Investigation of the Relationship between Estimation Skill, Estimation Skill Self-efficacy, and Academic Achievement of Secondary School Students

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Article Info	Abstract
	The purpose of this study is to investigate the relationship between secondary school students' estimation skills, estimation skills self-efficacies and academic achievements. The research was designed in a correlational survey model, one of the quantitative research models and it was carried out in Adana, a city in the Mediterranean Region during the spring semester of the 2020-2021 academic year with secondary school students (n=155) who were selected by maximum variation sampling method, one of the purposive sampling methods. The Estimation Skills Self-Efficacy Scale that was developed by Er, Artut and Bal (2021) was used to determine the students' estimation self-efficacy. Also, the Estimation Skill Test which was developed by the researchers was used to determine the students' estimation skills. One-way analysis of variance (ANOVA) and regression analysis techniques were made use of in the process of data analysis. The research findings showed that the students' estimation skills were at moderate level and their estimation self-efficacy levels were low. It was also concluded that the students' estimation skills and their estimation self-efficacies differed according to their grade levels. Furthermore, it was found that there was a positive and moderate relationship between students' estimation skills and estimation self-efficacies and a positive and moderate relationship between their estimation skills and academic achievements. It was also determined that there is a positive and moderately significant relationship between estimation self-efficacies and academic achievement. In addition to this, it was seen that students' estimation self-efficacies and academic achievements explained 17% of the total variance of their estimation skills. In other words, students' estimation skills increase in parallel with their estimation skill self-efficacies and academic achievements.

Introduction

The knowledge gains importance in the world. The concept of "knowledge" and the understanding of "science" are also changing and technology is advancing, and the concepts of democracy and management are transforming. The rapid change in science and technology has also affected the change in the skills which are expected from individuals in society. These are skills of producing knowledge and using it functionally, solving

problems and predicting etc. (MEB, 2016). The curriculums of countries come into prominence for individuals to acquire these skills. In this context, the mathematics curriculum of elementary education in Turkey has been updated and put into its final form by Ministry of National Education.

Estimation skill is mentioned in the related literature as one of the skills to which importance should be given in teaching of mathematics (NCTM, 2000). Together with the educational reforms in our country, "estimation skill" has been emphasized in the mathematics curriculum of elementary education and the acquisitions about this skill have been included in the curriculum. Significant competence fields were added into the mathematics curriculum of elementary education in MEB (2016). Pursuant to these competencies, the individuals who have mathematical competence are expected to have acquired the qualification of taking initiative and entrepreneurship, predicting, comparing the estimation with the calculated result and doing mental computation. From this point of view, it is also seen that estimation skills are remarkable in the framework of competencies.

Van de Walle (2016) defines the term "estimation" as the most appropriate predicted value that can replace an accurate number corresponding to a certain context alone (Van De Walle, 2016). Reys and Bestgen (1981) defined estimation as finding the result of an operation or problem approximately based on mental computation, and Reys (1986) defined it as the process of reaching the real answer in the closest way. Estimation is a concept which is continuously used in both scientific studies and daily life.

Predicting the values of air temperature, making scientific estimations, earthquake estimations by geologists, predicting in how many minutes the bus will arrive, predicting the length of a tall building, predicting how long it will take to cook the food can be examples of estimations which are made frequently in daily life. Despite giving importance to estimation skills and achievements in mathematics curriculums, in the literature, it was revealed in studies which investigated the estimation skills of elementary and secondary school students (Aytekin & Uçar, 2014; Baroody & Gatzke, 1991; Bobis, 1991; Boz &Bulut, 2012; Crites, 1992; Çilingir & Türnüklü, 2009 ; Dowker, 1997; Er & Artut, 2021; Hanson & Hogan, 2000; Kılıç & Olkun, 2013; Luwel & Verschaffel, 2008; Pilten & Yener, 2009; Star Rittle, Lynch & Perova, 2009; Tekinkır, 2008) that students have low level of estimation skills. Due to these findings, the question of what factors might affect this situation comes to the mind.

The concept of self-efficacy is the belief of an individual about his/her own capacity. The belief of self-efficacy affects the individuals' academic achievements. Individuals with high self-efficacy can be more productive and can feel more comfortable when they face difficulties. On the other hand, individuals with low self-efficacy can display more anxious behaviours against difficulties.

Bandura (1986) stated that individuals' condition of not being unsure about themselves might trigger learning. However, it might block the use of previously acquired experiences as well. It was seen in the related literature that self-efficacy has some effects on making preferences, making effort, commitment and achievement (Pajares, 1996; Schunk and Pajares, 2005), it affects any type of achievement significantly (Multon, Brown &Lent, 1991; Pajares, 1996; Schunk&Pajares, 2005; Valentine, DuBois & Cooper, 2004).Within this context,

this research aims at focusing on the relationship between individuals' estimation skills and estimation self-efficacy and academic achievement.

In the related literature, there are studies which dealt with the estimation skills of elementary and secondary school students and the estimation strategies they use and studies about the development of estimation skills. Among the available sources, no studies about the relationship between secondary school students' estimation skills and their estimation skill self-efficacies and academic achievements were found. The findings of this research will contribute to the related literature. In this context, the purpose of this study is to investigate the relationship between secondary school students' estimation skills and their estimation skill self-efficacies and academic achievements. In line with the general purpose of the research, the following sub-problems were formulated:

1) Do students' estimation skills differ significantly according to their grade levels?
2) Do students' self-efficacy scores differ significantly according to their grade levels?
3) Is there a significant relationship between students' estimation skills and their estimation skill self-efficacies and academic achievements?
4) Do students' estimation skill self-efficacies predict estimation skill?
5) Do students' academic achievements predict estimation skill?
6) Do students' estimation skill self-efficacies and academic achievements together predict estimation skill?

Method

In this research, it was aimed to determine the relationship between secondary school students' estimation skills and estimation skills self-efficacies and academic achievements. Therefore, this research was designed as a descriptive study in correlational survey design. Survey models are research approaches that aim to describe a past or present situation as it is (Köse, 2010). Correlational survey model is a research model that aims to determine whether there is a difference between two or more variables. If a difference is found, the degree of this difference is investigated (Karasar, 1995; Cohen, Manion & Morrison, 2000).

Sample of the Research

The sample of the research consists of students at 5th, 6th, 7th and 8th grades of secondary schools in Adana (n=155). While selecting the sample, maximum variation sampling method, one of the purposive sampling methods, was adopted. In this context, the representative ability of the population was considered and students with different grade levels and different academic achievements were tried to be selected to the sample of the research. In this kind of sampling method, it can be said that important presumptions will be provided about the values of population as various situations about the problem is taken into the sample (Büyüköztürk, Çakmak, Akgün, Karadeniz, Demirel, 2016). Personal information of the students in the sample of the research is presented in Table 1.

Table 1. Frequency and Percentage Distributions of the Students' Personal Information

Variables		Sample	
		N	%
Gender	Female	92	59.4
	Male	63	40.6
	Total	155	100
Grade Level	5th grade	56	36.1
	6th grade	22	14.2
	7th grade	40	25.8
	8th grade	37	23.9
	Total	155	100.0
Academic Achievement	Very Good	101	7.7
	Good	42	27.1
	Average	12	65.2
	Total	155	100.0

Data Collection Tool

In this research, (i) estimation skill self-efficacy scale and (ii) estimation skill test were used in order to assess the students' estimation skill self-efficacy and estimation skill. Some information about the data collection tools which were used in the study is provided below in short.

Estimation Skill Self-efficacy Scale

In order to determine the students' Estimation Skill Self-Efficacy Perception Scores, Estimation Skill Self-efficacy Scale (PSSE) which was developed by Er, Artut, and Bal (2021) was used. The scale consists of five sub-dimensions and twenty-nine questions. These are the sub-factor of Measurement Estimation Perception based on Acquisition (MPPA), sub-factor of Measurement Estimation Perception based on Real Life (MPPRL), sub-factor of Affective Perception based on Estimation (APP), sub-factor of Affective Perception based on Real Life (APRL), sub-factor of Computational Estimation Perception based on Acquisition (CPPA) dimensions (Er, Artut and Bal, 2021). Internal consistency coefficients are shown in Table 2.

Table 2. Cronbach Alpha Values of Estimation Skill Self-efficacy Scale Total Scores and Sub-factors' Scores

Sub-factors	Cronbach Alpha
Factor 1	.884
Factor 2	.872
Factor 3	.826
Factor 4	.779
Factor 5	.630
Total score	.926

Reliability coefficient for the whole of the scale is .926. It is .884 for the sub-dimension of MPPA, .872 for the sub-dimension of MPPRL, .826 for the sub-dimension of APP, .779 for the sub-dimension of APRL and .63 for the sub-dimension of CPPA. These reliability coefficients which were found for this particular implementation show that the scale and the scores about the sub-dimensions are reliable enough and they can be used in line with the purpose of the research (Tavşancıl, 2002).

Estimation Skill Test

So as to determine estimation skill, the researchers developed a test which contains 24 multiple choice questions. Validity and reliability studies of the test were conducted and it was finalized with 21 multiple choice questions. While preparing the questions of the test, the acquisitions about estimation skill in the elementary mathematics curriculum were taken into consideration and the related literature was reviewed. A specification table was generated for the questions in the Estimation Achievement Test (PAT), which was developed by the researchers. Then, the test was submitted to experts for their approvals. In the process of constituting the test, the views of 2 experts in the field of mathematics education, 3 elementary school mathematics teachers, 4 elementary school students and 1 expert in the field of grammar were taken. It can be stated that the content validity of the test was provided by the specification table of PAT (Büyüköztürk et al. 2016).Moreover, item analysis of PAT was done. Tekin (2018) expressed for item discrimination that the values of 0.30 or above can be taken into the test, the ones between 0.20-0.30 can be used after they are corrected and the ones of 0.19 or below should be excluded from the test. It can be reminded that Şeker (2017) described item difficulty index distribution as difficult if the value is between 0-0.40, as moderate if the value is between 0.40-0.60 and as easy if the value is between 0.60-1. 4th, 16th and 24th items were excluded from the Estimation Skill Test as their item discrimination values were lower than 0.19. After these three items were excluded from the test, the reliability of the test was calculated. Cronbach Alpha Coefficient was used to test the reliability. If the Cronbach Alpha coefficient (α) is lower than 0.40, the scores obtained by the students from the test are not reliable, if it is between 0.40-0.60, the reliability of the scores obtained by the students from the test is low, if it is between 0.60-0.90, the scores obtained by the students from the test are quite reliable, and if it is above 0.90, the test scores of the students are are highly reliable (Can, 2014).The reliability coefficient for the estimation skill test was calculated as $\alpha=0.701$. In this context, it can be said that the scores of the students in the estimation skill test are quite reliable.

Academic Achievement

In this research, the academic achievements of the students in the academic year of 2019-2020 were handled on the basis of the 5-point system and they were included in the research analysis process.

Data Collection Process

In order to perform the data collection tools, official permission and the approval of the ethics committee were taken from the related institutions. Before performing the tools, the students were informed about the subject on

which the research would be conducted and how the tools would be performed. It was also stated that participation in this study was on a voluntary basis. In addition, it was also stated that all the answers to the data collection tools will not be shared by anyone other than the researcher. Data collection tools were performed on 155 secondary school students in one class hour in the spring semester of the 2020-2021 academic year. In the data collection tools, there is a personal information section where gender, grade level and academic achievement scores are tried to be determined. The self-efficacy perception of the estimation skill took an average of 10-15 minutes. The estimation skill achievement test took an average of 20-30 minutes. While performing the tests, the estimation skill self-efficacy scale was given to the students first and then the estimation skill achievement test was implemented. While the data collection tools were being received from the students, it was checked whether the students left any item in the data collection tools blank. If there was an unanswered item, the students were guided to complete it. In each application, it was tried to prevent students from influencing each other as much as possible.

Data Analysis

Before analyzing the data, the descriptive values of the scores of the students from estimation skill test and estimation skill self-efficacy scale were investigated and it was decided which analysis to perform in line with those values. The descriptive statistics of estimation skill test and estimation skill self-efficacy scale are presented in Table 3.

Table 3. Descriptive Statistics

Variables	N	M	ss	Skewness	Kurtosis
Estimation Skill	155	11.13	3.76	.14	-.29
Estimation Skill Self-efficacy	155	96.92	19.7	.193	.486
Academic Achievement	155	4.55	.70	-1.2	.35

According to the results of the descriptive statistics in Table 3, it is accepted that the data showed normal distribution. If Skewness and Kurtosis values are between -/+1, the distribution is accepted as normal (Çokluk, Şekercioğlu, & Büyüköztürk, 2012). It is seen that Skewness and Kurtosis values are between -/+1. Therefore, it was decided to perform parametric tests for the data obtained from the research in order to answer the research questions. The data were analyzed by using one-way analysis of variance (ANOVA) (LSD test, one of the post Hoc tests, to determine the difference between groups), correlation analysis and regression analysis with the help of SPSS 26package program. The significance level was taken as $p < .05$ in the analysis results. The independent variable of this study was estimation skill and the dependent variables were estimation self-efficacy levels and academic achievement. The estimation skill self-efficacy scale is a 5-point Likert type scale, and reference intervals were taken into account while evaluating the arithmetic averages. These reference ranges are: "1.00-1.80 = Never", "1.81-2.60 = Rarely", "2.61-3.40 = Sometimes", "3.41-4.20 = Often" and "4.21-5.00 = Always". Er, Artut and Bal (2021) claimed that the total scores or the scores obtained from sub-factors can be divided by the total number of items in order to facilitate the interpretation of estimation skill self-efficacy scale. In the estimation skill test, each correct answer was coded as "1" and each wrong answer was coded as "0". The

maximum score which can be obtained from the test was 24. Academic achievement scores were included in the analyses based on the 5-point system according to the answers of the students in the data collection tool.

Findings

In this part, the findings obtained from the analysis which was done on the answers to the questions of the study, the results and interpretations are presented.

Findings about the First Sub-problem

In line with the first research question, the mean and standard deviations of the students' estimation skill test scores according to grade level are presented in Table 4.

Table 4. Estimation Skills of Secondary School Students according to their Grade Levels

Grade Level	M	Sd
5th grade	11.46	3.45
6th grade	10.27	3.58
7th grade	10.75	4.63
8th grade	11.56	3.26
Total	11.13	3.76

When Table 4 is considered, it is seen that the highest mean (11.56) belongs to 8th grade students and the lowest mean (10.27) belongs to 6th grade students. When it is taken into consideration that the highest score that can be received from estimation achievement test is 21, it can be said that the students' estimation skills are at moderate level. Following the basic information above about the mean and standard deviation of grade levels, one-way analysis of variance was performed for the independent samples to find out whether there is a significant difference between the estimation skill test scores of secondary school students according to their grade levels. The findings are presented in Table 5.

Table 5. ANOVA of Secondary School Students' Estimation Skill Test according to Grade Levels

Source of the Variance	Sum of Squares	Sd	Mean of Squares	F	p
Between-groups	35.282	3	11.761	.826	.482
Within-groups	2150.873	151	14.244		
Total	2186.155	154			

It is seen in Table 5 that there is not a significant difference between the estimation skills of the students according to their grade levels (F(3.151) =.826, p> 0.05). In other words, the estimation skills of students do not differ significantly according to their grade levels.

Findings about the Second Sub-problem

In line with the second research question, the mean and standard deviations of the students' estimation skill self-efficacy scores according to grade level are presented in Table 6.

Table 6. Estimation Skill Self-efficacy Scores of Secondary School Students according to their Grade Levels

Grade Level	M	Sd
5th grade	105.33	19.50
6th grade	90.04	15.33
7th grade	90.17	22.04
8th grade	95.59	14.97
Total	96.92	19.70

It is shown in Table 6 that the highest mean (105.33) belongs to 5th grade students and the lowest mean (90.04) belongs to 6th grade students. When it is taken into consideration that the highest score that can be received from estimation skill self-efficacy test is 145, it can be said that the students' estimation skill self-efficacy levels (145/96=1.49) are at low level according to gradation scale (1-1.80 Never). Following the basic information above about the mean and standard deviation of grade levels, one-way analysis of variance was performed for the independent samples to find out whether there is a significant difference between the estimation skill self-efficacy scores of secondary school students according to their grade levels (see Table 7).

Table 7. ANOVA Results of Secondary School Students' Estimation Skill Self-efficacy Scores according to Their Grade Levels

Source of the Variance	Sum of Squares	Sd	Mean of Squares	F	p	Significant Difference
Between-groups	6894.017	3	2298.006	6.559	.000	5>6, 7 and 8
Within-groups	52900.202	151	350.332			
Total	59794.219	154				

Table 7 presents that there is a significant difference between the estimation skill self-efficacies of the students according to their grade levels ($F_{(3.151)}$ =6.559, p> 0.05). In other words, the estimation skill self-efficacy scores of students differ significantly according to their grade levels. According to the results of LSD test, which was performed to find out between which groups the difference was, the estimation skill self-efficacy scores of 5th grade students were higher than 6th, 7th and 8th grade students.

The Findings about the Third Sub-problem

In line with the third research question, Pearson Correlation Analysis was done in order to determine the relationship between the students' estimation skills and estimation skill self-efficacy and academic achievement. The findings are presented in Table 8.

Table 8. Correlation Analysis Results of the Students' Estimation Skills, Estimation Skill Self-efficacies and Academic Achievement

Variables		Estimation Skill	Estimation Skill Self-efficacy	Academic Achievement
Estimation Skill	R	1		
	P			
	N	155		
Estimation Skill Self-efficacy	R	.314[**]	1	
	P	.000		
	N	155	155	
Academic Achievement	R	.326[**]	.239[**]	1
	P	.000	.003	
	N	155	155	155

According to Table 8, a positive and moderate level relationship was observed between the students' estimation skills and estimation skill self-efficacy scores (r=0.314; p<0.05). Furthermore, a positive and moderate level relationship was observed between the students estimation skills and academic achievements(r=0.326; p<0.05). Besides, a positive and moderate level relationship was found between the students' estimation skill self-efficacies and academic achievement(r=0.239; p<0.05). For the regression analysis of these findings about Pearson correlation analysis, it is believed that multiple common correlation assumption is met and the data show conformity.

The Findings about the Fourth Sub-problem

In line with the fourth research question, the data obtained about whether estimation skill self-efficacies predict the students' estimation skill or not was presented in Table 9.

Table 9. Simple Regression Analysis Results about whether Estimation Skill Self-efficacies Predict the Students' Estimation Skill or not

Dependent Variable	Independent Variable	B	Std Error	β	t	p	R	R^2	F	p
	Invariant	5.322	1.452		3.666	.000				
Estimation Skill	Estimation Skill Self-efficacy	.060	.015	.314	4.086	.000	.314	.098	16.698	.000

When Table 9 is considered, it is seen that estimation skill self-efficacies of the students predict their estimation skill at a significant level (R²=.098, F=16.698; p<.005). The students' estimation skill self-efficacies explain about 10% of total variance. In other words, the students' estimation skills increase as their estimation skill self-efficacies increase.

The Findings about the Fifth Sub-problem

In line with the fifth research question, the data obtained about whether the students' academic achievements predict the students' estimation skill or not was presented in Table 10.

Table10. Simple Regression Analysis Results about whether the Students' Academic Achievements Predict the Students' Estimation Skill or not

Dependent Variable	Independent Variable	B	Std Error	B	t	p	R	R^2	F	p
	Invariant	2.272	2.097		1.083	.280				
Estimation Skill	Academic Achievement	1.938	.454	.326	4.266	.000	.326	.106	18.201	.000

As it is seen in Table10, it is revealed that the students' academic achievements predict their estimation skill at a significant level (R^2=.106, F=18.201; p<.005). The students' academic achievements explain about 11% of total variance. In other words, the students' estimation skills increase as their academic achievements increase.

The Findings about the Sixth Sub-problem

In line with the sixth research question, the data obtained about whether the students' estimation skill self-efficacies and academic achievements together predict the students' estimation skill or not was presented in Table 11.

Table11. Simple Regression Analysis Results about whether the students' estimation skill self- self-efficacies and academic achievements together

Dependent Variable	Independent Variable	B	Std Error	β	t	p	R	R^2	F	p
	Invariant	-.735	2.231		-.330	.742				
Estimation Skill	Estimation Skill self-efficacy	.048	.015	.250	3.275	.001	.406	.165	15.043	.000
	Academic Achievement	1.582	.454	.266	3.488	.001				

Table 11 presents that students' estimation skill self-efficacies and academic achievements together predict their estimation skills at a significant level (R^2=.165; p<.005). The students' estimation skill self-efficacies and academic achievements together explain about 17% of total variance. In other words, the students' estimation skills increase as their estimation skill self-efficacies and academic achievements increase.

Discussion, Conclusion and Recommendations

This study, in which it was aimed to determine the relationship between secondary school students' estimation skills and their estimation skill self-efficacies and academic achievements, depends on findings obtained from 155 secondary school teachers. In accordance with the research questions, it was found out that students' estimation skills were at moderate level and their estimation skill self-efficacies were at low level and their estimation skills and estimation skill self-efficacies differ according to grade levels. It was also concluded that there was a positive and moderate level significant relationship between their estimation skills and estimation skill self-efficacies; a positive and moderate level significant relationship between their estimations skills and academic achievements; positive and moderate level significant relationship between their estimation skill self-efficacies and academic achievements. Moreover, the students' estimation skill self-efficacies and academic achievements together explain about 17% of total variance. In other words, the students' estimation skills increase as their estimation skill self-efficacies and academic achievements increase.

In line with the first research question, it is seen that the highest mean (11.56) of the students' estimation skills belongs the 8th grade secondary school students and the lowest mean (10.27) belongs to the 6thgrade secondary school students. When it is taken into consideration that the highest score that can be obtained from the estimation achievement test is 21, it can be said that the estimation skills of the students are at moderate level. In addition, it was observed that the estimation skills of the students differed according to their grade level, but this difference was not significant. Munakata (2002) conducted a study with 5th, 7th, 9th and 11th grade students and concluded that the 5th grade students' estimation skills were much lower than the students studying in the other grades. Furthermore, the researcher stated that the estimation skills of students at all grade levels were low. Dowker (1997) carried out a study with children aged 5–9 and asked them to predict the result of the addition operation and concluded as a result of analysis that older children could make more rational estimations. Tekinkır (2008) conducted a study with 6-8 grade students and revealed that students' estimation skill levels differ according to their grade levels and their estimation skills increase as their grade levels increase. Similarly, LeFevre et al. (1993) compared the estimation skills of 4th, 6th, and 8th grade students and adults and presented that estimation skills developed depending on the ages of participants. Therefore, it can be said that the finding obtained in this study is partially similar to the other research findings.

In line with the second research question, it is seen that the highest mean of the students' scores of estimation skill self-efficacies belongs the 5th grade secondary school students and the lowest mean belongs to the 6thgrade secondary school students. When it is taken into consideration that the highest score that can be obtained from the estimation skill self-efficacy scale is 145, it can be said that the estimation skill self-efficacies of the students (145/96=1.49) are at low level as it corresponds to the level of "1-1.80 Never" according to the gradation scale. Besides, it was observed that the self-efficacies of the students differed according to their grade level and this difference was significant. It was also concluded that self-efficacies of the 5th grade students was higher than of the 6th, 7th and 8th grade students. The researchers claimed the reason of 5th and 6th grade students' having higher estimation skill scores as the acquisitions about estimation skills were presented more at elementary

school level. Therefore, it can be said that the findings obtained in this study show similarity with the results of the studies in the literature.

In accordance with the third research question, a positive and moderate level relationship between the students' estimation skills and their estimation skill self-efficacies and a positive and moderate level relationship between the students' estimation skills and their estimation skill self-efficacies were observed. Moreover, a positive and moderate level relationship between the students' estimation skill self-efficacies and their academic achievements was found. In line with the fourth research question, it was concluded that the students' estimation skill self-efficacies predict their estimation skills significantly. Besides, it was seen that the students' estimation skill self-efficacies explained 10% of total variance in estimation skill. In other words, the students' estimation skills improve as their estimation skill self-efficacies step up. In line with the fifth research question, it was presented that the students' academic achievements predict their estimation skills significantly. Besides, it was seen that the students' academic achievements explained about 11% of total variance in estimation skill. In other words, the students' estimation skills improve as their academic achievements ascend. It was concluded in line with the sixth research question that the students' estimation skill self-efficacies and academic achievements together predict their estimation skills significantly. Moreover, it was seen that the students' academic achievements and estimation skill self-efficacies explained 17% of total variance in estimation skill. In other words, the students' estimation skills develop as their estimation skill self-efficacies and academic achievements increase. Tekinkır (2008) stated that there was no difference between the computational estimation skills of the students with poor and pass ing grade achievement in mathematics. She also claimed that the computational estimation skills of the students with moderate, good and very good achievement level increased as their mathematics achievement ascended. Similarly, there was not a significant difference between the measurement estimation skills of students with poor and passing grade achievement in mathematics while there was a positive relationship between the measurement estimation skills of students with poor and passing grade achievement in mathematics and of ones with moderate, good and very good achievement in mathematics.

Levine (1982) expressed that there was a positive relationship between quantitative skills and computational estimation skills. Dowker (1997) grouped the students according to their computational estimation skills and compared the estimation skills of these groups in his study. The results of the study showed that children with high computational skills put forward more logical and acceptable estimations. In the study of Dowker (1991) with students from different professions, the estimation test means of students with high mathematics skills and students with weak mathematics skills were compared. The results presented that the estimation skills of the students with high achievement in mathematics were also high. Similarly, Montague and van Garderen (2003) stated in their study that students with high mathematics achievement have high estimation skills. Therefore, it can be said that the findings obtained in this study provided similar results with the studies in the literature.

To sum up, the relationship between estimation skill and estimation skill self-efficacy and academic achievement was investigated in this study. According to the results of the research, it was seen that the students' estimation skill self-efficacies and academic achievements together explained 17% of the total variance of their estimation skills. This research was conducted with secondary school students. It can be recommended to carry

out the same research with various sample groups (elementary school, high school, pre-service teachers). When the importance of estimation skill in terms of mathematics education is taken into consideration, more comprehensive studies can be conducted with other factors that are believed to be influencing this skill. In addition, qualitative research can be recommended to determine the reason for the low estimation skills of the students.

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