that the irrational beliefs of the student are at the lower levels. As a last item, the draft form was applied as a pre-application to 30 students, who were selected randomly, studying at a state school in Izmir in order to determine the item/items that were not understood and to detect the spelling mistakes and approximate response time. According to the data, it was determined that there was no misunderstandings and spelling mistakes in the draft form. The sixth grade students completed the scale in approximately 25 minutes. Since the scale would be applied to upper grades (7th and 8th grades), this time was considered to be adequate. The draft form was applied in classroom medium after explaining the purpose of the study to the participants.

The Collection and Analysis of the Data

In order test the validity and reliability of the IBIMS which was prepared as a draft form, it was pre-applied to 700 students, who were in the first study group by the authors of the study. The Kaiser-Meyer Olkin (KMO) coefficient was applied to determine whether the sampling size was suitable for factorization or not, and the Barlett Test of Sphericity was applied to determine whether or not the data were from multivariate normal distribution. The validity investigations of the scale were performed by examining the structural validity. For the structural validity, the factorial structure of the scale was determined by using the Explanatory and Confirmatory Factor Analyses. The EFA is applied to determine the association between the unknown latent variables and the observed variables (Çokluk, Sekercioglu & Buyukozturk, 2014). This analysis is defined as being explanatory or a discoverer for researchers who do not have any ideas on the issue of under which factor the items perform measurements in reality (Byrne, 1994). As a matter of fact, it is expected in factor analysis, which is performed to locate the variable in the factor group in question, that the factor loads are high. When the literature is scanned it is observed that there is a widely-held belief that an item must have at least 0.30 minimum size for the factor load of the relevant item. According to Tabachnick and Fidell (2001), the load value of each variable must be evaluated at or over 0.32 as a basic rule. In addition to these, the explained total variance in single-factor designs being minimum 30% is considered to be adequate (Buyukozturk, 2011), while it is expected to be over 41% in multi-factorial designs (Kline, 2005).

The CFA, on the other hand, is beneficial in efforts to develop, organize and review the measurement scales (Floyd & Widaman, 1995). According to Kline (2005), in the CFA results of a measurement model, the correlation predictions among the factors, the loads under the factors to which the indicators are connected, and the amount of the measurement error for each indicator are given. CFA is the most influential analysis used to assess whether a pre-defined factor model fits the data (Çokluk et al., 2014). Many fit indices are used in order to determine the adequacy of the model tested in CFA (Jöreskog & Sörbom, 1993). In this study, the Chi-Square Goodness Test, Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Comparative Fit Index (CFI), Incremental Fit Index (IFI), Parsimony Normed Fit Index (PNFI), Standardized Root Mean Square Residual (SRMR), and Root Mean Square Error of Approximation (RMSEA) were examined for CFA. In these goodness indices, GFI, AGFI, CFI, IFI and PNFI being >.90, RMSEA and SRMR being <.08 are considered as criteria, which is generally the situation (Çokluk et al., 2014; Tabachnick & Fidell, 2001). The internal consistency (alpha) and test-retest reliability coefficients were examined for the reliability investigations of the IBIMS. For item analysis, the significance of the difference between the item average values of the upper 27% and lower 27% groups and the corrected item-total scores correlation were examined by using the t-test. The SPSS 22.0 and AMOS 24.0 programs were used for the validity and reliability analyses of the scale.

Findings

In this part, the findings on validity and reliability tests, which were conducted to develop the IBIMS are provided.

Explanatory Factor Analysis

Firstly, the internal consistency of the scale was examined for the suitability of structural validity. As a result of the analysis, no items were detected with low item-total correlation in the 24-item scale. The KMO and Barlett Sphericity tests were applied to determine whether the 24-item scale fit the factor analysis or not. The KMO value, which is used to determine whether or not the data and the sampling size are adequate and suitable for the selected analysis, was found to be .87. In addition, the Barlett Sphericity test, which is used to check whether the data come from multi-variate normal distribution or not, was applied and the result was found to be significant (x^2=4234.6, p<.01). It is necessary that the KMO measurement test result is .60 and over, and the result of the Barlett Sphericity test is statistically significant (Jeong, 2004). Since the values obtained as a result of the aforementioned analyses fit the basic hypotheses at a good level, it was decided that the factor analysis could be conducted (Tavsancil, 2010). Since the factor loads show the correlation between the item to be measured and the main structure, the relevant dimensions that appeared as a result of the basic component analysis and the factor loads were examined. Since 3 items showed high load values in two or more factors, and because they did not fit the factor that was supposed to measure a certain attribute, they were excluded from the scale by receiving the expert opinion. In situations where the difference in cross items was below .20, which contributed greatly to the content validity of the sub-dimensions, the items that fit the sub-dimension was preferred (Plotnikoff, 1994). Another item was also excluded from the scale because it had low factor load (<.30). After these processes, the last form of the IBIMS was given as 20 items.

The rotated components matrix, which was converted with Varimax method, and which was obtained as a result of the factor analysis, is given in Table 2, and the eigenvalue graphics is provided in Figure 1. The Varimax method, which is one of the vertical spinning methods, was preferred in order to ensure that the factor variances would have high value with a few variables. According to the analysis results, there are six items about the *"inclination for finding reasons"* factor of the irrational beliefs in mathematics, which are given in Table 2. It is observed that the factor load values of the items vary between .568 and .840, and explain 22.18% of the total variance. In the second factor, there are six items of *"inclination for perfection"* factor of the irrational beliefs in mathematics, and the factor load values of the items vary between .541 and .734, and explain 18.03% of the total variance. In the third factor, there are five items of the *"inclination on being conditioned"* of the IBIMS and the factor load values of the items vary between .578 and .735, and explain 7.26% of the total variance. In the fourth factor, there are three items of *"inclination for being accepted"* factor of the IBIMS, and the factor load values of the items vary between .715 and .730, and explain 6.37% of the total variance. As a result, the total variance explained by these four factors is 53.86%.

Table 2. *Explanatory factor analysis results of the scale*

		Factor Load Values*			
Item	Common Factor Variance	Factor 1	Factor 2	Factor 3	Factor 4
7	.756	.840			
5	.716	.821			
6	.602	.764			
2	.568	.738			
1	.511	.691			
8	.517	.568		.437	
16	.579		.734		
18	.488		.695		
14	.501		.692		
12	.517		.673	.207	
17	.452		.645		
15	.375		.541		.241
9	.639			.735	.279
11	.479		.250	.641	
3	.452			.637	
10	.450			.603	.220

Table 2 (Cont.). *Explanatory factor analysis results of the scale*

4	.406			.578	
23	.631		.264		.730
22	.552				.724
24	.582		.246		.715
Eigenvalue (Total=10.773)		4.437	3.607	1.454	1.275
Explained Variance (Total=53.865)		22.184	18.037	7.269	6.375

*Values below ±0.20 are not given.

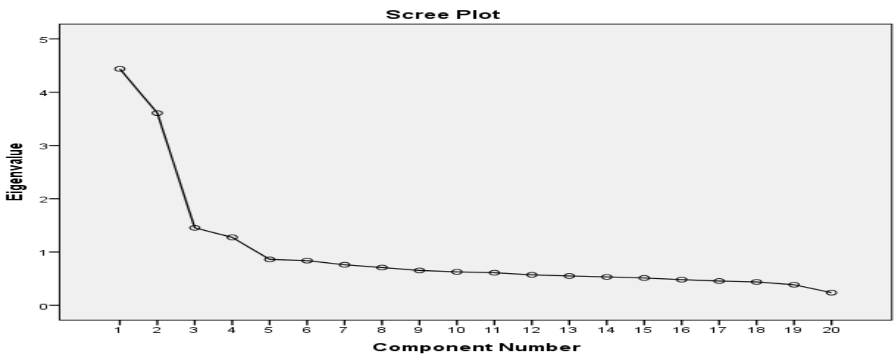

Figure 1. *Scree Plot*

Confirmatory Factor Analysis

The structure of the IBIMS, which consisted of 20 items and four factors, was tested by using the CFA. This analysis was made over 484 students, who were selected randomly from the sampling group (n=700) that were used in EFA work. The findings obtained as a result of analyzing the model with CFA are given below. The chi-square/sd value (411.502/164=2.50) was found to be showing that the CFA results have a good fit [RMSEA=.056, SRMR=.056, GFI=.92, AGFI=.90, CFI=.92, IFI=.90, PNFI=.76]. The standard values for the indices: The GFI and AGFI values must be between 0 and 1. Although there is no consensus on these values in the literature, if the values are over 0.85 and 0.90, this is the evidence of a good fit (Kline, 2005; Schumacker & Lomax, 1996). The RMSEA values also vary between 0 and 1. The more these values are close to 0, the more they indicate a fit. The x^2/df ratio is a good fit indicator, and if it is below 2, this shows a perfect fit (Jöreskog & Sörbom, 1993; Kline, 2005). As a result, all the standard fit indices show that the factor structure of the model is approved.

Table 3. *The fit indices and standard fit criteria for the proposed model*

Fit Indices	Good Fit	Acceptable Fit	Scale Values
x^2/df	≤3	≤5	2.50
RMSEA	≤.05	≤.08	.056
SRMR	≤.05	≤.08	.056
GFI	≥.95	≥.90	.92
AGFI	≥.90	≥.85	.90
CFI	≥.95	≥.90	.92
IFI	≥.95	≥.90	.90
PNFI	≥.95	≥.50	.76

x^2=411.512, *sd*=164, 90% probable confidence interval=[.049, .063] for RMSEA

The t-test values of the four-factor model obtained as a result of CFA are given in Table 4. When the findings in Table 4 are examined it is observed that the t-test values for *Inclination for Finding Reasons* [F1] sub-scale vary between 13.08 and 23.79; for

Inclination for Perfection [F2] sub-scale vary between 11.86 and 14.89; for the *Inclination for Being Conditioned* [F3] sub-scale vary between 8.90 and 12.70; and for *Inclination for Being Accepted* [F4] sub-scale vary between 13.31 and 19.00. The t values' being over 1.96 shows that they are significant at .05 level; and being over 2.58 shows that they are significant at .01 level (Jöreskog & Sörbom, 1993; Kline, 2005). In this context, it was determined that all the t values obtained in CFA were significant at .01 level. For this reason, the t values obtained in CFA confirm that the number of the participants is adequate for factor analysis, and reveal that there are no other items to be excluded from the model.

Table 4. *The t-test values obtained from CFA for IBIMS*

F1		F2		F3		F4	
Item No	t Value	Item No	t Value	Item No	t Value	Item No	t Value
1 (7)	23.79*	7 (12)	14.89*	13 (3)	11.60*	18 (22)	14.31*
2 (5)	22.15*	8 (14)	14.19*	14 (4)	8.90*	19 (23)	19.00*
3 (6)	17. 47*	9 (15)	11.86*	15 (9)	12.70*	20 (24)	13.31*
4 (2)	15.53*	10 (16)	14.37*	16 (10)	11.54*		
5 (1)	13.08*	11 (17)	13.55*	17 (11)	10.60*		
6 (8)	14.33*	12 (18)	13.19*				

*$p<.01$ (the numbers in the brackets denote the item numbers in the draft scale)

Reliability Study

The reliability of the measurement values obtained with IBIMS was computed with the Cronbach alpha reliability and test-retest reliability methods. The Cronbach alpha reliability coefficients of the measurements was found to be .85 for inclination for finding reasons sub-scale; .78 for inclination for perfection sub-scale; .71 for the inclination for being conditioned sub-scale; .66 for inclination for being accepted sub-scale; and .81 for the whole of the scale. The test-retest reliability of the scale was tested on 56 students after three weeks, and was found as .75. When the fact that the measurements whose reliability coefficients are .70 and over are accepted as reliable is considered (Fraenkel, Wallen & Hyun, 2012), it is possible to suggest that the reliability coefficients are adequate. The results on reliability analysis are given in Table 5.

Table 5. *Reliability coefficient values of the scale*

Sub-dimensions	Cronbach's α
Finding reasons inclination	.85
Perfection inclination	.78
The inclination for being conditioned	.71
Inclinations for being accepted	.66
The whole of the scale	.81
Test-retest measurement	.75

In order to determine the distinctiveness level of the items in IBIMS, and to see its prediction power for the total scores, the corrected item total correlation was computed, and 27% bottom-up group comparisons were applied. The results obtained in the item analysis are given in the table below. When the findings in Table 6 are examined it is observed that the t values of the differences in item scores of the 27% bottom-up groups varies between 5.78 and 15.94 for all items ($p<.01$). In addition to this, when the results of the item total correlation are examined, it is observed that the items in the scale have values between .36 and .78. The t value of the differences between the bottom-up groups being significant is considered as a proof for the distinctiveness of the item (Erkus, 2012). Based on these findings, it is possible to suggest that all the items in the scale are distinctive.

Table 6. *The corrected item-total correlations of the scale, and the t values on 27% lower-upper group difference*

Item no	Item total correlation	*t*	Item no	Item total correlation	*t*
1	.46	13.868*	11	.49	11.359*
2	.45	14.346*	12	.36	5.789*
3	.42	14.236*	13	.53	14.774*
4	.38	10.898*	14	.50	12.595*
5	.40	11.501*	15	.52	12.177*
6	.50	13.151*	16	.57	15.940*
7	.43	8.918*	17	.50	12.559*
8	.42	8.698*	18	.62	10.438*
9	.50	11.636*	19	.78	14.538*
10	.38	7.395*	20	.65	11.387*

*$p<.01$

Criterion Validity

In order to ensure the criterion validity of the scale, the application was made with 116 female (48.74%) and 122 male (51.24%) students, 238 students in total. 95 (39.1%) of the 238 students who participated in the study were 6th graders; 65 (27.3%) were 7th graders; and 78 (33.6%) were 8th graders. The scores of the students received from the IBIMS were examined firstly according to the gender and the t-test results for the validity study of the scale. The results are given in the table below.

Table 7. *The t-test results according to gender variable*

Group	*N*	Mean	Std. Deviation	df	*t*	*p*
Female	116	2.669	.514	236	-2.591	.010
Male	122	2.846	.534			

When Table 7 is examined, it is observed that the scores received by the students from IBIMS vary according to gender ($t_{(236)}$=-2.591; $p<.05$). According to this result, the mean score received by male students (M=2.84) is more than that of the female students (M=2.66), and therefore, we can conclude that the irrational beliefs in mathematics are more. The relation between the irrational beliefs of the students on mathematics and their academic grades were examined for another scale validity examination. The academic success criteria of the students consist of the average grades (all subjects at school) in the report card in the semester before the study was conducted. In this context, three terms were evaluated for the 6th grade, five terms were evaluated for the 7th grade, and seven terms were evaluated for the 8th grade. The measurements were made according to the 5-point system. The average of the academic success levels of the students was 3.24; the standard deviation was 1.22; the mode was 4 and the median was 3.

The issue of whether or not the irrational beliefs in mathematics of the students varied according to academic grades of the students was analysed with the ANOVA test for repetitive measurements. On the other hand, in order to determine the source of the possible differences that might appear between the variables that showed normal distribution, the Post Hoc *"Bonferroni Test",* which is one of the multiple comparison tests, was used. The results obtained are given in the table below.

Table 8. *The ANOVA results according to the academic grades on IBIMS*

Variance source	Sum of squares	*df*	Mean square	*F*	*p*	The source of the significant difference
Between Groups	3.286	4	.822	3.006	.019*	1-5**
Within Groups	63.681	233	.273			
Total	66.967	237				

*Significant at *p< .05* level. **The measurements in which differences were detected in Bonferroni test.

When Table 8 is examined it is observed that there are statistically significant differences between the mean scores of the students who had different academic grades on irrational beliefs in mathematics ($F_{(4\text{-}233)}$=3.006; p<.05). The source of this significant difference was concluded to be between 1-5 academic grades. In this context, we can suggest that as the academic grades of the students increase, they have less irrational beliefs in mathematics.

Evaluation of the Scores Received from IBIMS

There are 20 items in IBIMS. A 5-point Likert scale was used in the scale which consisted of statements "I definitely do not agree (1)" and "I definitely agree" (5). The scale has a 4-dimensional structure consisting of 6 items in the *inclination for finding reasons* and *inclination for perfection* dimension; 5 items in *inclination for being conditioned* dimension; and 3 items in the *inclination for being accepted*. For this reason, the scores that may be received from inclination for finding reasons and inclination for perfection dimensions vary between 6 and 30; the scores that may be received from inclination for being conditioned dimension vary between 5 and 25; and the scores that may be received from inclination for being accepted dimension vary between 3 and 15 (Appendix-1). When the scores received from IBIMS were being assessed, the scores received from the sub-scales were used for the processes. The scores received from the sub-dimensions of IBIMS being high shows that students have high-level perceptions in that dimension.

Results

In this study, the aim was to develop a measurement scale that would allow obtaining valid and reliable results in irrational beliefs in mathematics of the students. When the IBIMS was being developed, the REBT hypothetical structure developed by Albert Ellis (1955) and the irrational beliefs scale developed by Jones (1969) were taken into consideration. In addition, expert opinions were received in order to ensure the content and face validity of the scale. In the light of the expert viewpoints, 9 items were excluded from the item pool that was initially formed. In this way, a draft form consisting of 24 items were obtained. The items in the scale were applied to the students in the study group with the 5-point Likert scale as I definitely agree (5) → I definitely do not agree (1). The first scale form, which had twenty-four items, was applied to 700 secondary school students consisting of students from sixth, seventh and eighth grades. Since three items showed high load values in two or more factors, and since one item showed low factor load value (<.30), they were excluded from the scale. The structural validity of the scale was analyzed with EFA and CFA. Four items were removed from the scale after EFA and a structure consisting of four factors were obtained. The factor load values of the items varied between .54 and .84, and explained 53.86% of the total variance. On the other hand, the total eigenvalue of the scale was found to be 10.77. Generally, it is recommended that .50 value is taken as the criterion about the common variance (Thompson, 2004). In this context, it is possible to claim that the total common variance of the scale is at a good level. The factors were named as *inclination for finding reasons, inclination for perfection, inclination for being conditioned* and *inclination for being accepted*. The total internal consistency coefficient of the scale was found as .81; and the internal consistency coefficients of the inclination for finding reasons, inclination for perfection, inclination for being conditioned and inclination for being accepted were found as .85, .78, .71 and .66 respectively. The test-retest measurement reliability was found as .75. When the fact that the measurement whose internal consistency coefficient is .70 and over are accepted as being reliable is considered (Fraenkel, Wallen & Hyun, 2012), it is possible to claim that the reliability coefficients are at a good level.

The factors that were obtained at EFA were tested with CFA. The fit values were computed as x^2/df=2.50, RMSEA=.056, SRMR=.056, GFI=.92, AGFI=.90, CFI=.92, IFI=.90, PNFI=.76. According to this result, the AGFI value has a good fit value, and the RMSE, SRMR, GFI, CFI, IFI and PNFI values have acceptable good fit values. When the fact that the fit indices computed in CFA are in acceptable limits is considered, it is possible to claim that the structural validity of the measurements obtained from IBIMS has been achieved. On the other hand, it was determined that the t-test values of the model with four factors obtained as a result of CFA varied between 8.90 and 23.79. The t values being higher than 2.58 shows that it is significant at .01 level (Jöreskog & Sörbom, 1993; Kline, 2005). In this context, all the t values obtained in CFA were found to be significant at .01 level. As a conclusion, the t values obtained in CFA confirmed that the number of the participants in the study was adequate for factor analysis, and revealed that there were no items that needed to be eliminated from the model.

The item analysis was performed in order to determine the prediction power of the items for the total score and to determine the distinctiveness levels. In item analysis, the corrected item total correlation was examined, and 27% bottom-up group comparisons were made. After the analysis, it was determined that the corrected item total correlations varied between .38 and .50 for inclination for finding reasons sub-scale; between .36 and .50 for inclination for perfection sub-scale; between .50 and .57 for inclination for being conditioned sub-scale; and between .62 and .78 for inclination for being accepted sub-scale; and that the t values of the differences between the 27% bottom-up groups was significant for all items included in the scale. These findings indicate that all of the items included in IBIMS are distinctive. An application was performed with 238 secondary school students who were studying at sixth, seventh, and eighth grades in order to ensure the scale validity of the measurement tool. Firstly, the IBIMS was tested according to the gender variable, and was examined according to the t-test result. According to the findings, the scores received by the students in IBIMS showed variations according to gender variable ($t_{(236)}$=-2.591; p<.05). Since the mean score obtained by male students (M=2.84) is more than that of the female students (M=2.66), it was concluded that the irrational beliefs in mathematics were more. Another scale validity test was performed according to the academic grades of the students. Whether the irrational beliefs in mathematics of the students varied according to academic grades or not was analysed with ANOVA. The Bonferroni test, which is one of the multiple comparison tests, was applied to the dataset in order to determine the source of possible differences that might appear among the academic grade variables. According to the results, it was concluded that the source of the significant difference stemmed from the academic grades between 1 and 5. In this context, it was also concluded that as the academic success levels increased, the logical beliefs of the students in mathematics decreased ($F_{(4\text{-}233)}$=3.006; p<.05). As a result, it was concluded that the scale, which was developed in the scope of the study, is a scale that produces valid and reliable results, and may be used in determining the irrational beliefs of students in mathematics.

Recommendations and the Limitations of the Study

When the relevant literature is examined it has been observed that there are no measurement tools in international studies to determine the irrational beliefs of students in mathematics and to obtain conclusions in the light of different variables. It is considered that IBIMS, which has been developed in this study, will fill the gap in this field in the literature. For this reason, the strongest aspect of this study is that it will ensure that the consideration of irrational beliefs is included in the field of mathematics education. Another strong side of the measurement tool is that it provides more than one single proof for the distinctive, structural validity and reliability of the items of the scale. In addition to this, with the help of the scale, it is expected that the concept of irrational beliefs, which is a psychoanalytic approach, will provide the opportunity to know students better in a wide range by handling the mathematics education in this context. By doing so, the cognitive structures that are not accepted to be true in terms of logic, including *Inclination for Finding Reasons, Inclination for Perfection, Inclination for Being Conditioned* and *Inclination for Being Accepted,* developed by students in mathematics will be investigated in a detailed manner. As a matter of fact, the concept of irrational beliefs, which is used frequently in today's world in psychology education, is handled with some parameters like the level of anxiety (Çivitci, 2006; Lorcher, 2003), gender (Bozkurt, 1998; Yurtal-Dinc, 1999), anger (Ford, 1991), and exam anxiety (Boyacioglu, 2010; Guler, 2012). However, the notion of irregular beliefs is spread to a wider area that cannot be limited with psychology education. For this reason, one of the greatest contributions of the study, which was conducted on mathematics teaching, to the literature is to provide the instructors with a different practice field. In addition to this, the study was conducted with the students from secondary school level, and this will facilitate the conduction of future similar studies at different educational levels. Especially the irrational beliefs of high school and university students developed in mathematics may be investigated and the factor groups that influence the mathematical success may be examined. On the other hand, the irrational beliefs of students in mathematics may be investigated with new studies in terms of gender and grade level as well as in terms of some other variables (educational medium, the success in classes, student-teacher communication, anxiety, school management, income levels, etc.) which may be influential in the beliefs in the classes. It is expected that the scale, which has been developed in the scope of this study, may be used in studies that investigate the factors influencing school success together with sub-dimensions. The study also has some limitations as well as its strong sides mentioned above. The first limitation of the study is the issue of whether the structure obtained with the EFA was confirmed or not was examined by conducting the CFA over the same dataset. In this context, the CFA must be tested again over different datasets, and it must not be underestimated that additional proof must be obtained for the confirmation of the structure obtained. Studies that will be conducted with multiple method matrix may provide stronger proofs on the validity of the scale. Another limitation is the fact that one single educational institution was used in the process of developing the measurement tool. In this context, different educational institutions must be included in future studies, and this will contribute to the structural validity of the scale.

• • •

References

Abrams, M., & Ellis, A. (1994). Rational emotive behaviour therapy in the treatment of stress. *Journal of Guidance and Counselling, 22*(1), 117-123.

Aksu, M. (1985). *Problems in mathematics education and secondary education institutions.* Ankara: T.E.D. Publishing.

Alcay, A. (2015). *Examining the relationship between self-efficacy and irrational beliefs of adolescents.* Unpublished master dissertation, Education Science Institute, Dokuz Eylül University, Izmir-Turkey.

Altintas, G. (2006). *Investigating the relationship of communication skills and irrational beliefs of high school adolescents with respect to some independent variables.* Unpublished master dissertation, Education Science Institute, Gazi University, Ankara-Turkey.

Ambler, B., & Elkins, M. (1985). *An examination of relationship between irrational beliefs and communication apprehension.* Paper presented at the 71st annual meeting of the Speech Communication Association (Denver, CO, November 7–10). Retrieved from http://files.eric.ed.-gov-/fulltext/ED278081.pdf.

Amutio, A., & Smith, J. C. (2008). Stress and irrational beliefs in college students. *Ansiedad y Estrés, 14*, 211-220.

Arslan, Ç., & Altun, M. (2007). Learning to solve non-routine mathematical problems. *Elementary Education Online, 6*(1), 50-61.

Bandura, A. (1997). *Self-efficacy: The exercise of control.* New York: Freeman.

Bloom, B. S. (1998). *Human nature and learning in school (Trans. D. A. Ozcelik) (3th Ed.).* Istanbul: Ministry of National Education Publishing.

Bilge, F., & Arslan, A. (2000). Problem solving skills of university students whose irrational thoughts are different. *Turkish Psychological Counselling and Guidance Journal, 2*(13), 7-18.

Boyacioglu, N. E. (2010). *Irrational beliefs and test anxiety among early adolescents.* Unpublished master dissertation, Health Science Institute, Istanbul University, Izmir-Turkey.

Bozkurt, N. (1998). *An investigation of automatic thoughts and depression related with school achievements in high school students.* Unpublished doctoral dissertation, Social Science Institute, Dokuz Eylül University, Izmir-Turkey.

Bridges K. R., & Roig, M. (1997). Academic procrastination and irrational thinking: A re-examination with context controlled. *Personality and Individual Differences, 22*(6), 941-944.

Bruner, J. S. (1977). *Process of education.* Cambridge, MA: Harvard University Press.

Buyukozturk, Ş. (2011). *Data analysis handbook for social sciences (15th Ed.).* Ankara: Pegem Academy.

Byrne, B. M. (1994). *Structural equation modelling with EQS and EQS/windows: Basic concepts, applications, and programming.* California: Sage Publishing.

Byron, M. K. (1995). *Confronting the verbal/visual issue: The mathematical problem-solving processes of a small group of female junior secondary students.* Unpublished doctoral dissertation, The Ohio State University, Ohio-USA.

Cai, J. (2003). Singaporean students' mathematical thinking in problem solving and problem posing: An exploratory study. *International Journal of Mathematical Education in Science and Technology, 34*(5), 719-737.

Campbell, F. A., & Ramey, C. T. (1994). Effects of early intervention on intellectual and academic achievement: A follow-up study of children from low-income families. *Child Development, 65*(2), 684-698.

Can, Ö. (2009). *Examination of the irrational beliefs of university students and decision making style.* Unpublished master dissertation, Social Science Institute, Selçuk University, Konya-Turkey.

Corey, G. (2005). *Psychological counselling psychotherapy theory and applications (Trans. T. Ergene).* Ankara: Mentis Publishing.

Çivitci, A. (2006). Irrational beliefs in adolescents: An investigation according to socio-demographic variables. *Pamukkale University Journal of Education, 19,* 7-17.

Çokluk, Ö., Sekercioglu, G., & Buyukozturk, Ş. (2014). *Multivariate statistics for the social sciences: SPSS and LISREL applications (3th. Ed.).* Ankara: Pegem Academy.

Daly, M. J., & Burton, R. L. (1983). Self-esteem and irrational beliefs: An exploratory investigation with implications for counselling. *Journal of Counselling Psychology, 30,* 361–366.

De Villiers, M. (1994). The role and function of a hierarchical classification of quadrilaterals. *For the Learning of Mathematics, 14*(1), 11-18.

Dilmac, B., Aydogan, D., Koruklu, N., & Deniz, M. E. (2009). The explication of primary school students' perfectionist properties with irrational beliefs. *Elementary Education Online, 8*(3), 720-728.

Dryden, W., & Neenan, M. (1996). *Dictionary of rational emotive behaviour therapy.* London: Whurr Publishing.

Ellis, A. (1955). New approaches to psychotherapy techniques. *Journal of Clinical Psychology Monograph Supplement, 11,* 1-53.

Ellis, A. (1993). Reflection on rational-emotive therapy. *Journal of Consulting and Clinical Psychology, 61*(2), 199-201.

Ellis, A. (1999). Early theories and practices of rational emotive behaviour therapy and how they have been augmented and revised during the last three decades. *Journal of Rational-Emotive and Cognitive-Behaviour Therapy, 17*(2), 69-93.

Ellis, A., & Dryden, W. (1997). *The practice of rational-emotive behaviour therapy.* New York: Springer Publishing.

Ellis, A., & Harper, R. A. (1997). *A guide to rational living.* North Hollywood. CA: Melvin Powers Books.

Erkuş, A. (2012). *Measurement and scale development in psychology.* Ankara: PegemA Publishing.

Eurydice (2012). *The European higher education area in 2012: Bologna process implementation report.* Brussels: EACEA P9 Eurydice. Retrieved from http://sgb.meb.gov.tr/eurydice/.

Floyd, F. J., & Widaman, K. F. (1995). Factor analysis in the development and refinement of clinical assessment instruments. *Psychological Assessment, 7*(3), 286-299.

Ford, B. D. (1991). Anger and irrational beliefs in violent inmates. *Personality and Individual Differences, 12*(3), 211-215.

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2012). *How to design and evaluate research in education (8th ed.).* New York: McGram-Hill Companies.

Güler, D. (2012). *Relationship of test anxiety with irrational beliefs and parental attitudes in 12th year high school students.* Unpublished master dissertation, Social Science Institute, Akdeniz University, Antalya-Turkey.

Higgins, K. M. (1997). The effect of long instruction in mathematical problem solving on middle school students' attitudes, beliefs and abilities. *Journal of Experimental Education, 66*(1), 5-24.

Isik, C., & Kar, T. (2012). The analysis of the problems posed by the pre-service teachers about equations. *Australian Journal of Teacher Education, 37*(9), 93-113.

Jeong, J. (2004). *Analysis of the factors and the roles of HRD in organizational learning styles as identified by key informants at selected corporations in the Republic of Korea.* Unpublished doctoral dissertation, Texas A & M University, USA.

Jones, R. G. (1969). *A factored measure of Ellis's irrational belief system with personality and maladjustment correlates.* Unpublished doctoral dissertation, Texas Technological College, Texas-USA.

Jöreskog, K. G., & Sörbom, D. (1993). *Lisrel 8: Structural equation modeling with the simplis command language.* Lincolnwood: Scientific Software International, Inc.

Karasar, N. (2005). *Scientific research methods.* Ankara: Nobel Publishing.

Kilicarslan, S. (2009). *The relationships between irrational beliefs and aggressiveness in adolescent.* Unpublished master dissertation, Social Science Institute, Çukurova University, Adana-Turkey.

Kline, R. B. (2005). *Principles and practice of structural equation modelling (2nd ed.).* New York: Guilford Publications, Inc.

Lorcher, P. S. (2003). Worry and irrational beliefs: A preliminary investigation. *Individual Differences Research, 1*(1), 73-76.

Martin, M. O., Mullis, I. V. S., & Kennedy, A. M. (2007). *PIRLS 2006 technical report.* Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

McLennan, J. P. (1987). Irrational beliefs in relation to self-esteem and depression. *Journal of Clinical Psychology, 43*, 89-91.

Ministry of National Education [MNE] (2014). *TIMMS 2011 national report of mathematics and science eight classes.* Retrieved from http://timss.meb.gov.tr/?page_id=25.

Mullis, I. V. S., Martin, M. O., Robitaille, D. F., & Foy, P. (2009). *TIMSS advanced 2008 international report: Findings from IEA's study of achievement in advanced mathematics and physics in the final year of secondary school.* TIMSS & PIRLS International Study Center, Lynch School of Education, Boston College.

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

Nelson-Jones, R. (1982). *The theory and practice of counselling psychology.* London: Holt, Rinehart and Winston.

Nelson, R. E. (1977). Irrational beliefs in depression. *Journal of Consulting and Clinical Psychology, 45*(6), 1190-1191.

Organisation for Economic Co-operation and Development [OECD] (2014). *PISA 2012 Results: What students know and can do-student performance in mathematics, reading and science (Vol. I, Rev. ed.)*. Paris: OECD Publishing.

Ozcelik, D. A. (1998). *Measurement and evaluation.* Ankara: OSYM Publishing.

Ozsoy, G. (2005). The relationship between problem solving skills and mathematical achievement. *Gazi University Journal of Education, 25*(3), 179-190.

Piaget, J. (2013). *The construction of reality in the child (Vol. 82).* Routledge.

Plotnikoff, R. C. (1994). *An application of protection motivation theory to coronary heart disease risk factor behaviour in three Australian samples: community adults, cardiac patients, and school children.* Unpublished doctoral dissertation, The University of Newcastle, Australia.

Schoenfeld, A. H. (1992). Learning to think mathematically: Problem solving, metacognition, and sense-making in mathematics. In D. Grouws (Ed.), *Handbook for research on mathematics teaching and learning (pp. 334-370).* New York: MacMilla.

Schumacker, R. E., & Lomax, R. G. (1996). *A beginner's guide to structural equation modelling.* Mahwah, NJ: Lawrence Erlbaum Associates.

Schunk, D. H., & Zimmerman, B. J. (Eds.). (1998). *Self-regulated learning: From teaching to self-reflective practice.* New York: Guilford.

Senemoglu, N. (2009). *Development, learning and teaching from theory to practice.* Ankara: Pegem Academy.

Tabachnick, B. G., & Fidell, L. S. (2001). *Using multivariate statistics (4th ed.).* New York: Harper Collins Publishing.

Tavsancil, E. (2010). *Measurement of attitudes and data analysis with SPSS (4th ed.).* Ankara: Nobel Publishing.

Thompson, B. (2004). *Exploratory and confirmatory factor analysis: Understanding concepts and applications.* Washington DC: American Psychological Association.

Turkum, S. A. (1996). *Cognitive behavioural therapy-based group effect on cognitive distortions and communication skills of counsellors.* Unpublished doctoral dissertation, Social Science Institute, Ankara University, Ankara-Turkey.

Van de Walle, J. (2004). *Elementary and middle school mathematics: Teaching developmentally.* New York: Pearson Education, Inc.

Veneziano L., & Hooper J. (1997). A method for quantifying content validity of health-related questionnaires. *American Journal of Health Behaviour, 21*(1), 67-70.

Walen, S. R., DiGiuseppe, R., & Dryden, W. (1992). *A practitioner's guide to rational emotive therapy (2nd ed.).* New York: Oxford University Press.

Webber, J., & Coleman, M. (1988). Using rational-emotive therapy to prevent classroom problems. *Teaching Exceptional Children, 21*(1), 32-35.

White, A. H. (2003). *Cognitive behavioural therapy in children with autistic spectrum disorder.* STEER, 4(5). Retrieved from www.signpoststeer.org.

Wong, D. F. K. (2008). Cognitive behavioural treatment groups for people with chronic depression in Hong Kong: A randomized wait-list control design. *Depression and Anxiety, 25*(2), 142-148.

Wynn, K. (1992). Addition and subtraction by human infants. *Letters to Nature, 358,* 749-750.

Yalcin, S., & Tavsancil, E. (2014). The comparison of Turkish students' PISA achievement levels by year via data envelopment analysis. *Educational Sciences: Theory and Practice, 14*(3), 961-968.

Yurtal-Dinc, F. (1999). *An investigation of the irrational beliefs of university students according to some variables.* Unpublished doctoral dissertation, Education Science Institute, Gazi University, Ankara-Turkey.

Appendix
Irrational Beliefs in Mathematics Scale (IBIMS)

No	Items	Levels				
1	I hate mathematics because it is a complex subject.	1	2	3	4	5
2	I hate mathematics because it is a difficult subject.	1	2	3	4	5
3	Mathematics always makes me anxious.	1	2	3	4	5
4	The homework given by mathematics teachers always makes students feel exhausted.	1	2	3	4	5
5	The most difficult things in life are related to mathematics.	1	2	3	4	5
6	I will never be able to learn mathematics.	1	2	3	4	5
7	I must have perfect mathematics knowledge.	1	2	3	4	5
8	I must succeed in mathematics if I want to have a good profession in the future.	1	2	3	4	5
9	Each statement of a mathematics teacher must be definitely true.	1	2	3	4	5
10	Everything I do in mathematics classes is important for me to be successful.	1	2	3	4	5
11	I must not make mistakes if I want to be successful in mathematics.	1	2	3	4	5
12	Mathematics requires seriousness.	1	2	3	4	5
13	If I am not successful in mathematics, my value will decrease in the eye of the teachers of other subjects.	1	2	3	4	5
14	There are no compensations if I make mistakes in mathematics.	1	2	3	4	5
15	I participate in mathematics classes to make my friends like me more.	1	2	3	4	5
16	When the mathematics teacher does not love me, I am nothing.	1	2	3	4	5
17	All students have to be successful in mathematics.	1	2	3	4	5
18	My family seeing that I am successful in mathematics is very important for me.	1	2	3	4	5
19	Everybody must see my efforts in mathematics classes.	1	2	3	4	5
20	My efforts in mathematics classes must always be appreciated.	1	2	3	4	5

1. Dimension [inclination for finding reasons]: 1-2-3-4-5-6
2. Dimension [inclination for perfection]: 7-8-9-10-11-12
3. Dimension [inclination for being conditioned]: 13-14-15-16-17
4. Dimension [inclination for being accepted]: 18-19-20

Turkish Version: Matematiğe Yönelik Akılcı Olmayan İnançlar Ölçeği (MYAOİÖ)

No	Maddeler	Dereceler				
1	Matematik karmaşık bir ders olduğu için nefret ediyorum.	1	2	3	4	5
2	Matematik zor bir ders olduğu için nefret ederim.	1	2	3	4	5
3	Matematik dersi beni her zaman endişelendirir.	1	2	3	4	5
4	Matematik öğretmenlerinin verdiği ödevler öğrencileri canından bezdirir.	1	2	3	4	5
5	Hayatta en zor şey matematik ile ilgili uğraşılardır.	1	2	3	4	5
6	Matematiği hiçbir zaman öğrenemeyeceğim.	1	2	3	4	5
7	Her zaman mükemmel bir matematik bilgim olmalıdır.	1	2	3	4	5
8	Gelecekte iyi bir meslek sahibi olmak istiyorsam matematikte başarılı olmak zorundayım.	1	2	3	4	5
9	Matematik öğretmeninin kullandığı her ifade mutlaka doğru olmalıdır.	1	2	3	4	5
10	Matematik derslerinde yaptığım her şey başarılı olmam için çok önemlidir.	1	2	3	4	5
11	Matematikte başarılı olmak istiyorsam hata yapmamalıyım.	1	2	3	4	5
12	Matematik ciddiyet gerektirir.	1	2	3	4	5
13	Matematikte başarılı olamazsam diğer ders öğretmenlerinin gözündeki değerim düşer.	1	2	3	4	5
14	Matematikte hata yaparsam bunun telafisi yoktur.	1	2	3	4	5
15	Matematik derslerine arkadaşlarımın beni daha çok sevmesi için katılırım.	1	2	3	4	5
16	Matematik öğretmeni beni sevmediği zaman ben bir hiçim.	1	2	3	4	5
17	Tüm öğrenciler matematikte başarılı olmak zorundadır.	1	2	3	4	5
18	Ailemin matematik derslerinde başarılı olduğumu görmesi benim için önemlidir	1	2	3	4	5
19	Matematik derslerindeki gayretimi herkes görmelidir.	1	2	3	4	5
20	Matematik derslerindeki çabalarım her zaman takdir edilmelidir.	1	2	3	4	5

1. Boyut [Neden Bulma Eğilimi]: 1-2-3-4-5-6
2. Boyut [Kusursuzluk Eğilimi]: 7-8-9-10-11-12
3. Boyut [Şartlanma Eğilimi]: 13-14-15-16-17
4. Boyut [Kabul Görme Eğilimi]: 18-19-20