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Development of the Estimation Skills Self-Efficiency Scale for Pre-Service Teachers

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Abstract

Estimation skills matters most for both daily life and mathematics education. Teachers have great responsibilities in helping students acquire estimation skills. In this context, it can be said that investigating the pre-service teachers' sense of efficacy about their estimation skills deems important. In this regard, in this study, it was aimed to develop a reliable and valid scale to determine pre-service teachers' self-efficacy for estimation skills. Accordingly, in this quantitative research, a 40-item draft scale was developed based on literature review and expert opinions. Psychometric properties of the scale was tested on data obtained from 158 pre-service teachers. While developing the scale, exploratory and confirmatory factor analyses, Guttman Split Half and Cronbach Alpha internal consistency coefficients were calculated. As a result of the analyses, the percentage of total variance explained for the scale consisting of 20 items and 4 factors was estimated as 69%. The model-fit-indices obtained from the confirmatory factor analysis were acceptable. Cronbach Alpha internal consistency coefficient value for the entire scale was found.90. As a result of the research, a valid and reliable 5-point Likert-type Estimation Skills Self-Efficacy Scale was developed to measure the pre-service teachers' sense of efficacy about their estimation skills. It is thought that this research will contribute to the relevant literature, considering that there is no scale aimed at measuring the self-efficacy perceptions of pre-service teachers in the related literature.

Introduction

As the technology advances in the world, the understanding of "science" and the concept of "knowledge" also change. The change in technology and science has also affected the change in skills expected from individuals. The change in the skills expected from individuals has brought along the countries to renew and review their education reforms (Tekinkır, 2008). With the education reforms in Turkey, the concept of estimation skills has been emphasized in the primary education mathematics curriculum, and the learning outcomes related to this skill were included in the curriculum. Important areas of competence were included to the primary school mathematics curriculum updated in 2018. Most of these competencies support each other. It is stated in the documents of the Turkish Ministry of National Education (MoNE, 2018) that individuals with mathematical competence are expected to gain posing skills and problem-solving. In these documents, it is also stated that individuals are

expected to gain such skills as taking initiative, having entrepreneurial competencies, making predictions, comparing the estimated result with the calculated result, and making mental operations. These explanations reveal that the estimation skills have an important place within the framework of the determined competencies in the Turkish education system.

The Concept of Estimation and the Importance of Estimation Skills

Micklo (1999) defined estimation as quickly developing an idea about the size or quantity of something without actually counting and measuring it. Segovia and Castro (2009), on the other hand, defined the estimated response as predetermining the value of the desired measure or the outcome of a transaction. Reys (1986) described estimation as the process of coming up with 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 involve doing mathematics in daily life and are frequently used. Er and Artut (2014), on the other hand, emphasized that estimation is a concept that is constantly used both in scientific studies and in daily life, and estimation is not a random action, but a skill developed as a result of experiences gained in mathematics.

There are three types of estimation in mathematics education: numerosity estimation, computational estimation and measurement estimation (Hanson & Hogan, 2000; Sowder, 1992). Computational estimation is defined as the process of finding a number that gives an approximate result of a calculation that we cannot or do not want to pinpoint. For example, if you travel 325 km with 15 liters of gas in your car, you may want to know the approximate amount of gas consumed per kilometer. Hogan and Brezinski (2003) stated that numerosity estimation is a subset of measurement estimation. The difference between numerosity and measurement estimation is the continuous and discontinuous feature sought in estimating the amount of the object to be measured (Segoiva & Castro, 2009). Measurement estimation can be expressed as the determination of a measurement without making an exact measurement. Numerosity estimation is the determination of the approximate number of pieces in a stack. For example, when the number of apples in a basket is asked, since there is a discontinuity, this type of estimation is called the numerosity estimation, and if it is desired to estimate how many kilograms the apples will weigh, it has been deemed appropriate to call this estimation type as the measurement estimation since the weight is a unit containing continuity.

When the relevant literature is examined, it is seen that there are studies to investigate the estimation skills of secondary and primary school students (Aydoğdu & Çimen, 2021; Aytekin & Uçar, 2014; Boz & Bulut, 2012; Çilingir & Türnüklü, 2009; Luwel & Verschaffel, 2008; Roebyanto,2018; Star Rittle, Lynch & Perova, 2009), pre-service teachers (Boz & Bulut, 2002; Son, Hu & Lim, 2019; Sulak, 2008; Özcan,2015), and teachers' (Bozkurt & Yavaşça;2021;Dowker, 1992). Results of these researches reveal that the estimation skill levels of the individuals are low. The low level of estimation skills revealed the idea that it is important to investigate their self-efficacy for subjects that require the use of estimation skills of individuals. Individuals with high self-efficacy can be more active and productive, and more relaxed when faced with difficult situations. Individuals with low self-efficacy beliefs may exhibit more anxious behavior.

The Concept of Self-Efficacy

Self-efficacy is the belief in one's own capacity. Self-efficacy beliefs affect academic success in the face of difficulties. Korkmaz (2005) stated that an individual with high self-efficacy can cope with complex events, can overcome any problem, show patience in his studies, have confidence in himself to achieve success, and is successful in education and business life. In addition, Korkmaz (2005) stated that individuals with low self-efficacy cannot cope with the events, feel despair and are unhappy, and do not find themselves sufficient for solving any problem. High self-efficacy perception is a matter of special importance for teachers as it is necessary for all individuals, because teachers' self-efficacy perceptions affect both their commitment to their profession, their attitudes and thoughts towards their profession, and their educational activities (Caprara, Barbaranelli, Steca & Malone, 2006). In addition, studies show that teachers with high self-efficacy perform more positively than teachers with low self-efficacy (Kiremit, 2006). Bandura (1986) stated that individuals' being unsure of themselves would trigger learning, but would also prevent the use of previously acquired skills. In the literature, it is reported that self-efficacy has effects on preference, commitment, effort, and success (Schunk & Pajares, 2005), while self-efficacy has a significant effect on all kinds of success (Schunk & Pajares, 2005; Phan, 2011; Valentine, DuBois & Cooper, 2004).

Significance and Research Questions

Estimation skills matters most for both daily life and mathematics education. Having predictive 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 skills and the concept of self-efficacy, it is thought that this research will make a significant contribution to the field.

During the educational process, teachers have great responsibilities in helping students acquire estimation skills. In this context, it can be said that it may be important to measure the pre-service teachers' self-efficacy about their estimation skills, because in the education process, teachers have great responsibilities in helping students gain estimation skills. Er, Artut and Bal (2022) stated that there is a relationship between estimation skill and estimation skill self-efficacy. Thus, first of all, teachers should have estimation skills self-efficacy. An instrument is needed to measure the self-efficacy perceptions of teachers and pre-service teachers. Due to the limited number of studies on this subject in the relevant literature, it is thought that this study will shed light on future studies and contribute to the literature.

In this context, the aim of this study is to develop a scale to measure the pre-service teachers' self-efficacy for estimation skills. Accordingly, following research questions were asked in this research:

1. In terms of content validity, do the items in the draft form of estimation skill self-efficiency scale (ESSES) represent the self-efficacy for estimation skill according to the opinions of subject experts?
2. In terms of construct validity, is the structure of the ESSES simple and stable?
3. In terms of reliability,
   a. What are the Guttman Split Half and Cronbach Alpha coefficients of the ESSES?

b. What is the item-total correlation coefficients for each item in the ESSES?

4. In terms of discrimination, is the ESSES able to distinguish between upper and bottom group members?

Method

This quantitative research was conducted to develop a reliable and valid scale to determine pre-service teachers' self-efficacy beliefs for their estimation skills.

Study Group

The population of the research consists of pre-service teachers studying at the Department of Elementary Mathematics and Science, Faculty of Education, Çukurova University in Adana. While determining the pre-service teachers constituting the study group, the typical case sampling method was used. Typical case sampling is the selection of average or typical cases from a large number of cases in the population related to the research (Fraenkel, Wallen, & Hyun, 2012). The personal information of the pre-service teachers in the study group participating in the research is shown in Table 1.

Table 1. Percentage and Frequency Distribution of Pre-service Teachers by Personal Information

Variables		**Study Group**	
		N	%
Gender	Female	116	73 .4
	Male	42	26 .6
Grade Level	First grade	114	72 .2
	Second grade	44	27 .8
Department	Mathematics Teachers	70	44 .3
	Classroom Teacher	39	24 .7
	Science Teacher	49	31 .0
Academic Success Average	0-1.99	52	32 .9
	2.0-2.99	22	13 .9
	3-3.49	38	24 .1
	3.5-4	46	29 .1
	Total	158	100 .0

When Table 1 is examined, 73.4% of the pre-service teachers in the study group participating in the research were female and 26.6% were male. 72.2% of pre-service teachers were 1st year students, 27.7% of them were 2nd year students. In addition, 44.3% of the pre-service teachers participating in the research were studying at mathematics education program, 24.7% at classroom teaching program and 31% at science education program. In addition,

general academic average of 32.9% of the pre-service teachers were between 0-1.99, 13.9% of them were between 2.0-2.99, 24.1% of them were between 3-3.49%, and 29.1% of them were between 3.5-4.0.

Data Collection Tool

The Preparation Process of the ESSES

The ESSES for teacher pre-service was developed by following the steps given below (Devellis, 2016). In this regard, the process steps consisting of creating an item pool, piloting and content validity construct reliability, validity studies and finalizing the scale are given in Figure 1.

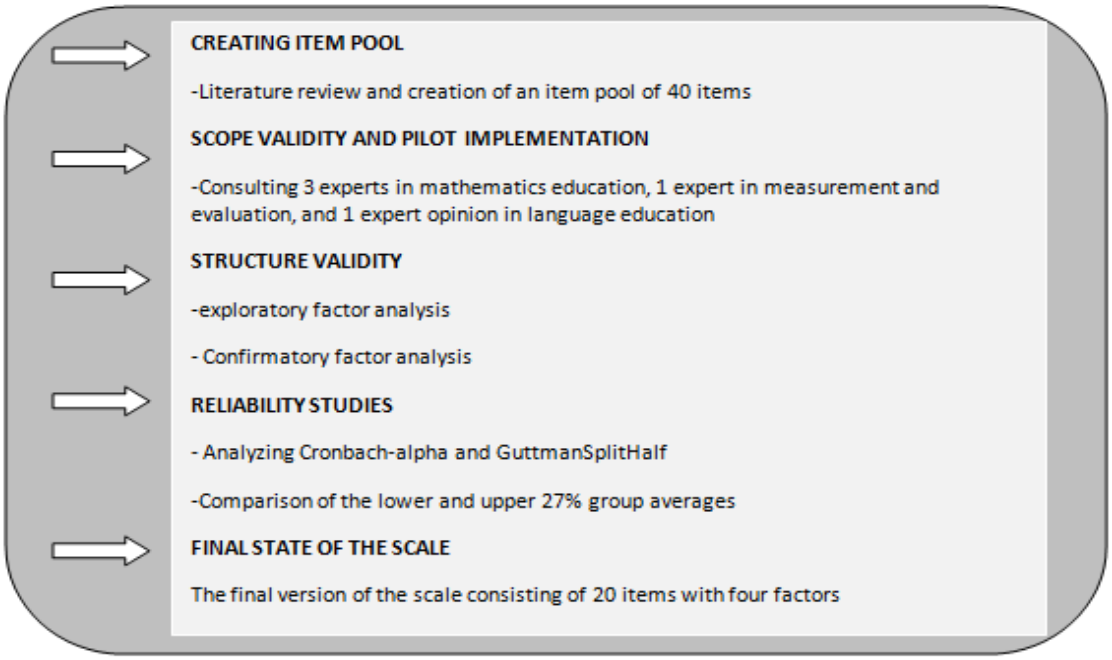

Figure 1. The Development Process of the ESSES

When Figure 1 is examined, first an item pool of 40 items was created by reviewing the literature in the process of creating the item pool in the preparation of the measurement tool. After the item pool was created, necessary permissions and ethics committee approval were obtained. Secondly, a pilot application was carried out after getting the opinions of 4 experts [Mathematics education (n=2), language education (n=1) and assessment-evaluation (n=1)] in the content validity process of the measurement tool. Thirdly, exploratory and confirmatory factor analyses were applied for the construct validity process. Fourthly, Guttman Split Half,Cronbach Alpha analysis, and 27% lower-upper group discrimination analyses were performed for the reliability studies of the data collection tool. Finally, a scale form consisting 20 items under four factors was obtained.

Developing the Item Pool

In the process of preparing the items related to the ESSES, first of all, the relevant literature was reviewed. In this context, the definition of estimation skill, types of estimation skills, and self-efficacy concepts were examined. In

this context, the studies were examined and draft articles were prepared. In this process, a mathematics teacher who continues his postgraduate education in mathematics education was also interviewed and his opinions on estimation skills were obtained. In line with the opinions received from the teacher, the estimation skill acquisitions in the mathematics curriculum were examined and an item pool of 40 items was prepared.

Content Validity

The content validity of the 40-item draft form was examined through an expert panel. Content validity means that the instrument should be able measure without confusing the feature that the instrument aims to measure with other features (Çepni, Baki, Demircioğlu, & Akyıldız, 2009). In this regard, first of all, the items in the item pool were presented to the opinion of two experts in the field of mathematics education, one expert in the field of evaluation and assessment and one expert in the field of language education. Mathematics and assessment experts evaluated each item in the draft form as “corrected”, “appropriate”, “not appropriate” according to the purpose of the scale. Later, language experts examined the language structure, grammatical structure and comprehensibility of each item. Based on the expert opinions, it was decided to remove the 23rditem from the scale as it was misleading and unclear, the 34thand 35thitems were corrected and a new item was added to the scale. In line with these views, the item "23. My math teacher says I am successful in subjects that require guessing" was removed since the student's self-perception is important. Also, item “34. I cannot estimate the surface area of our country close to its real area" was revised as "I have difficulty in precisely estimating the area of our school garden". Similarly, item “35. I cannot precisely estimate the distance between two cities" has been corrected as "I have difficulty in estimating the distance between home and school". In addition, the ıtem "I can precisely estimate the weight of a product we buy from the market" has been added.

Pilot Study

The 40-item draft form, which was prepared in line with expert opinions, was applied to 88pre-service teachers. For the face validity of the draft form, the page layout was also examined in terms of the size and usefulness of the fonts. The 40-item scale form obtained as a result of the arrangements was administered to the pre-service teachers studying at the Primary Education, Mathematics Education, and Science Education Departments at the Faculty of Education in Çukurova University in Adana.

Data Analysis

Before proceeding to the analysis process, the data were numbered and recorded into the computer. In the first stage, 158 data obtained from the study group were evaluated during the development of the scale. In this regard, the construct validity of the data set was tested using EFA in IBM SPSS 26.0 program, and the reliability of the data collected were calculated using Guttman Split Half values and Cronbach Alpha analysis in the same program. In addition, the standard deviation and arithmetic mean values of the items in the scale and the item-total correlations were examined, and item discrimination indices were calculated by independent groups t-test analysis. In addition, CFA was calculated using the Lisrel software program.

Strengths and Limitations of the Research

It is a powerful research since all the scale development steps were applied in this research. Validity and reliability analyses make the study valuable. However, although some reliability analyzes have been made, it is somewhat limited in terms of temporal reliability since no test-retest analysis was applied. Obtaining data only from first and second grade pre-service teachers due to the pandemic process was another imitation of the research.

Results and Discussion

In this section, the findings regarding the validity and reliability applied during the development of the "Estimation Skills Self-Efficiency Scale (ESSES)" are presented.

Findings Regarding the Construct Validity of the ESSES

Exploratory and Confirmatory Factor Analyses were applied to establish the construct validity of the ESSES. EFA is used to obtain information about the number of factors measured by the researcher's measurement tool (Sharma, 2006), and CFA is applied to test a hypothesis developed by the researcher in line with the theory (Tabachnick & Fidell, 2001). In this context, firstly, information about the number of factors was obtained by applying exploratory factor analysis, and then the goodness-of-fit of the obtained construct was tested with confirmatory factor analysis.

Findings Related to EFA of the ESSES

For the EFA applied to the ESSES, first of all, the suitability of the data for the factor analysis and the adequacy of the sample size was checked with the Kaiser-Meyer-Olkin (KMO) test and the Bartlett Sphericity test (Büyüköztürk 2011). The results of the applied analyses are shown in Table 2.

Table 2. KMO and Barlett Sphericity Test Values

KMO	.88	
Barlett Sphericity Test	X^2	2033.59
	P	.00

When Table 2 is examined, the KMO value was determined as .88. In line with this result, it was concluded that the sample fit was "very good" for EFA (Sharma, 1996). In addition, the result of the Bartlett Sphericity test was calculated as X^2= 2033.59 and. It was found to be significant at the .01 level. These results show the suitability of the data for factor analysis.

While applying EFA to the ESSES, Promax rotation was applied during the principal components analysis. According to this analysis, four factors with eigenvalues above 1 were obtained for 20 items. The structure of

factors with eigenvalues of one or above is considered stable (Büyüköztürk, 2002). The scree plot is shown in Figure 2.

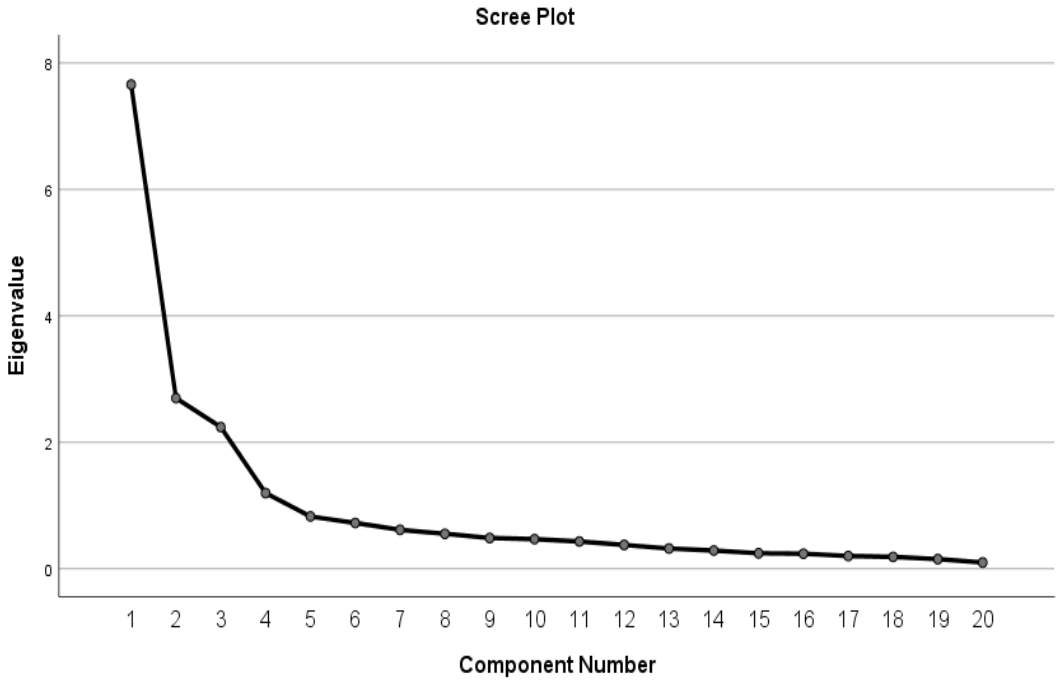

Figure 2. Scree Plot

As seen in Figure 2, the scree plot follows a horizontal line after four factors. As a result of the analysis, a four-factor structure was obtained n four iterations. The factor loads for each item, explained variance values for each factor and eigenvalues are given in Table 3.

Table 3. Factor Analysis Results Regarding the ESSES

Items	F1	F2	F3	F4
I13: I can estimate perimeters of polygons close to their true value	.899			
I19: I can estimate lengths in units of meters or centimeters close to the true value	.889			
I8: I can estimate close to the number of objects in the given multiplicity	.864			
I10: I can estimate an area close to its true value with non-standard area measurement units	.859			
I12: I can estimate the amount of liquid in a container close to its true value in liters and milliliters	.834			
I7: I can estimate the length of an object close to its true value in non-standard units of measurement	.826			

Items	F1	F2	F3	F4
I11: I can approximate the mass of an object	.824			
I14: I can estimate the areas of polygons close to their true value	.811			
I2: My fear decreases when solving problems that require guessing		.834		
I1: I like problems that require guessing in mathematics lessons.		.814		
I3: I can easily solve problems that require estimation		.808		
I4: Problems that require estimation interest me		.798		
I19: I find it hard at most to guess correctly the product of a two-digit natural number and a one-digit natural number			.811	
I17: I find it difficult to do mental additions			.723	
I22: I find it difficult to predict the result of operations with decimal representations of numbers			.688	
I20: I can predict the result of a division operation close to the true value			.630	
I18: I can predict the result of subtraction with natural numbers close to its true value			.627	
I24: I am aware of the level of my estimation skill				.910
I23: I am aware of what I need to do to improve my estimation skill				.855
I25: I am aware that my estimation skill level has improved over time				.682
Eigen value	7.659	2.698	2.240	1.197
Percentage of Variance Explained	**38.29**	**13.49**	**11.20**	**5.98**
Range	.088	.036	.184	.228
Number of items	8	4	5	3

When Table 3 is examined, the percentage of total variance explained for the scale consisting of 20 items and four factors is 68.97%. Of this variance, 38.29% belongs to Measured Estimation Perception factor, 13.49% belongs to Affective Perception-Related factor, 11.20% belongs to Operational Estimation Perception factor, and 5.98% belongs to Perception of Estimation Skill Level factor. Factor loads of the scale ranges between .63 and .91.

In determining the items measuring the same factor; item's having high loadings on a single factor was taken into consideration. In addition, the items with factor loadings under .30 were not considered (Kline, 2005; Tabachnick & Fidell, 2001). The correlation values of the factors of ESSES, the arithmetic mean and standard deviation values are given in Table 4.

Table 4. Correlation Coefficients of Total Score and Sub-Factors of ESSES

Item sub-factors	**F1**	**F2**	**F3**	**F4**
F1	1			
F2	.416**	1		
F3	.106	.139	1	
F4	.459**	.542**	.224**	1
Total	.850**	.709**	.432**	.722**

**p <.01

As seen in Table 4, it is concluded that there is a statistically significant relationship (p <.01) between the total score of the ESSES and its factor scores. In total scores of 416, .106 and .459. 850; factor 2 sub-factor was .416, .139 and .542 with other sub-factors, and .709 with total score; factor 3 sub-factor was .106, .139 and .224 with other sub-factors, and .432 with total score; factor 4 sub-factors showed a positive correlation of .459, .542 and .224, respectively, and .722 with the total score. According to Büyüköztürk (2011) the correlation is at moderate level if the correlation coefficient is between .70 and .30. If the correlation coefficient is less than .30, it's low. It can be said that while the inter-correlations between the factors of the scale are statistically significant in positive direction and at low-to-moderate levels, there is a moderate and high level of positive and statistically significant relationship between the factors for the scale and the total scale.

In the process of naming the factors of the ESSES, both the item contents and the relevant literature were taken into account. Accordingly, the four factors were named as "Measured Estimation Perception (MEP)", "Affective Perception of Estimating (APE)", "Operational Estimating Perception (OEP)", and "Perception of Estimation Skill Level (PESL)", respectively.

Findings Related to CFA of the ESSES

CFA was applied to determine whether the four-factor structure of ESSES obtained as a result of the EFA was confirmed. The goodness-of-fit indices and limit values obtained during the analysis are shown in Table 5. When Table 5 is examined, fit indices were found to be $\chi 2/df=2.04$; RMSEA=.081; SRMR=.068; NNFI=0.95; GFI=0.82; CFI=0.96; and IFI = 0.96. SRMR and RMSEA range from 0 to 1. They are expected to be close to "0" (minimum error between observed and produced matrices). A value less than or equal to 0.05 indicates excellent fit, values up to 0.08 indicate an acceptable good fit. According to the results obtained, it can be said that the RMSEA and SRMR values are acceptable. The GFI ranges from 0 to 1. Values equal to or above 0.90 are considered good fit, and values above 0.85 are also considered acceptable. However, it is affected from the sample size, and it yields smaller values in large samples. Accordingly, it can be said that the GFI value obtained shows a weak fit. CFI is a criterion that considers the sample size and the degree of freedom in the model in the evaluation of model fit. A CFI value above 0.90 indicates adequate fit, and values above 0.95 indicate perfect fit. Accordingly, it can be said that the obtained CFI value shows a perfect fit. According to the results obtained, it is observed that the values are between good-to-perfect fit.

Table 5. ESSES Calculated Values and Limit Values

Goodness of Fit indices	**Calculated Value**	**Acceptable Threshold Values**	**References**
χ2/df	2 .04	≤3= perfect fit	Hooper, Coughland and Mullen(2008),Kline(2005)
RMSEA	.081	≤.08= good fit	Hooper et al.(2008), Brown (2006),
SRMR	.068	≤.08= good fit	Kline (2011), Brown (2006)
NNFI	.95	≥.95= perfect fit	Kline (2005), Hu and Bentler (1999), Tabachnick and Fidell (2001).
GFI	.082	<.85=weak fit	Cole (1987)
CFI	.96	≥.95= perfect fit	Brown (2006), Tabachnick and Fidell (2001)
IFI	.96	≥.95= perfect fit	Hu and Bentler(1999)

The *t* values of the four-factor model as a result of CFA are shown in Table 6.

Table 6. t-Values Obtained from CFA for the ESSES

Item No	**t**	**Item No**	**t**
Item13	13.67**	Item3	12.30**
Item9	12.87**	Item4	10.25**
Item8	12.26**	Item19	7.23**
Item10	13.47**	Item17	6.07**
Item12	12.38**	Item22	5.82**
Item7	11.93**	Item20	10.00**
Item11	12.08**	Item18	9.04**
Item14	12.04**	Item24	11.62**
Item2	12.97**	Item23	11.15**
Item1	13.32**	Item25	10.04**

*p<0.05

When Table 6 is examined, the *t*test values of the items of the ESSES range from 5.82 to 13.67, which are statistically significant, since *t* values are significant above 1.96 at.05 level or above 2.58 at .01 level (Kline, 2005; Çokluk, Şekercioğlu, & Büyüköztürk, 2014). These findings confirm the factor structure of the ESSES. The standardized values of the proposed ESSES are given in Figure 3. The numbers of the items are presented in the form of T1, T2.

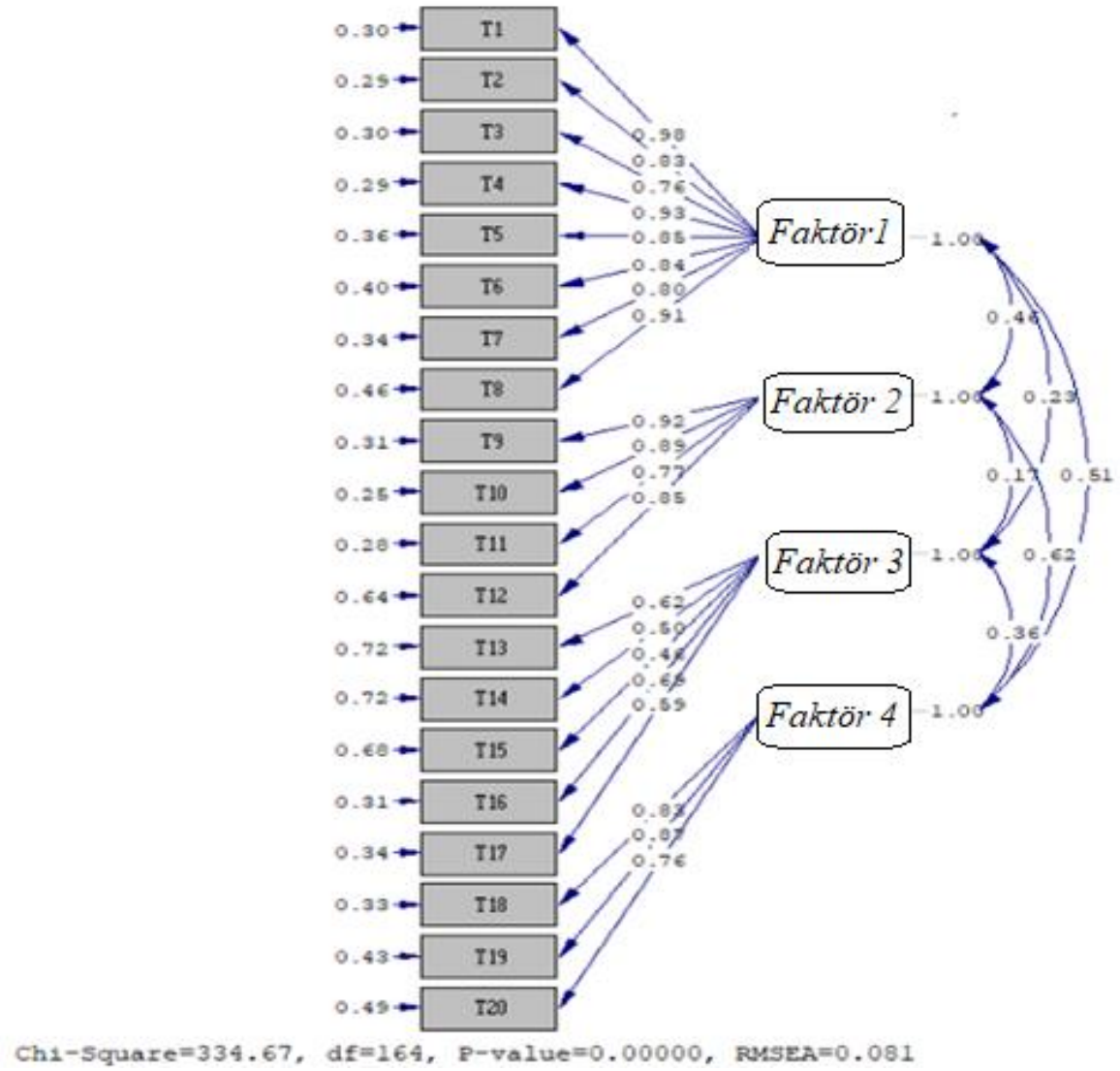

Figure 3. Standardized Values of the Proposed Model as a Result of DFA

When Figure 3 is examined, the factor loadings of the proposed model are between .48 and 98. In addition, the correlation values between the observed variables are appropriate (Çokluk et al., 2014).

Findings Related to the Reliability of the Scale

Guttman Split Half and Cronbach Alpha coefficients were calculated in order to determine the internal consistency of ESSES. The results of the analyses are presented in Table 7. When Table 7 is examined, the Cronbach Alpha internal consistency coefficients were.944 for the first factor, .885 for the second factor, .747 for the third factor, and .816 for the fourth factor. The internal consistency value for the entire scale is .899. Also, Guttman Split Half coefficients were calculated to determine the consistency of the scale, which were found .954 for the first factor, .864 for the second factor, .599 for the third factor, .670 for the fourth factor, and .625 for the whole scale. Internal consistency coefficients above .70 indicates that the scores obtained from the scale is reliable (Fraenkel, Wallen, & Hyun, 2012; Tavşancıl, 2010). Although third and fourth factors were found to be moderately reliable, other factors were found to have high and acceptable reliability in general.

Table 7. Guttman split-half and Cronbach Alpha Values of the Total Scores and Sub-Factor Scores of the ESSES

Sub-factors	**Cronbach Alpha**	**Guttman Split Half**
F1	.944	.954
F2	.885	.864
F3	.747	.599
F4	.816	.670
Total score	.899	.625

In addition, the corrected item-total correlation values and Cronbach Alpha values when the item was discarded as a result of the analysis performed to determine the reliability of the ESSES are given in Table 8.

Table 8. Corrected Item-Total Correlations of Estimation Skills Self-Efficacy Scale and Cronbach Alpha Value When Item was Excluded

Item No	**Corrected Item Total Correlations**	**Cronbach's Alpha Value When the Item is deleted**
M1	.701	.889
M2	.678	.890
M3	.665	.891
M4	.722	.889
M5	.654	.891
M6	.684	.890
M7	.680	.890
M8	.630	.891
M9	.579	.893
M10	.596	.893
M11	.621	.892
M12	.440	.897
M13	.155	.905
M14	.122	.905
M15	.184	.903
M16	.404	.898
M17	.332	.899
M18	.547	.894
M19	.540	.894
M20	.590	.893

As seen in Table 8, the item-total correlation coefficients ranged between .122 and .722. These values should be non-negative and at least expected to take a value of .30 and above (Büyüköztürk, 2002). According to these findings, it can be said that the scale meets these criteria. In addition, the Cronbach Alpha value obtained when

the items were discarded between. 889 and 905. A score of 70 and above is sufficient for the reliability of the test scores (Fraenkel, Wallen, & Hyun, 2012; Tavşancıl, 2010).

Findings about Discrimination of the Items of the Scale

It is expected that the developed measurement tool will distinguish whether it exhibits the desired behavior or not (Can, 2013). Therefore, independent samples t-test was applied to determine the discrimination power of the items in the ESSES (Balcı, 2001). The bottom and upper 27% groups were determined by ranking the total scores of the data obtained from 158 students, and the independent samples t-test was used to compare the upper and lower group scores. Analysis results are given in Table 9.

Table 9. t-Test Results of Prediction Self-Efficacy Scale Lower and Upper Group Scores

Item No	Bottom Group			Up Group		
	N	X̄	S	X̄	Ss	t
I1	43	2 .0233	.77116	4 .0930	.89480	.000
I2	43	2 .5349	.76684	4 .3023	.74113	.000
I3	43	2 .7209	.73438	4 .3953	.65971	.000
I4	43	2 .2558	.75885	4 .2326	.84056	.000
I5	43	2 .2326	.78185	4 .0698	.82794	.000
I6	43	2 .4651	.82661	4 .2558	.75885	.000
I7	43	2 .5814	.79380	4 .3721	.69087	.000
I8	43	1 .8837	.69725	3 .8837	.95641	.000
I9	43	2 .4651	.90892	4 .2326	.71837	.000
I10	43	2 .8140	.93238	4 .3953	.76031	.000
I11	43	2 .6047	.65971	4 .0698	.79867	.000
I12	43	2 .3256	.99333	3 .7943	1 .05669	.000
I13	43	3 .5581	.98325	4 .1163	.98099	.000
I14	43	3 .8140	1 .05234	4 .2558	1 .02569	.000
I15	43	3 .2885	.95848	3 .6744	.96907	.000
I16	43	3 .3023	.88734	4 .3721	.72451	.000
I17	43	3 .7907	.91439	4 .4884	.79798	.000
I18	43	2 .6744	1 .01702	4 .2093	.80351	.000
I19	43	2 .5116	1 .03215	4 .1628	.78468	.000
I20	43	2 .8605	1 .01375	4 .4651	.63053	.000

**p<0.01

When Table 9 is examined, it was concluded that there is a statistically significant difference (p<.01) between the mean scores of the upper group and the mean scores of the lower group. Accordingly, it can be said that the items of the ESSES are distinctive.

Conclusions and Recommendations

This study was carried out in order to develop a reliable and valid scale to determine the predictive skill self-efficacy levels of pre-service teachers. In the first stage, an item pool of 40 items was developed by reviewing the literature in the development process of the scale, and content validity was ensured by submitting it to expert opinions. As a result of the EFA applied to establish the construct validity of the scale, a four-factor contract explaining the 68.97% of the total variance was obtained. Four factors of the scale were named as "Measured Estimation Perception", "Affective Perception of Estimating", "Operational Estimating Perception" and "Perception of Estimating Skills Level", respectively.

Item factor loadings of the scale ranged between .63 and.91. In order to test the goodness-of-fit of the four-factor construct of ESSES, a follow-up confirmatory factor analysis was applied. As a result of CFA, acceptable-to-perfect fit indices were obtained: $\chi 2/df=2.04$; RMSEA=.081; SRMR=.068; NNFI=0.95; GFI=0.82; CFI=0.96; IFI= 0.96). As a result of the reliability analyzes (Cronbach Alpha and Guttman Split Half) of the ESSES, the values obtained were found to be .625 and above. This value is an indication that the scale is quite reliable. On the other hand, in order to determine the item discrimination power within the scope of the reliability of the scale, it was concluded that there was a significant difference between the score of the upper group of 27% over the total score and the score of the subgroup ($p<0.01$) and that the items in the scale were distinctive. Consequently, the scale can be used as a reliable and valid data collection tool that can measure pre-service teachers' self-efficacy for estimation skills.

Having estimation 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 the scale obtained as a result of this research will make a significant contribution to the literature. This scale was used to determine the estimation skill self-efficacy of pre-service teachers only. However, it can be suggested to conduct reliability and validity studies again by considering different sample groups (primary or high school teachers) of the prepared scale. In addition, future studies can examine the differentiation of pre-service teachers' self-efficacy in estimation skills according to academic achievement, department of education and gender.

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