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Developing the Self-Efficacy Scale for Middle School Students' Estimation Skills: Validity and Reliability

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Abstract

This research aims to develop a reliable and valid scale to determine middle school students' self-efficacy about estimation skills. In addition, with the developed scale, the estimation skill self-efficacy of middle school students was examined in terms of various variables.For these purposes, a draft scale of 40 items was developed by reviewing the literature and taking expert opinions.In this context, data were obtained from two different study groups in the research.The first stage of this research was the development of the scale, and the data obtained from 327 middle school students.The second stage of this research was the testing process of the developed scale, and it was carried out on the data obtained from 317 middle school students. While developing the scale, confirmatory factor analysis, exploratory factor analysis, Guttman Split-half values reliability and Cronbach Alpha internal consistency coefficient calculations were performed. As a result of the analysis, the total variance percentage of the scale consisting of 23 items and 5 factors was found to be 55.61%. In addition, it was seen that the model obtained as a result of CFA was at an acceptable level. Cronbach Alpha value for the whole scale was determined as .91.As a result of this study, a reliable and valid scale was developed to determine the middleschool students' self-efficacy for estimation skills. It was concluded that middle school students' self-efficacy for estimation skills differed according to grade level, but not according to gender. When total score of the whole scale was considered, it was seen that estimation skill self-efficacies of the female students were higher than of the male students but that difference was not significant. Besides, when the estimation skill self-efficacy levels of students were investigated according to their grade level in this research, it was concluded that the self-efficacy scores of the 7thgrade students were higher than of the 5th, 6thand 8thgrade students.

Keywords: Developing a scale; estimation skill; middle school students; self-efficacy.

Introduction

The importance of knowledge is increasing rapidly in the world, the concept of knowledge and understanding of science are changing, the concepts of management and democracy have become different and technology is improving. The rapid change in technology and science has also affected the change of skills expected from individuals in society,which has guided countries to renew and review their education reforms (Tekinkır, 2008). With the education reforms in our country, the concept of estimation skill was emphasized in mathematics curriculum, the acquisitions related to this skill were included in the curriculum. Important competence areas have been added to the updated 2018 primary education mathematics curriculum. Many of these competencies are compatible with each other; they support and encompass each other.

Individuals with mathematical competence are requested to obtain the acquisitions about the skills of problem-solving and setting skills in MoNE (2018). Also, individuals with initiative and entrepreneurial competencies are also expected to obtain acquisitions including estimating, It is also seen here that problem-solving and estimation skills are important.

Estimation Skills

There are many definitions of the concept of estimation in the literature. Micklo (1999) defined estimation as knowing quickly the size or quantity of something without the measuring process. Segovia and Castro (2009), On the other hand, defined the estimated response as predetermining the value of a desired measure or the outcome of a transaction. According to Reys and Bestgen (1981), estimation is to approximate the result of an operation or problem by making mental calculations. Reys (1986) described estimation as the process of arriving at the true answer. Levine (1982) argues that the reason why the concept of estimation is important is that it is frequently used in daily life. Similarly, Panhuizen (2001) stated that estimation and mental processing skills are doing mathematics in daily life and are frequently used.

There are three types of estimation in the literature: computational, abundance (heap estimation), measurement

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estimation (Sowder, 1992).Computational estimation is the process of finding a number that gives an approximate result of a calculation that we cannot do or need to pinpoint. Although heap estimation and measurement estimation are perceived as two concepts that are very similar to each other, the fact that the feature sought in the estimation of the amount of the object to be measurement is continuous-continuous or discontinuous-discrete has caused the estimation type to be divided into heap estimation or measurement estimation (Segoiva & Castro, 2009). For example, when asked about the number of apples in a bag, it is appropriate to call this type of estimation as the heap estimation, since there is a limited number of apples among a certain number of oranges, that is, there is a discontinuity. On the other hand, if it is desired to estimate how many kg the orange will weigh, it would be appropriate to call this type of estimation as a measurement estimation, since the weight is a continuous unit. Heap estimation is the determination of the approximate number of pieces in a stack. For example, heap estimation is estimating the number of spectators in a concert hall or the number of marshmallows in a specified container. Measurement estimation is the determination of a measurement without making an measurement. For example, estimating the length of a rope or the weight of a bag is a measurement estimation (Van De Wallevd.,2016).

When the relevant literature was examined, it is seen that there are some studies which found that examined the estimation skills of pre-service teachers (Boz & Bulut, 2002;Sulak, 2008; Özcan, 2015) and mathematics teachers (Dowker, 1992). In addition, it is seen that there are some studies conducted to determine the estimation skills of primary and secondary school students (Aytekin & Uçar, 2014; Boz & Bulut, 2012; Çilingir & Türnüklü, 2009; Hanson &Hogan, 2000; Luwel & Verschaffel, 2008; Pilten &Yener, 2009; Yazgan, Bintaş & Altun, 2002).

Self-Efficacy Perception

The concept of self-efficacy is one's belief in his/her own capacity. Self-efficacy belief affects people's academic success. Individuals with high self-efficacy can be more efficient and they can behave more comfortably when they face difficult situations. Individuals with low self-efficacy can display more anxious behaviours when they face difficulties (Canpolat & Çetinalp, 2011).There is an important difference between having a variety of skills and demonstrating them when necessary. The knowledge, learned and skills strategies will not be functional unless the person has the belief to use them under appropriate conditions (Bandura, 1997).Self-efficacy is not a person's existing skills, but a belief about what one can do with those skills under different conditions (Sakız, 2013). Bandura (1986) stated that individuals' states of not being self-confident would trigger learning, but would also prevent the use of skills, which they acquired previously.In the related literature, there are some studies in which it was presented that self-efficacy had effects on choice, effort, commitment, and success (Pajares, 1996; Schunk&Pajares, 2005), and that self-efficacy significantly affected all kinds of success (Schunk&Pajares, 2005; Valentine, DuBois&Cooper, 2004).

Self-efficacy perception, which has a very important power over the emotions, ideas and behaviors of individuals, is one of the tools necessary to achieve success. According to the comparison made by Korkmaz (2005), individuals with high self-efficacy can cope with complex events, overcome any problem, show patience in their studies, and are confident in achieving success.Individuals with low self-efficacy, on the other hand, cannot cope with events, fall into despair and are unhappy.These individuals do not find themselves sufficient to solve any problem, avoid trying again if their first attempt fails, and do not believe that their efforts will be effective on the result.

Importance of Research and Research Questions

Considering the importance of estimation in mathematics education and in daily life, it is thought that students' self-efficacy regarding estimation skills will affect their estimation success. In this context, there is a need for a measurement tool that will determine the self-efficacy of students' estimation skills. Among the available resources, no studies on determining the self-efficacy levels of the students about their estimation skills were found. In addition, in the literature, it has been found that students' estimation skills vary according to gender and grade level. In this context, in this study, students' self-efficacy levels of estimation skills were questioned in terms of these variables. Having estimate skills makes daily life easier. Having a high self-efficacy perception enables one to achieve success both in academic and daily life. Considering the importance of estimation skill and the concept of self-efficacy, it is thought that this research will make a significant contribution to the field. In this context, the major purpose of this study is to develop a scale for determining the self-efficacy levels of middle school students about estimation skills. In addition, in this study, it was aimed to compare the self-efficacy levels of middle school students regarding estimation skills according to some variables. In line with these purposes, answers were sought to the following questions.

1. Can the items constituting the self-efficacy scale for estimation skill represent the self-efficacy for estimation skill according to the opinions of field experts?
2. Is the construct of the self-efficacy scale for estimation skill simple and decisive?
3. Within the context of reliability;
   3a. What are Cronbach Alpha and Guttman Split-half values of the self-efficacy scale for estimation skill?

3b. What is the item-total score correlation of each item in the self-efficacy scale for estimation skill?
4. Can the self-efficacy scale for estimation skill differentiates the individuals of bottom and top groups?
5. Is there a significant difference between the scores that the middle school students got according to gender and grade level?

Method

Research Model

This quantitative study aims to develop a reliable and valid scale to determine the middle school students' self-efficacies for estimation skills and to examine the estimation skills of middle school students' gender and grade level variables.

Population and Sample

The population of the study consists of middle school students in the province of Adana in the southern part of Turkey. The students in this study were selected employing a typical case sampling method, which is one of the purposive sampling methods. Typical case sampling is the selection of an average but not unusual case related to the research case, from a large number of cases in the population (Fraenkel, Wallen, & Hyun, 2012). In this context, the study was conducted on two different sample groups. Research data were collected at the end of the 2020-2021 academic year. Personal information of the students in the first and second sample groups is shown in Table 1.

According to Table 1, it is seen that 54.4% of the students in the first sample were females and 45.6% of them were males.31.2% of the students were 5th graders, 19.9% of them were 6th graders, 18.7% of them were 7th graders and 30.3% of them were 8th graders. Also, it is seen that 54.25% of the students in the second sample were females and 45.74% of them were males.30.91% of the students were 5th graders, 20.18% of them were 6th graders, 18.92% of them were 7th graders and 29.96% of them were 8th graders.

Data Collection Tool

In this section, firstly, the development process of the estimation skill self-efficacy scale is explained. Then, with the developed scale, the changes in the self-efficacy of mıddle school students' estimation skills according to their demographic characteristics were examined.

The Process of Preparing the Self-Efficacy Scale for Estimation Skill: The self-efficacy scale for estimation skill was prepared by following the steps below (Devellis, 2016). In this context, first, the process steps consisting of creating an item pool, piloting, content validity, construct reliability, validity, studies, and finalizing the form are summarized in Figure 1.

According to Figure 1, it is seen that an item pool of 40 items was created after reviewing the literature. After the item pool had been created, necessary permissions and ethical approval were taken. The ethics committee document was approved by YYY and Publication Ethics Committee of XXX University on 08.06.2021 with the document numbered 111941. In the second stage, piloting was performed in touch with the views of 5 experts (3 in mathematics education, 1 in assessment and evaluation and 1 in language education). In the third stage, confirmatory and exploratory factor analyses were made in the process of construct validity. In the fourth stage, Guttman Split-half and Cronbach Alpha analyses were made and averages of top-bottom 27% groups were compared in the process of reliability of the scale. Finally, the scale consisting of 23 items and 5 factors was finalized.

Creating the Item Pool: At first, the related literature was reviewed while creating the items related to the self-efficacy scale for estimation skills. In this context, the definition of estimation skill, types of estimation skills, and the concepts of self-efficacy were investigated. Studies conducted within this scope were reviewed and draft items were created. In this process, a mathematics teacher who was still continuing his postgraduate education in mathematics education was also interviewed and his views on estimation skills were taken. In line with the views taken from the teacher, the acquisitions

Table 1: Percentage and Frequency Distributions of the Students

Variables		*1st group*		*2ndgroup*	
F		*%*	*F*	*%*	
	Female	178	54.4	172	54.25
	Male	149	45.6	145	45.74
Gender	Total	327	100	317	100
Grade Levels	5th	102	31.2	98	30,91
	6th	65	19.9	64	20,18
	7th	61	18.7	60	18.92
	8th	99	30.3	95	29.96
	Total	327	100.0	317	100.0

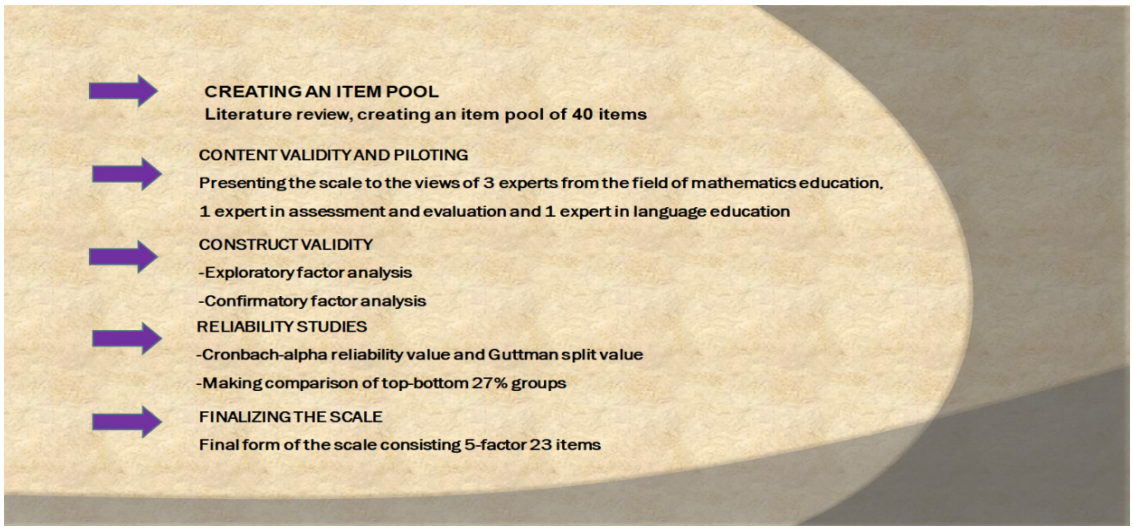

Fig. 1: The Steps of Developing Estimation skill Self-efficacy Scale

about estimation skill in the mathematics curriculum were reviewed and an item pool of 40 items was finally created.

Content Validity

Submitting the Item Pool to Expert Opinion*:* The draft version of 40 items was presented to the views of the experts to check if it had content validity. Content validity should be able to be measured without confusing the characteristic that the measuring tool will measure with other features (Balcı, 2001). In this context, firstly, the items in the item pool were presented to 3 experts in mathematics education, 1 expert in assessment and evaluation, and 1 expert in language education for their views. The experts in Mathematics and assessment and evaluation classified each item in the draft form as "appropriate", "should be corrected" and "inappropriate". Then, the experts in language education reviewed each item in the scale in terms of their language structure, grammar structure. Opinions from experts were calculated using the formula prepared by Lawshe (1975). Each question prepared for content validity was evaluated individually. The calculation method for a single question is as follows. For the content validity rate, only the number of experts who marked the "appropriate" option for each question were collected, and then the number of experts whose measurement tool was sent was divided by two. The number of experts who say it is necessary and the number of experts who emerge as a result of the section are divided again and 1 is subtracted from the resulting number. As a formula CVR = Na / (N/2) – 1.

In line with the views of the experts, it was recommended to exclude item 23 because it easy found to be illusive and unclear. Besides, it was recommended to make corrections in items 34 and 34 to add a new item. Therefore, the item"23. My mathematics teacher says that I am successful at topics which require estimation" was excluded as the self-perception of the student was important. Besides, the item "34. I have difficulty in estimating the surface area of our country close to its actual surface" was corrected as "I have difficulty in estimating the surface area of our school garden close to its actual surface". Similarly, the item "35. I have difficulty in estimating the distance between two cities close to its actual distance" was corrected as "I have difficulty in estimating the distance between my house and school close to its actual distance". Moreover, the item "I estimate the weight of a product that I buy from the market close to its actual weight" was added to the form.

***Pilot Study*:**The 40-item draft form, prepared in line with expert opinions, was applied to 20 students. Moreover, the draft form viewed was appearence validity the page layout, font size, and usefulness. The scale form of 40 items formed as a result of these arrangements was applied to 327 middle school students studying in different schools in Adana. The scale form consisting of 23 items obtained as a result of the analyzes was applied to the second sample consisting of 317 middle school students.

Data Analysis

During the test development process, data were obtained from two separate sample groups. In this section, it is stated for what purpose and with which tests the data obtained from two different sample groups were analyzed. The data was enumerated and computerized before starting the process of analysis. Then, 14 forms were excluded from the evaluation as there was some missing information and their endpoint values were determined by Mahalanobis Distance. In the first stage, 327 data obtained from the first study group were evaluated during the development of the scale. In this context, the construct validity

of the data set was calculated by using EFA in IBM SPSS 26.0 program and the reliability of the data set was investigated by Cronbach Alpha analysis in the same program and Guttman Split-half values. In addition, the arithmetic mean values, standard deviation values, and item-total score correlations of the statements in the scale were investigated, and item discrimination strength was calculated by independent groups t-test analysis. In the second stage, the 23 item final form of the scale was reapplied to 317 students and Confirmatory Factor Analysis (CFA) was done with the Lisrel program. After the reliability and validity studies of the self-efficacy scale for estimation skill were completed, independent groups t-test was administered in case of comparing two groups such as students' gender and one-way analysis of variance (ANOVA) was performed in cases where more than three groups were compared such as grade level. However, the homogeneity of the variances was checked before starting the variance analysis. In the current study, Kurtosis and Skewness values were examined for normality test. It has been observed that the Skewness value .015 and the Kurtosis value .605. Since the number of samples is larger than 300, the Skewness and Kurtosis values obtained are sufficient for a normal distribution (Kim, 2013). Scheffe test was performed in the process of comparing the groups. In this process, the significance level was accepted as p = .01 in the process of sorting out all statistical analyses.

Findings

This research findings are presented in two sections. First, the findings regarding the validity and reliability studies carried out during the development of the "Self-Efficacy Scale for Prediction Skills" are presented. Secondly, the findings regarding the differences of the developed scale according to the gender and grade level of the students are presented.

Construct Validity of the Estimation Skill Self-Efficacy Scale

Factor analysis was made to build the construct validity of the self-efficacy scale for estimation skill.EFA was made at first and some information was obtained about the number of the factors at first. Then, the appropriateness of the construct was tested through CFA.

Exploratory Analysis of the Estimation Skill Self-Efficacy Scale

First, Kaiser-Meyer-Olkin (KMO) test and Bartlett's Sphericity test (Büyüköztürk, 2011) were performed to check the appropriateness of the obtained data in terms of both the suitability for the factor analysis and the sufficiency of the number of samples for EFA which was implemented on estimation skill self-efficacy scale. The results of the analysis are shown in Table 2.

According to Table 2, KMO value was determined as .911. It was concluded in line with this result that the sample appropriateness of the scale was "very good" for EFA (Sharma, 1996). Besides, the result of Bartlett sphericity test was calculated as x^2= 3097.740and it was seen that it was significant at the level of .01. These results show that the scale is appropriate for the factor analysis.

While performing EFA on estimation self-efficacy scale, promax rotate operationwas implemented. According to this analysis, five factors, eigen value of which was above 1, were obtained for 23items. The construct of the factors are considered as stable when their eigen values were 1 or above. Scree plot graph, which is one of most frequently used criterion while determining the number of factors, can be seen in Figure 2.

As seen in Figure 2, scree plot takes a horizontal shape after five factors. Therefore, it is observed that the scale gathers under five factors. A five-factor construct, which is reached in five iterations, was obtained as a result of the analysis. Item factor loads, eigenvalues of each factor are seen in Table 3.

According to Table 3, it is seen that declared total variance percentage of the scale, which consists of 23 items and 5 factors, was found as 59.351% as a result of the analysis. It is also observed that the sub-factor of Acquisition-based Measurement Estimation Perception (ABMEP) explains 35.551% of this variance, the sub-factor of Affective Perception about Estimation (APAE) explains 8,134% of this variance, the sub-factor of the Real Life-based Measurement Estimation

Table 2: KMO, Barlett Sphericity Test Values

KMO		*.911*
Barlett Sphericity Test	*X*2	3097.740
	P	.000

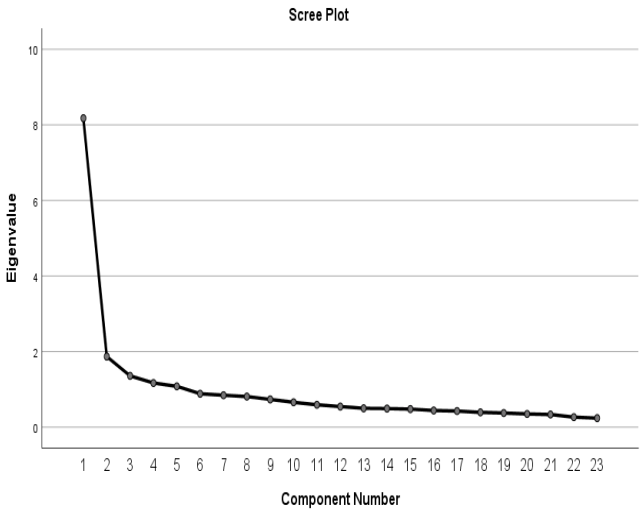

Fig. 2: Scree Plot

Perception (RLBMEP) explains 5.899% of this variance, the sub-factor of Real Life-based Estimation Perception (RLBEP) explains 5.078% of this variance and the sub-factor of Acquisition-based Computational Estimation Perception (ABCEP) explains 4.698% of this variance.The factor loads of the scale ranges from .30 to .92. In determining the items measuring the same sub-factor; it was considered for the item factor load to be at a single value and to have high load value. Besides, it was noted that item factor loads were minimum .30 (Seçer, 2013). The correlation values, standard deviation and arithmetic mean values of the estimation skill self-efficacy scale are shown in Table 4.

Table 3: Factor Analysis Results of Self-efficacy Scale for Estimation Skill

Item no	*Factor1*	*Factor2*	*Factor3*	*Factor4*	*Factor5*
Item9	.804				
Item13	.781				
Item14	.760				
Item12	.722				
Item8	.719				
Item11	.710				
Item7	.710				
Item10	.644				
Item2		.841			
Item1		.786			
Item3		.691			
Item21		.327			
Item26		.305			
Item37			.850		
Item38			.746		
Item36			.604		
Item30			.564		
Item24				.921	
Item23				.766	
Item20				.433	
Item19					.855
Item17					.835
Item22					.618
Eigenvalue	8.177	1.869	1.357	1.168	1.080
Declared Variance Percentage	35.551	8.124	5.899	5.078	4.698
Range	0.64 - 0.80	0.30.84	0.56 - 0.85	0.43 - 0.92	0.61 - 0.85
Number of Items	8	5	4	3	3

*Note:*Factor loads of the items, which were below .30, were not writte

According to Table 4, it is concluded that there are statistically significant relationships (p <.01) between the total score of estimation skill self-efficacy scale and the scores of sub-factors. The sub-factor of Factor1 displayed positive relationship with the other sub-factors at the values of .668, .576, .569, .200, respectively and in total scores at the value of .880. The sub-factor of Factor2 displayed positive relationship with the other sub-factors at the values of .508, .576, .292, respectively and in total scores at the value of .835. The sub-factor of Factor3 displayed positive relationship with the other sub-factors at the values of .508, .202,respectively and in total scores at the value of .754. The sub-factor of Factor4 displayed positive relationship with the other sub-factors at the values of .321, respectively and in total scores at the value of .762. The sub-factor of Factor5 displayed positive relationship in total scores at the value of .449. According to Büyüköztürk (2011), there is a low relationship when the correlation value is lower than .30 and there is a medium-level relationship when the correlation value is between .30 and .70.Therefore, it can be said that the sub-factors of the scale were statistically significant at positive low level and medium-level between each other while there is a medium-level and high level positive and statistically significant relationship between the sub-factors and total score. It is also seen in Table 4 that the arithmetic mean of the sub-factors and total score ranges between 11.30 and 81.03 and the standard deviation of them ranges between 2.68 and 15.25

While naming the sub-factors of estimation skill self-efficacy scale, both the contents of the items and related literature were taken into consideration. Factor 1 was named as Acquisition-based Measurement Estimation Perception (ABMEP), factor 2 was named as Affective Perception about Estimation (APAE), factor 3 was named as Real Life-based Measurement Estimation Perception (RLBMEP), factor 4 was

Table 4: Correlation Between Factors, Standard Deviation and Arithmetic Mean Values

Item sub-factors	*F1*	*F2*	*F3*	*F4*	*F5*	*Arithmetic mean*	*Standard deviation*
F1	1					27.0221	6.28058
F2	.668**	1				17.7192	4.21646
F3	.576**	.508**	1			13.6025	3.75176
F4	.569**	.576**	.508**	1		11.3912	2.85266
F5	.200**	.292**	.202**	.321**	1	11.3028	2.68312
Total	.880**	.835**	.754**	.762**	.449**	81.0379	15.25392

**p <.01

named as Real Life-based Estimation Perception (RLBEP) and factor 5 was named as Acquisition-based Computational Estimation Perception (ABCEP).The scale items are presented in Appendix 1.

Confirmatory Factor Analysis of the Estimation Skill Self-efficacy Scale

CFA was performed to determine whether the five-factor construct which was obtained from EFA implemented on the self-efficacy scale for estimation skill was appropriate or not.CFA analyzes were performed on the data obtained from the second sample group (Table 1).Fit indices values and threshold values that were obtained in the analysis process are presented in Table 5.

According to Table Table 5, it is seen that the fit indices were determined as X2/sd=2.28 RMSEA=.064; SRMR=.052; NNFI=0.96; GFI=0.88; CFI=0.97; IFI= 0.97RMSEA and SRMR range between 0 and 1. It is desired to produce values close to "0" (it is expected to have minimum errors between observed and produced matrices). If the value is equal or lower than 0.05, it is considered to be perfect fit. If the value is up to 0.08, it is considered to be acceptable good fit. According to these results, it can be said that RMSEA and SRMR values display good fit. The values of GFI (Goodness of Fit Indices) range between 0 and 1. If the value is greater than 0.90, it is considered to be good fit. If the value is greater than 0.85, it is considered to be acceptable values. It is affected by the largeness of the sample. It produces smaller values in large samples. Therefore, it can be said that the obtained GFI value displayed good fit. CFI (Comparative fit index) is a criterion, which considers the sample size and degrees of freedom while evaluating the model fit. The CFI value greater than 0.95 indicates a perfect fit and value greater than 0.90 indicates an acceptable fit. Thus, it can be said that the obtained CFI value displayed perfect fit. According to the results, it is observed that the obtained values were between perfect fit and good fit. In other words, they confirm the construct of the self-efficacy scale for estimation skill consisting of five factors. T values of the five-factor model are presented in Table 6.The items are listed in Table 6 according to the factors.

Table 5. Calculated Values and Threshold Values of Estimation Skill Self-efficacy Scale

Goodness of Fit indices	*Calculated Value*	*Acceptable Threshold Values*	*References*
2/df	503.21/ 220=2.28	≤3= perfect fit	Hooper, Coughland and Mullen(2008),Kline(2005)
RMSEA	0.064	≤.08= good fit	Brown (2006), Hooper et al.(2008)
SRMR	.052	≤.08= good fit	Brown (2006), Hu and Bentler(1999),Kline(2005)
NNFI	0.96	≥.95= perfect fit	Hu and Bentler(1999), Kline(2005), Tabachnick and Fidell(2001).
GFI	0.88	<.85= good fit	Cole (1987), Hooper et al.(2008)
CFI	0.97	≥.95= perfect fit	Brown (2006), Hu and Bentler(1999), Kline(2005), Tabachnick and Fidell(2001).
IFI	0.97	≥.95= perfect fit	Hu and Bentler(1999)

According to Table 6, it is seen that the t test values of the items in the estimation skill self-efficacy scale are between 9.52 and 14.26. It is considered significant at .05 level if these t values are greater than 1.96, at the .05 level; it is considered significant at .01 level if they are greater than 2.58 (Çokluk, Şekercioğlu&Büyüköztürk, 2014). Accordingly, when the t values for all items are considered as a result of the analysis, it is seen that the significance level is .01. These findings confirm the factor construct of the estimation skill self-efficacy scale. The standardized values of the proposed estimation skill self-efficacy scale are shown in Figure 3.

When Figure 3 is reviewed, it is observed that factor loads of the proposed model are between .63 and .77.When error variances of the observed changes are considered, it is noticed that error variances of scale ıtems weren't high.

Table 6: T values obtained from the CFA for Estimation Skill Self-Efficacy Scale

Items	*T*	*Items*	*T*	*Items*	*T*	*Items*	*T*	*Items*	*T*
I9	14.00*	I2	10.63*	I37	13.48*	I24	12.30*	I19	9.92*
I13	13.28*	I1	12.00*	I38	14.27*	I23	14.36*	I17	10.20*
I14	12.77*	I3	14.00*	I36	13.36*	I20	11.32*	I22	10.07*
I12	14.03*	I21	11.82*	I30	9.52*				
I8	13.97*	I26	13.49*						
I11	12.45*								
I7	12.26*								
I10	14.26*								

*p<0.01

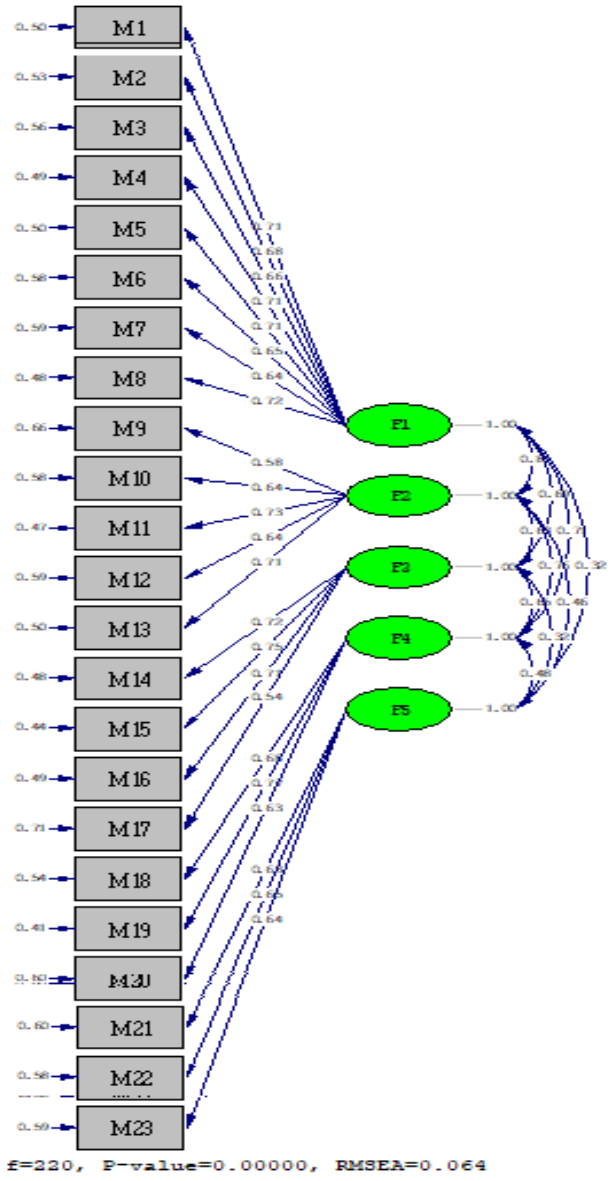

Figure 3: The standardized values of the proposed estimation skill self-efficacy scale

Reliability of the Scale

The Cronbach Alpha value and the Guttman Split-halftest were calculated in order to determine the reliability of the estimation skill self-efficacy scale. Analysis results are presented in Table 7.

According to Table 7, Cronbach Alpha were calculated as .876 in sub-factor of factor 1, .792 in sub-factor of factor 2; .771in sub-factor of factor 3; .725 in sub-factor of factor 4 and .678 in sub-factor of factor 5. Cronbach Alpha for the whole scale was .912. Besides, Guttman Split-half test was calculated in order to to determine the consistency of the scale. It was calculated as .850 in sub-factor of factor 1, .684 in sub-factor of factor 2; .761 in sub-factor of factor 3; .513 in sub-factor of factor 4, .563in sub-factor of factor 5 and .816 for the whole scale. These obtained values show that the scale is reliable as it is greater than 70 (Fraenkel, Wallen &Hyun, 2012; Tavşancıl, 2010). Moreover, it is seen that factor 5 is moderately reliable and the other factors are reliable at high and acceptable levels. Besides, corrected item total correlation values as a result of the analysis which was made to determine the reliability of the self-efficacy scale for estimation skill and Cronbach's Alpha values when the item is deleted are shown in Table 8.

Table 7. Cronbach Alpha and Guttman Split-half Values of the Total Score and the Scores of Sub-factors of the Self-Efficacy Scale for Estimation Skill

Sub-factors	*Cronbach Alpha*	*Guttman Split-half*
F1	.876	.850
F2	.792	.684
F3	.771	.761
F4	.725	.513
F5	.678	.563
Total score	.912	.816

According to Table 8, item total correlation coefficients range between .24 and .65 as a result of item analysis. It is expected for these values not to be negative and to be minimum .30 or above (Büyüköztürk, 2002). Thus, it can be said that the scale meets these criteria. Furthermore, it is observed that Cronbach Alpha value when items are deleted range between .906 and .914. It is enough for test scores to be considered reliable when this value is .70 or above (Fraenkel, Wallen &Hyun, 2012; Özdamar, 1999;Tavşancıl, 2010;).

Discriminative Features of the Items in the Estimation Self-Efficacy Scale

Independent groups t-test was performed to determine the discrimination strength of the items in the self-efficacy scale for estimation skill. Total scores of the data obtained from 327 students were sorted and top-bottom 27% groups were specified and independent groups t-test was calculated for the scores of the groups. Since the scores of these groups showed normal distribution, independent groups t-test was performed. The analysis results are presented in Table 9.

As seen in Table 9, it was concluded that there was a statistically significant difference between average scores of the top-bottom group ($p<.01$). Accordingly, in the estimation skill self-efficacy scale, it can be said that the average scores of the students in the lower group and the upper group from the items are distinctive (Büyüköztürk, 2011).

Answering the Items in the Scale and Scoring the Scale

A reliable and valid assessment tool which aims to measure the middle school students 'self-efficacies for estimation skill has been developed. The scale which consists of 5 factors has 23 items. After completing the data entry in the SPSS program, scoring the answers given to the negative items; "1-5;

Table 8: Corrected Item Total Correlation Values of the Estimation Skill Self-efficacy Scale and Cronbach's Alpha Values When the Item is deleted

Item No	*Corrected Item Total Correlations*	*Cronbach's Alpha Value When the Item is deleted*
I1: I can estimate lengths in units of meters or centimeters close to the true value	.595	.907
I2: I can estimate perimeters of polygons close to their true value	.579	.907
I3: I can estimate the areas of polygons close to their true value	.570	.907
I4: I can estimate the amount of liquid in a container close to its true value in liters and milliliters	.628	.906
I5: I can estimate close to the number of objects in the given multiplicity	.646	.906
I6: can approximate the mass of an object	.568	.907
I7: I can estimate the length of an object close to its true value in non-standard units of measurement	.568	.907
I8: I can estimate an area close to its true value with non-standard area measurement units	.651	.906
I9: My fear decreases when solving problems that require guessing	.500	.909
I10: I like problems that require estimating in mathematics lessons.	.547	.908
I11: I can easily solve problems that require estimation	.615	.906
I12: I can easily make estimation on different subjects in math lessons.	.565	.907
I13: I easily solve estimation problems that are difficult for my friends	.625	.906
I14 : I can estimate the amount of water that a glass of water will take, close to its true value.	.516	.908
I15: I can estimate the amount of water that a tablespoon will take, close to its true value.	.562	.907
I16: I can accurately estimate the volume of a sugar cube	.579	.907
I17: I can estimate my classmate's weight close to its true value	.440	.910
I18: I am aware of the level of my estimation skill	.495	.909
I19: I am aware of what I need to do to improve my estimation skill	.607	.906
I20: I can make estimates close to the true value in daily life.	.583	.907
I21: I find it hard at most to estimate correctly the product of a two-digit natural number and a onedigit natural number	.241	.914
I22 : I find it difficult to do mental additions	.255	.913
I23: I find it difficult to estimate the result of operations with decimal representations of numbers	.347	.912

Table 9.T-Test Results About Bottom And Up Group Scores Of Estimation Self-Efficacy Scale

	Bottom Group			*Up Group*		
Item No	*n*	*x*	*Sd*	*x*	*Sd*	*T*
I1	86	2.7442	.97240	4.4651	.66328	-13.558**
I2	86	2.3721	1.07426	4.0930	.83494	-11.730**
I3	86	2.3140	1.02051	3.9419	.92488	-10.961**
I4	86	2.3953	1.00912	4.1977	.79439	-13.014**
I5	86	2.8372	.90567	4.4884	.68159	-13.509**
I6	86	2.5930	.98671	4.2093	.86930	-11.398**
I7	86	2.7791	.88652	4.1744	.82877	-10.663**
I8	86	2.3721	.94616	4.0930	.79154	-12.937**
I9	86	2.4419	1.16422	4.1395	1.09719	-9.841**
I10	86	2.8372	1.03878	4.4651	.76231	-11.717**

	Bottom Group			*Up Group*		
Item No	*n*	*x*	*Sd*	*x*	*Sd*	*T*
I11	86	2.6744	.88706	4.4884	.76303	-14.377**
I12	86	2.8023	.99196	4.5000	.73164	-12.773**
I13	86	2.4767	1.01433	4.3605	.76563	-13.746**
I14	86	2.7326	1.15223	4.3953	.88489	-10.614**
I15	86	2.4535	1.06999	4.3140	.89786	-12.352**
I16	86	2.3488	1.10366	4.1512	.91417	-11.663**
I17	86	2.7558	1.25498	4.1279	.94304	-8.106**
I18	86	3.1047	1.33750	4.6860	.57928	-10.061**
I19	86	2.6512	1.16586	4.6163	.68888	-13.457**
I20	86	3.0349	1.08950	4.6047	.67352	-11.365**
I21	86	3.3372	1.15413	4.1628	1.32719	-4.353**
I22	86	3.6512	1.22491	4.5465	1.01352	-5.223**
I23	86	2.8372	1.17684	4.0116	1.19306	-6.499**

**p<0.01

Table 10: T Test Results about the Students' scores of Sub-Factors and Total Score of the Self-Efficacy Scale according to Gender

Scale	*Gender*	*N*	*X*	*Sd*	*Df*	*t*	*p*
Total score	Female	172	82.5814	15.38851	315	1.971	.050
	Male	145	79.2069	14.93918			

Table 11: One-Way Variance Values of Total Scores of the Students According to the Grade Level

Scale	*Grade level*	*N*	*X*	*Sd*	*df*	*F*	*F*	*Significant difference*
Total score	5	98	79.4388	10.97332	3	3.478	.016	5. 6. 8. sınıf<7
	6	64	73.9063	15.88722				
	7	60	93.9167	18.55847				
	8	95	79.3579	11.25140				

2-4; 3-3; 4-2; It has been converted to be 5-1".The scores that can be obtained from five-point likert scale range between 23 and 115 (23x5=115). In order to facilitate the interpretation of the self-efficacy scale for estimation skill, total scores or the scores obtained from sub-factors can be divided by the number of total items. High scores obtained from this scale mean that students' self-efficacies about the related dimension are high. The scale can be administered to middle school students at different grade levels.

Middle School Students 'Self-efficacies for Estimation Skill According to Gender:The result of the analysis which was made to determine whether the students who participated in the study indicate a significant difference according to gender in terms of sub-factors and total scores of the estimation skill self-efficacy scale is shown in Table 10.

According to Table 10 it is seen that there isn't a significant difference between the total score according to gender [t(315)= 1,971, p<0.01]. In terms of arithmetic means, it can be said that female students have higher self-efficacy levels than male students.

Middle School Students 'Self-efficacies for Estimation Skill According to Grade Levels:Whether there is a difference between the self-efficacy levels of students for estimation skills according to the grade level was tested by one-way analysis of variance. These results are presented in Table 11.

According to Table 11, it is seen that there are differences in the self-efficacy levels of the students for estimation skill according to grade levels (F[3–3.478], p<.01). Scheffe test, one of the multiple comparison tests, was used and the results of the analysis showed that the differences between the 5^{th}, $6^{th}$and 8^{th} grade students were in favour of 7^{th} grade students.

Discussion

This study was carried out to develop a reliable and valid scale in order to determine the middle school students 'self-efficacy levels for estimation skill and to investigate the middle school

students 'self-efficacy levels for estimation skill in terms of various variables through scale. In the first stage of the process of developing the scale, the literature was reviewed, an item pool of 40 items was created and its content validity was provided by presenting the scale to the views of experts. As a result of EFA which was performed to form the construct validity of the scale, 59.351% of the total variance was explained. Five factors of the scale were named as the sub-factor of factor 1 Acquisition-based Measurement Estimation Perception (ABMEP), the sub-factor of factor 2 Affective Perception about Estimation (APAE),the sub-factor of factor 3 Real Life-based Measurement Estimation Perception (RLBMEP), the sub-factor of factor 4 Real Life-based Estimation Perception (RLBEP) and the sub-factor of factor 5 Acquisition-based Computational Estimation Perception (ABCEP). Item factor loads which constitute the scale range between .30 and .92. When the fit indices that were obtained from second study groups as a result of CFA which was performed to test the appropriateness of the estimation skill self-efficacy scale's construct were considered (X^2/sd=2.28 RMSEA=.064; SRMR=.052; NNFI=0.96; GFI=0.88; CFI=0.97; IFI= 0.97), it was concluded that the construct of the scale was between the values of good fit. It was revealed that the values obtained as a result of the analysis which was made for the reliability of estimation skill self-efficacy scale were .70and above. This value is an indication for the scale to be quite reliable (Tavşancıl, 2010). On the other hand, it was revealed that there was a significant difference between the score of top 27% group and the score of bottom 27% group which they got out of total score which was calculated to determine the discriminative strength in the scope of reliability of the scale ($p<0.01$) and it was concluded that the items in the scale were discriminative. In line with these results, it can be said that the scale can be used as a reliable and valid data collection tool to measure the estimation skill self-efficacies of middle school students.

In the second part of the research, the functionality of the developed scale was tested in the context of the gender and grade level variables of middle school students. In the literature, it has been found that students' estimation skills vary according to gender and grade level. In this context, in this study, students' self-efficacy levels of estimation skills were investigated in terms of these variables. When total score of the whole scale was considered, it was seen that estimation skill self-efficacies of the female students were higher than of the male students but that difference was not significant. In addition, it can be said that the estimation skill self-efficacy of both female and male students is in the range of 3-4 and is at the upper-intermediate level. It was seen in some of the studies in the literature that males had higher self-efficacy perceptions than females (Koyuncu&Haser,2012;Özgen&Bindak, 2008;Pajares&Miller, 1994) while some other studies presented that self-efficacy showed no difference according to gender (Akkaya, Memnun&Katrancı, 2012; Goodwin, Ostrom&Scott, 2009; Nicolaidou&Philippou, 2003).Uçak and Bağ (2012) found that students' self-efficacy levels in science and technology lessons at secondary school level do not differ depending on gender. Similarly, Kurbanoğlu and Takunyacı (2012) found that the academic self-efficacy levels of high school students in mathematics lessons did not differ according to gender. Therefore, it can be said that the results obtained from this research are similar to the results of the studies in the related literature.

The findings of some studies are not similar to the findings of this study. Huang (2013) found a significant relationship in favor of men, although the power of influence was not high between gender and self-efficacy.In addition, Huang (2013) revealed that male students have higher academic self-efficacy in mathematics, social sciences and computer fields than female students, and female students have higher self-efficacy in linguistics than male students. A study conducted by Joët, Usher and Bressoux (2011) with third grade primary school students in France revealed that although the academic performance of female students in French lessons is higher than that of male students, their self-efficacy perceptions are lower than that of male students. On the other hand, it was determined that male students' performance in mathematics lessons and their mathematics self-efficacy were higher than female students.

Finally, when the estimation skill self-efficacy levels of students were investigated according to their grade level in this research, it was concluded that the self-efficacy scores of the 7^{th}grade students were higher than of the 5^{th}, $6^{th}$and 8^{th}grade students. Studies have been found in the literature showing that students' estimation skills have improved according to grade level. A study by Zimmerman, Bandura and Martinez-Pons (1992) concluded that students' self-efficacy levels tend to increase depending on age.The researchers revealed that the self-efficacy levels of the 11th graders were higher than the eighth grades, and the self-efficacy levels of the eighth graders were higher than the fifth grades. Contrary to this research, Stipek and Daniels (1988) argued that students' self-efficacy levels decrease as age increases.Stipek and Daniels (1988) attribute this to the increase in teacher feedback on social comparison in the later stages of students' education life.In this study, the difference between students' self-efficacy levels may be due to their developmental characteristics. The fact that the estimation skill self-efficacy of 8th grade students is lower than that of 7th grade students can be explained by the decrease in the expectations and beliefs of students that they can succeed even if they trust their abilities as they get older.

Recommendations

To sum up, a reliable and valid scale was developed to determine the middle school students 'self-efficacy for estimation

skill as a result of this study. It was concluded by means of the developed scale that estimation skill self-efficacies of middle school students differed according to grade level. It may be recommended to reconduct scale on different sample groups (primary school, high school students, teacher candidates). In addition, the differentiation of the estimation skill self-efficacies of students was focused only in terms of gender and grade level variables. In prospective studies, the differentiation of the estimation skill self-efficacies of students can be investigated according to academic achievement, school type (middle school, high school). In this study, it was concluded that the 7th grade students' estimation self-efficacy scores were higher than the 5th, 6th and 8th grade students' estimation skills self-efficacy scores. Qualitative research can be recommended to reveal the reasons for this result in more detail. In addition, it can be suggested to add gains according to grade level to improve estimation skills in the mathematics curriculum.

Eray (2022), in his study examining the effects of gamification-based activities in the mathematics lesson on the motivation, self-efficacy perception and mathematics anxiety of secondary school students, stated that the gamification method can have a positive effect on the self-efficacy perception towards mathematics. In this context, it can be suggested to conduct studies examining the effects of different teaching methods on the development of estimation skill self-efficacy perception.

Since self-efficacy is a structure that is highly effective on students' academic performance levels, it is an element that should be particularly emphasized in learning environments. It is important to strengthen the self-efficacy perceptions of students who spend a significant part of their lives with exams from an early age. A strong sense of self-efficacy developed at an early age enables students to demonstrate coping skills in case of failure in later years. In this context, it can be suggested that studies should be carried out to improve the self-efficacy perceptions of students' estimation skills.

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