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Research Article

Ortaokul Öğrencilerinin Ölçmede Tahmin Performanslarının İncelenmesi*

An Analysis of the Middle School Students' Performance in the Measurement Estimation

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ABSTRACT

The aim of the study is to analyse the middle school students' estimation performances (the accuracy of estimation) in regard to measurement based on several variables, including their attitudes towards estimation, their experience in regard to estimation, gender and grade level. The study employs the quantitative methods, namely causal comparison and relational designs. The participants of the study are 490 middle school students attending public schools in Ankara. Data collection tools are Measurement Estimation Skills Test, Estimation Attitude Scale and Estimation Experience Scale. The findings of the study indicate that the estimation performance of most of the students was at a moderate level. It is also found that the students had lower success in the area estimation in contrast to the length estimation. While there is no statistically significant difference among the variables based on the gender, it is found significant difference according to grade level. While there is a statistically significant relationship between the participants' estimation performance and their attitudes towards estimation, a similar correlation is not found with estimation-related experience.

Keywords: Estimation performance (accuracy), measurement estimation, attitudes towards estimation, estimation experience, middle school students.

ÖZ

Bu araştırmanın amacı ortaokul öğrencilerinin ölçmede tahmin performanslarını, yani tahminlerinin doğruluğunu, tahmine yönelik tutum, deneyim, cinsiyet ve sınıf seviyesi açısından incelemektir. Nicel araştırma yaklaşımlarından ilişkisel desen ve nedensel karşılaştırma deseni kullanılmıştır. Çalışmanın katılımcıları Ankara'daki devlet okullarında 5., 6., 7. ve 8. sınıfa devam eden öğrencilerdir. Veri toplama araçları Ölçmede Tahmin Beceri Testi (alan ve uzunluk tahmini), Tahmin Tutum Ölçeği ve Tahmin Deneyim Ölçeği'dir. Veri analizi için iki faktörlü varyans analizi (ANOVA), korelasyon analizi ve betimsel istatistik yöntemleri kullanılmıştır. Verilerden elde edilen bulgulara göre öğrencilerin büyük bir kısmının tahmin performansının orta düzeyde olduğu görülmüştür. Öğrencilerin uzunluk tahminine kıyasla alan tahmininde daha düşük başarıya sahip olduğu görülmüştür. Cinsiyet değişkeni açısından istatistiksel olarak anlamlı bir fark bulunmazken, artan sınıf seviyesi ile birlikte tahminlerin gerçek değere yakınlığının arttığı görülmüştür. Öte yandan öğrencilerin tahmin performansları ile tahmine yönelik tutumları arasında istatistiksel olarak anlamlı bir ilişki bulunurken aynı durum tahmin performansı ile tahmine ilişkin deneyimler arasında bulunmamıştır. Çalışmanın sonucunda öğrencilerle ölçmede tahmine yönelik çalışmaların yapılması önerilmektedir.

Keywords: Ölçmede tahmin, tahmin performansı, tahmine yönelik tutum, tahminle ilişkili deneyim, ortaokul öğrencileri.

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INTRODUCTION

Estimation is a skill that assist students in learning mathematics through understanding the topics and in making connections between mathematics and daily life (Van De Walle, Karp & Bay-Williams, 2014). The Turkish Language Society (TDK) defines "estimation" as "making an approximate evaluation" "predicting based on intution or some data". In literature, a variety of concepts are defined related to estimation, including guess, prediction, computational estimation, forecast and inference. In general, estimation can be defined as a process of giving answers as close as possible to the correct answer when making a decision on a subject (Reys,1986). Estimation is also defined as a basic mathematical competence closely linked to the development of numbers and number sense (National Council of Teachers of Mathematics (NCTM), 2000). Research suggests that there is a significant correlation between the estimation skills and the mathematical achievement of the students (Aytekin, 2012; Aytekin & Toluk-Uçar, 2014; Çilingir & Türnüklü, 2009; Kılıç & Olkun, 2013; Köse, 2013). Those students with higher levels of achievement in mathematics also have higher levels of the estimation skills (Tekinkır, 2008). Through the studies on estimation its significance has been well established and in mathematics education programs the skills of estimation have been given more place in Turkey and in other countries (Ministry of National Eduction, 2013; Mohamed & Johnny, 2010; NCTM, 2000).

The mathematics educators have proposed three categories of estimation as follows: computational estimation, numerosity estimation, and measurement estimation (Hanson & Hogan, 2000; Sowder, 1992). Of them the numerosity estimation refers to finding the approximate number of objects in a set of items (Hanson & Hogan, 2000; Sowder, 1992). The computational estimation refers to make estimations about the results of arithmetical operations without doing an operation (MONE, 2009). The measurement estimation refers to the estimation of the size of objects without any measurement tool using mental and visual information at hand (Van De Walle etc., 2014). This paper will focus on measurement estimation, particularly length and area estimation.

Measurement estimation is a skill that is frequently used in daily life and is employed when there is no tool or device to measure the length, height, mass, capacity or size of any object (O'Daffer, 1979). Covering the estimation in measurement activities in courses may help students focusing on the quality to be measured (such as length, area, volume), becoming familiar with the measurement units, and having an awareness about the measurement process (e.g., comparing, covering, filling) (NCTM, 2000). The measurement estimation is reported to support the understanding of important ideas about the measurement process as well as to encourage multiplicative reasoning by using reference values and focusing on the relationships between the units of measurement and the measurement result (Van De Walle et. al., 2014).

From 1948 the educational programs for mathematics courses have included the estimation skills in Turkey (Bulut, Yavuz, & Boz-Yaman, 2017). For instance, in the 2009 education program there is a statement as follows: "Students should be frequently asked to make estimations, to measure, and then to check their estimations." (MONE, 2009, p. 20). In the updated 2018 educational program for the mathematics courses, one of the general goals is about the estimation skills of the students which is given as follows: "The students will be able to use their estimation and mental processing skills effectively." (MONE, 2018, p. 9). However, the studies show that both school-age children and adults have difficulty in making measurement estimations, and the estimations they make are often not close to the actual measurement (Bulut et. al., 2017; Munakata, 2002; Sowder, 1992). Munakata (2002) argued that the estimation skills of the students were low, and that especially the 5th grade students' estimation skills were much weaker than those of the 7th, 9th and 11th grade students.

The deficiencies in number sense, difficulty in calculating large numbers, or immature operational estimation skills were cited as the reasons for why students were not successful in

making estimations (Crites, 1992). Forrester and Pike (1998) investigated the relationship between age-related development, the numerical perception, and the measurement estimation in their study on a sample of 62 students through the computer-assisted activities. In the study no significant difference was found between the area and length estimation performances by age groups. The length estimation results of the students were found to be closer to the correct values than those of the area estimations. It was also stated in the study that numerical perception develops with age. However, it is concluded that this situation is not valid for the estimation skills of the students. In other words, it is found that the estimation skills of the students do not show age-related development. However, in the study by Crites (1992), it is concluded that the accuracy of the estimations increases as the grade level increases. Considering the variables related to estimation performance, it is argued that gender also affects the estimation performance of the students (Munakata, 2002; Reys, Reys, & Penafiel, 1991). However, while some studies found a significant difference in favor of male students in terms of their estimation performance (Dowker, Flood, Griffiths, Harriss & Hook, 1996), some studies concluded that gender is not an important variable on their estimation performance (Aytekin, 2012; Aytekin & Toluk-Uçar, 2014; Boz, 2004; Forrester, et al., 1995; Mottram, 1995). Based on these findings reported in the previous studies, it can be argued that there is no clear understanding about the gender-related effects on the estimation skills (Tekinkır, 2008).

It is reported that the feelings and thoughts about estimation of individuals affect their estimation performance, and therefore, not only cognitive factors but also affective factors are influential in the estimation success (Altunkaya, Aytekin, Doruk, & Özçakır, 2014; Boz & Bulut, 2012). Boz and Bulut (2012) found in their study that there is an inverse relationship between students' opinions about their own estimations and their actual achievements. It is also concluded that the participants' beliefs, feelings and thoughts about estimation are different despite their high mathematics achievement and high success in the Estimation Skill Test. It is also reported that the different emotions, thoughts and approaches of the participants affect their estimation performance. Therefore, being successful in estimation can not only be explained based on the cognitive processes, and the affective factors should also be taken into consideration in this regard (Boz & Bulut, 2012). However, Munakata (2002) did not find any significant correlation between the attitudes of the participants and their estimation skills. Therefore, there is no well-established conclusion in this regard.

Researchers also argue that estimation skills could develop through instruction informal contexts as well as through experiences students encounter in daily life (Gooya, Khosroshahi, & Teppo, 2011; Joram, Subrahmanyam, & Gelman, 1998). For instance, students could develop personal reference points that they can use for measurement estimation through their own experiences (Joram et al., 2005). Hence whether and how measurement estimation is used in formal as well as informal contexts may contribute to the development of estimation competency. However, there is no accessible literature in which the students' experiences towards estimation are analyzed in relation to their estimation performance. While it is argued that there should be estimation activities related to daily life in order to improve the estimation skills of the students (Kılıç & Olkun, 2013), there is no study on what the students' estimation experiences are in Turkey. Being informed about students' estimation experiences at school and in their daily life will expand the existing views about the impact of the experience on the estimation skills. For this reason, in this study, it is also aimed to examine whether having estimation experience in and out of the classroom makes a difference in the estimation performance.

In general, the studies conducted in Turkey focuses on the operational estimation, but not on measurement estimation. In addition, there are limited number of studies examining the estimation performances of students at the 5th grade level when the estimation outcomes are frequently addressed in the Turkish mathematics curriculum. For this reason, this study

focuses on the estimation performance of middle school students attending from the fifth grade to the eighth grade, and on the effects of the variables (gender, grade level, attitude) of which effects on the estimation performance have not been clearly established. In addition, there is no study which examine the students' attitudes towards estimation and their estimation experiences. Based on these points it is decided to include these factors which may affect the measurement estimation performance of the students.

The determination of the students' estimation skills in measurement is important in terms of having information about the extent to which the achievements related to the measurement estimation included in the education programs can be achieved. The findings will help educators in the development of teaching materials as well as in the organization of the education programs. Again, by examining the estimation performances of students in terms of certain variables, it will be possible to determine which variables are related to the development of this skill. It is known that the materials used for each grade level may not be the same, especially considering the grade levels. Therefore, it is thought that the results of this study can answer the questions of what kind of features should be added to the materials used based on the grade level and what should be paid attention to in the education programs. The same can also be argued for the gender variable. Examining the students' attitudes and experiences towards the measurement estimation is considered important in terms of developing the estimation skills among students. Determining students' attitudes towards the estimation will guide teachers in classroom activities. Similarly, having an idea about students' estimation experiences and examining the relationship of these experiences with students' estimation performance will also make it possible to develop some suggestions for the development of estimation skills of the students.

1.1.Aim

The aim of the study is to analyse the middle school students' (those attending the grades of 5, 6, 7, and 8) performance in the measurement estimation based on some varibales (gender, grade-level, experience and attitudes). The research questions of the study are given as follows:

1. Is there a statistically significant relationship between the measurement estimation performance of the middle school students (those attending the grades of 5, 6, 7, and 8) and their gender and grade level?
1.1. At which level are the measurement estimation performance of the students?
1.2. Does the measurement estimation performance of the students significantly differ based on their gender?
1.3. Does the measurement estimation performance of the students significantly differ based on grade levels?
1.4. Is there a statistically significant interaction between the grade level and gender of the students in their estimation performance in measurement?
2. Is there a statistically significant relationship between the measurement estimation performance, the attitudes towards measurement and the experience in measurement estimation of the middle school students (those attending the grades of 5, 6, 7, and 8)?
2.1. Is there a statistically significant relationship between the students' estimation performance in measurement and their attitudes towards estimation?
2.2. Is there a statistically significant relationship between the students' estimation performance in measurement and their estimation experience?

METHOD

In the study, the causal comparison design and the relational (correlational) design, which are part of the quantitative research methods, were used. The causal comparison design is used to reveal the reasons for the differences in the estimation performances of the students and to

examine how their performance change in terms of the gender and grade level. The relational (correlational) design is used to examine the relationship between the students' estimation performance, their attitudes and experiences towards estimation.

2.1.Participants

The participants are middle school students attending public schools in the Çankaya district of Ankara. The accessible population of the study constituted approximately 30.000 middle-grade students. Since it is not possible to reach this population, researchers contacted the public schools in Çankaya and searched for those available for the study. Hence, the participants of the research were formed through the schools that gave permission for the study, taking into account voluntary participation by means of the available schools' method (Fraenkel, Wallen, & Huyn, 2012). A total of 490 students studying in three public schools, which serve for the children from families with middle and higher socioeconomic levels, were selected as the participants. Of them 48% are girls and 52% are boys, and 28.4% are attending the 5th grade, 22.7% the 6th grade, 23.7% the 7th grade and 25.3% the 8th grade. The distribution of students by grade level and gender is presented in Table 1.

Table 1. Distribution Of The Students By Grade Level And Gender

Grade	Gender	f	%
Grade 5	Female	66	47.5
	Male	73	52.5
	Total	139	100
Grade 6	Female	54	48.6
	Male	57	51.4
	Total	111	100
Grade 7	Female	52	44.4
	Male	65	55.6
	Total	117	100
Grade 8	Female	63	51.2
	Male	60	48.8
	Total	123	100

2.2. Data collection tools

The data of the study were collected using three data collection tools. In order to determine the estimation performance of the students, the Measurement Estimation Skills Test was developed by the authors (Appendix-A). In addition, the Estimation Attitude Scale was employed to measure the students' attitudes towards estimation. The Estimation Experience Scale was also developed to determine the participants' in-class and out-of-class estimation experiences. Each of these data collection tools are explained below.

2.2.1.Measurement Estimation Skills Test

The Measurement Estimation Skills Test was developed to assess estimation performance (i.e., the accuracy of estimation) related to lenght and area measurement. Before developing the test items the related studies were reviewed (Crites, 1992; Karaca, 2014; Köse, 2013; Munakata, 2002; Orhan, 2013; Tan & Şişman-Aksu, 2009; Taylor et. al., 2001; Tekinkır, 2008), and items related to measurement estimation were selected and adapted in accordance with the study aims.

The test was developed to cover the following two domains: the lenght estimation and the area estimation. An "Expert Opinion Form" was prepared to establish the content and construct validity of the skill test and presented to eight experts working on mathematics education. The experts evaluated (i) the adequacy of items in terms of assessing length and area estimation, (ii) the format of the test (language, the clarity of directions, etc.) and (iii) the appropriateness of the items for the middle school grade levels. Following the feedback taken from them, the necessary revisions was made. Then the test was conducted in a pilot study on a sample of 270 middle school students attending the 5th, 6th, 7th and 8th grades at a public school in Ankara. The factor analysis of the pilot study data showed that the distribution of the items in two dimensions (namely, length estimation and area estimation) was not statistically significant. Therefore, it was decided to use the test as having only one dimension. The draft version of the test was consisted of 20 items. Depending on the feedback from the experts, the number of the test items was reduced to 16, and three items were constructed as having sub-items. After the pilot study, the test was redesigned to have a total of 10 items. Of them the first six items are about length measurement and the remaining four items about area measurement. Two items about the length estimation and one -item about the area estimation contain sub-items (namely, the 3rd, 6th and 8th items). The maximum score that can be obtained from the test is 35 and the higher scores show greater accuracy of estimation (i.e., the closeness of the estimates to the actual measurement value). Based on the findings of the pilot study, the Cronbach alpha coefficient of the measurement estimation skill test was found to be 0.691. Although the Cronbach alpha coefficient is reported to be 0.7, in the study this coefficient is accepted to be reasonable due to the number of test items and the novelty of the test (Cortina, 1993; Gay & Airasian, 2003; Özdamar, 1999; Pallant, 2007). While determining the estimation performance of the students, their answers to each item in the test were evaluated using a rubric developed by the authors. In general, the item difficulty index should vary between 0.10 and 0.90 (Walsh & Betz, 1995). The item difficulty indexes for the items in this test is found to vary between 0.14 and 0.84.

2.2.2.Estimation Attitude Scale

The Attitude Scale Towards Mathematics Courses developed by Duatepe and Çilesiz (1999) was adapted in order to measure students' attitudes towards estimation. The scale is used to measure the student attitudes towards estimation. The items of the original version of the scale were rewritten to address the topic of the study. For instance, the original item "I like to solve the problems that I encounter using mathematics" is adapted as follows: "I like to solve the problems that I encounter using estimation". Another examples is as follows: "I don't understand why some people like mathematics so much" (original item) was rewritten as "I don't understand why people like estimation that much". In the attitude test, there are a total of 38 items, 18 of which are positive and 20 of which are negative. The answers to these items are given in a five-point Likert type. Higher scores mean a positive attitude toward estimation. Eight experts from different universities were consulted in regard to the validity analysis of the scale (e.g., appropriateness of the content and the format). The factor analysis indicated that the test had a single factor structure, since the distribution of the items to the dimensions was not statistically significant, and the structures with more than one factor did not form a meaningful structure. The results of the KMO test produced the value of 0.927, and the results of the Barlett test were found to be significant. In addition, the rate of explaining the total variance by the single factor structure was found to be 60.5%. The findings of the pilot study showed that the Cronbach's alpha value of the attitude test was 0.942.

2.2.3.Estimation Experience Scale

The Estimation Experience Scale was developed by the authors in order to measure the students' estimation experiences. It is a five-point Likert type scale and consists of 17 items. Higher scores mean having more experience with estimation. The items were developed to address the estimation experience of the students both in class, such as "We estimate the length

of the items such as the teacher's desk and of the desks in our classroom." and out-of-school estimation experience, such as "I do activities involving area estimation, such as estimating the area of the rooms in our house." The experts were consulted for the validity analysis of the test (e.g., appropriateness of the content and the format). The results of the factor analysis based on the findings from the pilot study conducted with 270 students indicated that the distribution of the items in these two dimensions was not statistically significant, so it was decided to construct the test as having one dimension. As a result of the analysis, the KMO test produced the value of 0.951, and the results of the Barlett test was found to be statistically significant. In addition, the rate of explaining the total variance by the single factor structure was found to be 57.4%. The Cronbach's alpha value of the estimation experience test was found to be 0.945.

2.3. Data collection process

Before the data collection process, a permission from the University Ethics Committee was obtained. The other necessary permissions were obtained from the Directorate of National Education for the implementation. The data was collected in the first semester of the 2019-2020 academic year with the classroom teachers. The tests of the Estimation Attitude, Estimation Experience and Estimation Skill were administered to the participants within one class hour in the students' own classrooms. In order for the students to answer the items carefully and sincerely, an information was given them about the purpose and importance of the study**.**

2.4. Data analysis

The answers given by the students to the measurement estimation skill test were examined in terms of the closeness of their estimates to the actual measurement value (estimation performance). While evaluating the estimation performances of the students, the related studies were examined to determine the acceptable ranges; however, it was observed that there is no clear consensus on this issue. For instance, while Baroody and Gatzke (1991) state that the acceptable estimation value could be between 25% less and more than the actual measurement value, Crites (1992) and Siegel, Goldsmith and Madson (1982) state this range as 50%. Considering that the current study is about length and area estimations and that there are participants at different age levels, the scoring system used by Levine (1982) was employed (25% deviation gets full score, 50% deviation gets half point). Accordingly, in this study, those participants who made estimations within the established correct value range and those participants who deviated 25% from this range were given 2 points, those participants who totally deviated by 50% were given 1 point, and those participants who deviated more than 50% were given 0 points.

Given that the scores of the students are used to reveal their estimation performance, a relative assessment was used in the study. As done in a similar study (Tekinkır, 2008) the average scores of the students were used to identify the level of estimation performance. It is found that the mean estimation performance of the students is 15.6 points out of 35 points and the standard deviation of the distribution is found to be 5.5 points. Therefore, the scores between the values one standard deviation below and above the arithmetic mean were accepted as the median value, and the values above and below them were accepted as the lower and upper values. Accordingly, the estimation performance of the students who scored between 10 and 22 was evaluated as moderate, the estimation performance of the students with a score of 10 and below was evaluated as low level, and the estimation performance of the students with a score of 22 and above was considered as high level.

The SPSS 24.0 package program was used for the quantitative analysis. In regard to the first research question, the aim is to investigate the effects of grade level and gender on the students' estimation performance, or their ability to make estimations close to actual measurement values. For this purpose, two factor analysis of variance (ANOVA) was used to examine whether the scores of the students in the estimation skill test differ according to grade level and gender. The assumptions of the two-factor analysis of variance include the normal

distribution, equality of variances, independent observation (Büyüköztürk et al., 2016), categorical two independent variables, and the dependent variable with equally spaced or proportional scales (Alpar, 2013). After checking that these assumptions were met, the analyses were carried out. In the second research question, the aim is to investigate the relationship between students' estimation performance or their ability to make estimations close to actual measurement values together with their attitudes and experiences towards estimation. For this purpose, the correlation analysis was conducted for the scores of the students in the estimation skill test and the scores they got from the estimation attitude and experience scales. The assumptions of the correlational analysis include the normal distribution, independent observation and linearity (Pallant, 2007). The analyses were made after checking that these assumptions were met.

FINDINGS

The results of the study are presented in two sections. The first section includes findings of the first research question related to the measurement estimation performance of students with regard to gender and grade level. The second section includes findings of the second research question related to the relationship between measurement estimation performance, attitudes towards estimation and experience in measurement estimation.

3.1. Estimation performance with regard to gender and grade level

The first research problem of the study is about determining whether students' measurement estimation performance differs in accordance with their gender and grade level. The findings regarding the first sub-problem (1.1.) of this research problem are presented in Tables 2 and 3. Table 2 shows the distribution of students at the low, medium and high estimation performance levels by gender.

Table 2. Distribution Of The Participants By The Levels Of Measurement Estimation Performance Based On Their Gender

Estimation performance	Female		Male		Total	
	f	%	f	%	f	%
Low	38	16.2	48	18.8	86	17.6
Moderate	160	68.1	167	65.5	327	66.7
High	37	15.7	40	15.7	77	15.7
Total	235	100	255	100	490	100

As can be seen in Table 2 approximately two-thirds (66.7%) of the students participated in the study are at the moderate level in terms of measurement estimation performance. In other words, 66.7% of the students got a score between 10-22 out of 35 from the Estimation Skill Test. The percentages of the students who are placed at the low and high levels of the measurement estimation performance are close to each other (approximately 15%). This distribution is also similar in terms of gender. More specifically, 68.1% of the female students and 66.5% of the male students are palced at a moderate level in terms of the measurement estimation performance. Table 3 shows the distribution of the participants depending on their measurement estimation performance by grade level.

Table 3. Distribution Of The Participants By The Levels Of Measurement Estimation Performance Based On Grade Level

Estimation performance levels	Grade 5		Grade 6		Grade 7		Grade 8	
	f	%	f	%	f	%	f	%
Low	35	25.2	24	21.6	15	12.8	12	9.8
Moderate	94	67.6	73	65.8	82	70.1	78	63.4
High	10	7.2	14	12.6	20	17.1	33	26.8
Total	139	100	111	100	117	100	123	100

Table 3 indicates that the number of students at the moderate level is dense (at least 63%) similar to the general distribution. However, as the grade level increases, the percentage of the low-level students decreases and the percentage of high-level students increases. These findings suggest that as the grade level increases, the students' measurement estimation performance improves or they can estimate closer to the correct values.

For the second, third and fourth sub-research problems (namely, 1.2, 1.3 and 1.4) of the first research problem, the estimation skill test scores of the participants were used to examine whether their estimation performance differs depending on the gender and grade level. Table 4 presents the results of the descriptive statistics for length estimation, area estimation, and overall performance scores of the participants. The maximum score that can be obtained from the length estimation section of the test is 23, while the maximum score that can be obtained for the area estimation is 12.

Table 4. The Results Of The Descriptive Statistics For The Measurement Estimation Performance Scores

Estimation performance scores	Minimum score	Maximum score	$\overline{X}$	SD
Total scores for the lenght estimation	1.00	22.00	12.96	4.35
Total scores for the area estimation	.00	10.00	2.65	2.14
Total	1.00	28.00	15.60	5.52

Table 4 indicates that the mean score of the participants (N=490) is 15,60 out of 35 (SD=5.52). It is 12.96 out of 23 for the mean lenght estimation scores and 2.65 out of 12 for the mean area estimation scores. It is seen that the latter scores are very low. The distribution of the participants based on these scores are given in Figure 1.

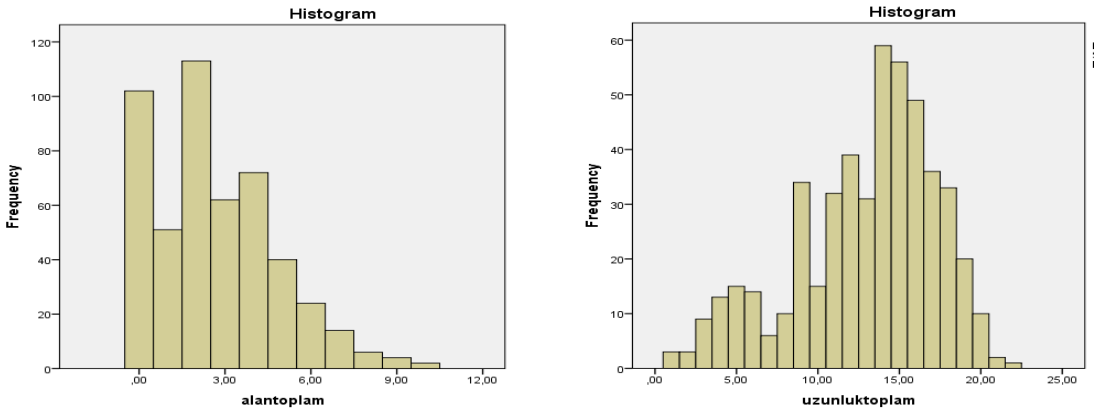


Figure 1. Area (Left) And Length (Right) Measurement Estimation Performance Scores

Figure 1 indicates that the mean lenght estimation scores of the participants concentrate on the middle points and become rare in the endpoints. It is also seen that the mean area estimation scores of the participants concentrate to the right side. In other words, the number of the students with lower scores is much higher. The results of the descriptive analyses clearly show that the students' area estimation performance is much lower than their length estimation performance.

In Table 5, the results of the descriptive statistics about the students' measurement estimation performance scores are presented by their grade level. It is seen that as the grade level increases, their estimation performance mean scores increase. The mean scores of the 7th and 8th grade students are above the general average ($M_{Grade\ 7}$ =16.2; $M_{Grade\ 8}$ =17.9). This increase is slightly conserved for the length estimate mean scores of the participants. However, it is seen that the averages of the area estimation scores are quite low for the participants at all grade levels.

Table 5. The Results Of The Descriptive Statistics For The Measurement Estimation Performance Scores By Grade Level

Estimation performance scores	Grade 5		Grade 6		Grade 7		Grade 8	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Mean lenght estimation score	11.5	4.4	12.5	4.4	13.6	3.8	14.5	4.3
Mean area estimation score	2.04	1.7	2.6	2.03	2.6	2.3	3.5	2.3
Total score	13.6	5.3	15.1	5.5	16.2	5.2	17.9	5.3

(n =490)

The results of the descriptive statistics for the measurement estimation performance scores by gender are given in Table 6.

Table 6. The Results Of The Descriptive Statistics For The Measurement Estimation Performance Scores By Gender

Gender	Estimation performance	$\overline{X}$	SD
Female	Mean lenght estimation score	12.9	4.5
	Mean area estimation score	2.8	2.3
	Total	15.7	5.8
Male	Mean lenght estimation score	13.1	4.3
	Mean area estimation score	2.5	2.1
	Total	15.6	5.5

As can be seen in Table 6 the mean estimation scores of the both groups are similar in terms of total estimation scores, lenght estimation and area estimation scores.

Whether the students' estimation skill scores differ based on the gender and grade level was tested with the two-way ANOVA analysis. The Tukey test was used to determine the sub-dimensions with significant differences. The assumptions were checked before the data were analyzed with two-way ANOVA. Since the answers given by the students are not affected by each other, it is thought that the independent observation assumption, which is not a statistical assumption, is met. The skewness and kurtosis coefficients were calculated to test whether or not the normal distribution was achieved. Since the skewness coefficient (-0.201) and the kurtosis coefficient (-0.169) are between +1 and -1, the data were accepted to show a normal distribution (Green & Salkin, 2016). The Levene Test was used to check the equality of variances. According to the Levene test results, the p value was 0.991. Given that this value is greater than 0.05, the assumption of equality of variances is also met.

The results of two-way ANOVA which was employed to see whether or not there was a significant difference in the participants' estimation skill test scores depending on the gender and grade level are given in Table 7.

Tablo 7. Results Of Two-Way ANOVA On The Estimation Skill Test Scores Bu Gender And Grade Level

Source of variance	Sum of squares	df	Mean of squares	F	p
Gender	.015	1	.015	.052	.820
Grade	14.041	3	4.680	15.952	**.000**
Gender and grade level	.382	3	.127	.434	.729
Error	141.416	482	.293		
Total	1363.913	490			

Table 7 shows that there is no statistically significant effect of gender on the participants' mean estimation performance scores [F=0.052, p=0.820>0.05]. In addition, since the significance level of the interaction between gender and grade level was found to be p= 0.729, it is safe to argue that the interaction of these two variables did not show a significant effect on the

students' mean scores about their measurement estimation performance. However, it is found that the difference between the mean estimation scores of the participants in terms of grade level is statistically significant [F=15.952, p=0.000<0.05]. The effect size for this value is found to be η2=0.09. Given that this value is greater than 0.06 it is safe to argue that the grade level has a moderate effect on the measurement estimation performance of the students (Alpar, 2013). In fact, this value is interpreted as 9% of the variance in test scores that are explained by the independent variable (grade level). As a result, it is seen that the measurement estimation performance scores differ statistically significantly depending on the grade level. The Tukey's test was used in complementary to the post-hoc analysis techniques to determine the source of this significant difference. The results of the Tukey test analysis are presented in Table 8.

Table 8. Results Of The Tukey Test Of The Measurement Estimation Skill Test By Grade Level

Grade	Grade 5 (5)	Grade 6 (6)	Grade 7 (7)	Grade 8 (8)	Direction of the difference
Grade 5 (5)		Non-significant p >0.05	**Significant difference* p<0.05**	**Significant difference* p<0.05**	8>5 7>5
Grade 6 (6)	Non-significant p >0.05		Non-significant p >0.05	**Significant difference* p<0.05**	8>6
Grade 7 (7)	**Significant difference* p<0.05**	Non-significant p >0.05		**Significant difference* p<0.05**	5<7 7<8
8. sınıf (8)	**Significant difference* p<0.05**	**Significant difference* p<0.05**	**Significant difference* p<0.05**		5<8 6<8 7<8

The results of the Tukey test indicate that the statistically significant differences in the estimation scores are between the eighth grade students and other students in favor of the former group (p=0.00 ve p=0.04 <0.05). In addition, there is also a statistically significant difference between the estimation scores of the fifth grade students and those of the seventh grade students (p=0.00<0.05). On the other hand, there is no such statistically difference between the sixth grade students and the fifth and seventh grade students in terms of their estimation scores (p=0.14 and p=0.32>.05). Although the learning goals concerning the estimation are concentrated at the 5th grade level, it is seen that the fifth and sixth grade students' performances in the measurement estimation are not very high. The possible reasons for this situation may be related to the cognitive development of the students, as well as the lack of giving more space for the estimation activities in the classrooms. There are studies showing that teachers do not spend much time in classroom activities for estimation related learning outcomes (Boz-Yaman & Bulut, 2017).

3.2. Estimation performance, attitudes and experience towards estimation

The findings related to the second research problem, which aims to examine the relationship between secondary school students' measurement estimation performance and their attitudes and experiences towards estimation, are presented below. In Table 9, the results of the descriptive statistics regarding the scores obtained from the Estimation Attitude Test and the Estimation Experience Test are presented. Both of these tests are of the 5-point Likert type.

Table 9. Results Of The Descriptive Statistics On The Scores Obtained From The Estimation Attitude Test And The Estimation Experience Test

Tests	$\bar{X}$	SD	Maximum score	Minimum score
Estimation Attitude Test	2.84	0.84	5.00	1.00
Estimation Experience Test	3.37	0.65	4.79	1.11

(n=490)

Table 9 indicates that the mean score is 3.37 (SD=0.65) for the estimation attitude test and 2.84 (SD=0.84) for the estimation experience test. These findings show that the students generally describe their attitudes towards estimation as positive and their experiences about estimation at a moderate level. The related assumptions were checked before the data were analysed regarding the correlation. In this study, it is thought that the independent observation assumption, which is not a statistical assumption, is provided. Because the author and the classroom teacher tried to prevent the students' answers from being affected by each other. The skewness and kurtosis coefficients were found to determine whether or not the data had a normal distribution. Since the skewness coefficient (0.114) and kurtosis coefficient (-0.107) found for the Estimation Experience test scores are between +1 and -1, the data show a normal distribution (Green & Salkin, 2016). Similarly, since the skewness coefficient (-0.012) and kurtosis coefficient (-0.003) for Estimation Attitude test scores range between +1 and -1, the data show a normal distribution. In order to perform the correlation analysis, there must be a linear relationship between the covariate and the dependent variable (Büyüköztürk, 2017). A scatter plot was used to see whether this linear relationship exists or not. When the scatter plot was examined, it is seen that the scores do not show a horizontal line distribution. In other words, there is a linear relationship between the participants' scores in regard to the estimation attitude, experience and performance.

A correlation analysis was performed to examine whether there was a relationship between the scores of the estimation performance and attitude towards estimation and experience about estimation. The results of the correlation analysis are presented in Table 10.

Table 10. Correlation Results Of The Relationship Between Estimation Performance Scores And Attitudes And Experience Scores Towards Estimation In Measurement

		Experience test	Attitude test	Estimation skills test
Experience test	Pearson Correlation	1	**.420****	**-.089***
	Sig. (2-tailed)		.000	.050
	N	490	490	490
Attitude test	Pearson Correlation	**.420****	1	**.110***
	Sig. (2-tailed)	.000		.015
	N	490	490	490
Estimation skills test	Pearson Correlation	**-.089***	**.110***	1
	Sig. (2-tailed)	.050	.015	
	N	490	490	490

** $p < 0.01$ *. $p < 0.05$

Table 10 indicates that there is no statistically significant relationship between the estimation performance scores and the scores obtained from the estimation experience test ($p=0.05 \geq 0.05$), but there is a low negative correlation between the scores from the estimation performance test and the estimation experience test. In other words, as the estimation experience of the students increases, there is a decrease in the estimation test scores, albeit at a very low level. On the other hand, it is seen that there is a positive and significant relationship between the estimation performance scores and the estimation attitude test scores ($p=0.015 < 0.05$; $r=0.110$). It is reported that there is a low relationship if the values are between 0-0.29, there is a

moderate relationship if the values range between 0.30-0.70, and there is a high level of relationship if the values are between 0.71-0.99 (Köklü, Büyüköztürk, & Çokluk-Bökeoğlu, 2006). Therefore, the statistically significant relationship between the scores obtained from the estimation skill test and those from the estimation attitude test is low (r=0.110). In other words, as the students' positive attitudes towards estimation increase, there occurs a statistically significant increase in estimation test scores, albeit at a low level. In addition, it is seen that there is a positive and moderate relationship between the results from the estimation experience test and those from the estimation attitude test ($p=0.00 <0.05$; r=0.420). This indicates that the estimation experience can indirectly affect the estimation performance.

DISCUSSION, CONCLUSION and SUGGESTIONS

One of the important findings of the study is that the estimation performance of the majority of the students participated in the study is at a moderate level. In the study, based on the average scores of the estimation skill test and standard deviation, it is found that the participants mostly performed at a moderate level in all grade levels. Approximately two-thirds of the students scored between 10-22 out of 35 in the Estimation Skill test. This distribution was also similar based on their gender. The findings show that as the grade level increases, the percentage of low-level students decreases and the percentage of high-level students increases. In other words, it is observed that as the grade level increases, the estimation performance of the students improves. Hence they are able to estimate closer to the actual values. However, no statistically significant interaction was found between the grade level and gender.

When the students' scores from the estimation performance test are analysed separately for the length estimation and area estimation, it is seen that their mean score for the length estimation is 12.96 out of 23, and their area estimation mean score is 2.65 out of 12. These findings support the previous findings stating that the students' estimation performance is weak (Aytekin & Toluk-Uçar, 2014; Bulut et al., 2017; Münakata, 2002). Considering the average score of the students, it can be stated that they are more successful especially in length estimation than in area estimation. This finding is consistent with the findings of the previous studies (Forrester & Pike, 1998). Similar to the findings obtained in terms of estimation performance levels, the mean scores of the estimation performance increase as the grade level increases. Although this increase is slightly preserved for the length estimate mean scores, the mean scores for the area estimation are quite low at all grade levels. These findings reveal that the improvement observed in length estimation over time do not occur for the area estimation. On the other hand, it is seen that the mean scores for the length and area estimation performance in terms of gender are close to each other. In addition, the inferential analyses also show that gender do not have a significant effect on the students' estimation performance. However, the grade level emerges as an important factor in the estimation performance. As the grade level increases, the estimation performance of the students increases significantly. While there is no difference between the 6th and 7th grade students' measurement estimation performance, the 8th grade students' measurement estimation performance is higher than the estimation performance of the students in other grades, and this difference is statistically significant. There are other findings in line with this finding of the study. For example, the findings reported by Tekinkır (2008) indicate that while there was no difference between the measurement estimation skills of the 6th and 7th grade students, the 8th grade students' measurement estimation skills were at the higher levels than those of the 6th and 7th grade students. Munakata (2002) stated in his study on a sample of the 5th, 7th, 9th and 11th grade students that the estimation skills of the 5th grade students are at a much lower level compared to other students. In the study by LeFevre et al. (1993), the estimation skills of 4th, 6th and 8th grade students and adults were compared, and it was concluded that the estimation skill developed with age. The possible

reasons for this situation may be related to the cognitive development of the students as well as to their experiences in measurement, getting familiar with standard and non-standard units. The reason why there is no improvement in terms of area estimation as the grade level increases may be due to the fact that the concept of area estimation is more difficult to understand than the concept of length estimation from a cognitive perspective (Dağlı & Peker, 2012). In addition, this finding may be related to the lack of the area estimation in the educational programs, course materials and practices. Teachers as well as families should be involved in engaging students with estimation activities in school and in daily life.

In most studies on estimation, gender has been considered as a variable affecting the estimation skills. However, the findings on this subject reported in the previous studies significantly differ. There are some studies (Dowker et al., 1996; Reys et al., 1991), which argue that there is a significant relationship between the gender factor and the estimation skills in favor of male students. It is also argued that female students perform well in the types of questions they learn at school, while male students are better at estimation in regard to its use in daily life activities. There are also other studies (Munakata, 2002) which argue that male students are more dominant in the daily life situations involving estimation, which might explain gender difference in estimation performance through sociocultural factors. While Reys et al. (1991) stated that the 5th grade male students performed better than female students, they also observed that there was no difference in estimation skills due to gender for the 8th grade students. On the other hand, there are also studies that conclude that there is no statistically significant correlations between the estimation skills and the gender variable (Aytekin and Toluk- Uçar, 2014; Boz, 2004; Forrester et. al., 1998; Mottram, 1995; Tekinkır, 2008). The present findings are consistent with the latter group.

Research suggests that the students with higher mathematics achievement generally have better estimation performance (Aytekin & Toluk- Uçar, 2014; Çilingir & Türnüklü, 2009; Levine, 1982). However, it is known that mathematics courses at many schools are generally aimed at the development of procedural skills (Gliner, 1991), and that some students who perform poorly in formal examinations can develop effective estimation strategies through out-of-school activities. Boz and Bulut (2012) conducted a study to examine the affective factors related to the operational estimation skills of seventh graders. In this study, although the participants' mathematics achievement was high, and they got high scores in the estimation skill test, their beliefs, feelings and thoughts about estimation appeared to differ in the interviews. It is found that there is an inverse relationship between the participants' views on their estimation skills and their actual success in estimation. Therefore, it is safe to conclude that the participants' feelings and thoughts about estimation affected their estimation performance and that not only cognitive factors but also affective factors are effective in their estimation success. A similar situation was obtained in the study of Altunkaya et al. (2014). On the other hand, Munakata (2002) administered an attitude test towards estimation in his study and concluded that there was no significant relationship between the attitudes towards estimation and the scores from the estimation skill test.

In this study, a positive and significant relationship is found between estimation performance and attitudes towards estimation. However, no statistically significant relationship was found between estimation performance and estimation experiences. One of the assumptions of this research was that estimation experiences could positively affect estimation performance. However, the results of the statistical analyses did not confirm this. The possible reason for this situation may be that the statements about the estimation experience in the items of the estimation experience scale include all types of estimation activities related to computational estimation, numerosity estimation, and measurement estimation. Therefore, even though the students reported that they engaged with estimation activities, this may not be limited to

measurement estimation. Furthermore, assessing students' estimation experiences by using a self-report scale may not be sufficient to get accurate data related to students' actual experiences. More research is needed to better understand students' experiences related to measurement estimation. In particular, researchers could consider using different tools (e.g., observations, interviews) to measure whether and how students use estimation in school or in daily life.

In conclusion, the findings show that a positive attitude towards estimation is associated with higher levels of estimation performance. In addition, it is found that there is a moderately significant positive relationship between the scores from the estimation attitude test and those from the estimation experience test. These findings suggest that although estimation experiences are not directly related to the estimation performance, they may affect the estimation performance indirectly by influencing attitudes towards estimation. Although the effect of estimation experience is not observed, it is suggested in the previous studies that primary school students should carry out estimation activities based on measurement in their environment in order to improve their estimation skills (Kılıç & Olkun, 2013).

In this study, the experiences related to the processes of developing measrement estimation tests and determining the accuracy of measurement estimation also revealed the difficulty of evaluating estimations involving measurement related to daily life. For example, for the expected situation in each item (for example, the length of an adult woman's index finger or the height of a newborn baby), the values in real-life examples were examined and it was seen that there were situations with significant variability. For this reason, attention was paid to ensure that the acceptable estimation range for varying situations should be within the probability range. In the study, acceptable estimation values were kept wide in order to prepare an answer key to cover different situations in estimations related to daily life. In other words, the possibility of the students' estimates falling within the acceptable range increased. This situation allowed the most of the participants to have an estimation performance at the moderate level. Therefore, while interpreting this finding of the study, it is important to consider that the acceptable estimation ranges which are used in the study are broad in measuring the participants' estimation performance. It is recommended that further research be undertaken to develop more precise ways to assess students' estimation performance related to real life situations.

In order to improve the measurement estimation performance of students, first of all, the importance of estimating the values close to the actual ones should be emphasized. It is suggested to carry out the estimation activities in the classroom and to make comparisons between the estimations and actual values, to discuss why the estimations may be smaller or larger than the actual values, to focus on unit sizes for length and area during the estimation, to make sense of these topics, and to improve the estimation performance of students. It is observed that the estimation performance of the students increases significantly as the grade level increases. However, as the grade level increases, it is determined that the improvement observed in the length estimation do not occur for the area estimation. Therefore, it may be suggested to increase the time and activities allocated for in-class area estimation. This situation may also be related to the difficulties arising from the characteristics of the subject of the field. In other words, students need to consider two dimensions (e.g., unit squares) while measuring and estimating area. These challenges and possible solutions can be made clearer through qualitative studies.

Another finding of the study is that a positive attitude towards estimation is associated with higher levels of estimation performance. In order for students to develop a positive attitude towards estimation, the importance of estimation should be mentioned frequently, its benefits

should be emphasized, and these topics should be given through enjoyable in-class activities. However, it is not enough to just make students realize the importance of estimation. Because it is also important for teachers to realize the importance of this skill as well. Although the estimation experiences are not directly related to performance, it has been found to be related to estimation-related attitudes and that the related experiences can indirectly affect the estimation performance. For this reason, it is suggested to carry out estimation activities based on measurement in a way to support the students' positive attitudes towards estimation. This study is limited to length and area estimation. Further research might explore students' estimation performances regarding other areas of measurement such as volume, mass or time.

REFERENCES

Altunkaya, B., Aytekin, C., Doruk, B. K., & Özçakir, B. (2014). The analysis of the relation between eight-grade students' estimation performance in triangles with their teaching style expectations and sources of motivation. *Participatory Educational Research, 1*(1), 44-64.

Alpar R. (2013). *Uygulamalı çok değişkenli istatistiksel yöntemler*. (4. Baskı) Ankara: Detay Yayıncılık.

Aytekin, C. (2012). *İlköğretim ikinci kademe öğrencilerinin kesirlerde tahmin becerilerinin incelenmesi.* (Yüksek Lisans Tezi). Abant İzzet Baysal Üniversitesi Eğitim Bilimleri Enstitüsü. Bolu.

Aytekin, C. & Uçar, Z.T. (2014). Ortaokul öğrencilerinin kesirlerde tahmin becerilerinin incelenmesi. *İlköğretim Online, 13*(2), 546-563.

Baroody, A. J., and Gatzke, M. R. (1991). *The estimation of set size by potentially gifted kindergarten-age children. Journal for Research in Mathematics Education, 22*(1), 59-68.

Boz, B. (2004). *Investigation of the computational estimation ability of high school student*. (Yüksek Lisans Tezi). Ortadoğu Teknik Üniversitesi Fen Bilimleri Enstitüsü. Ankara.

Boz, B. & Bulut, S. (2012). A case study about computational estimation strategies of seventh graders. *Elementary Education Online, 11*(4), 979-994.

Boz, Y. B. & Bulut, S. (2017). Ortaokul matematik öğretmenlerinin tahmin hakkındaki görüşleri. *Necatibey Eğitim Fakültesi Elektronik Fen ve Matematik Eğitimi Dergisi, 11*(1), 48-80. https://doi.org/10.17522/balikesirnef.354985

Bulut, S., Yavuz, F. D., & Boz-Yaman, B. (2017). Tahmin becerilerinin 1948'den 2015'e 1-5. sınıflar matematik dersi öğretim programlarındaki yeri. *Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi Dergisi (KEFAD), 18*(1), 19-39.

Büyüköztürk, Ş. (2017). *Sosyal bilimler için veri analizi el kitabı: İstatistik, araştırma deseni SPSS uygulamaları ve yorum (*11.Baskı*).* Ankara: Pegem Yayıncılık.

Cortina, J. M. (1993). What is coefficient alpha? An examination of theory and applications. *Journal of Applied Psychology, 78*(1), 98–104. https://doi.org/10.1037/0021-9010.78.1.98

Crites, T.(1992). Skilled and less skilled estimators' stratejies for estimating discrete quantities. *The Elemantary School Journal, 92*(5), 601–620.

Çilingir, D., & Türnüklü, E. (2009). İlköğretim 6-8. sınıf öğrencilerinin matematiksel tahmin becerileri ve tahmin stratejileri. *İlköğretim Online, 8*(3), 637-650.

Dağlı, H., & Peker, M. (2012). İlköğretim 5. sınıf öğrencileri geometrik şekillerin çevre uzunluğunu hesaplamaya ilişkin ne biliyor? *Kuramsal Eğitimbilim Dergisi, 5*(3), 330-351.

Dowker, A., Flood, A., Griffiths, H., Harriss, L., & Hook, L. (1996). Estimation strategies of four groups. *Mathematical Cognition, 2*(2), 113-135.

Forrester, M. A., & Beatrice,S. (1995). The influence of nesnect size, dimension and prior context on children‟s estimation abilities. *Educational Psychology, 14*(4), 451-465. Erişim adresi: https://doi.org/10.1080/0144341940140407.

Forrester, M. A., & Pike, C. D. (1998). Learning to estimate in the mathematics classroom: a conversation analytic approach. *Journal for Research in Mathematics Education, 29*(3), 334-356.

Fraenkel, J.R. & Wallen, N.E. (2012). How to design and evaluate research in education. (8. Baskı). New York: McGraw-Hill İnternational Edition.

Gay, L. R., & Airasian, P. (2003). Educational research: competencies for analysis and applications (7th ed.). Upper Saddle River, NJ: Merrill Prentice Hall.

Green, S. B., & Salkind, N. (2016). Using SPSS for windows and macintosh: Analyzing and understanding data (8th edition). Pearson Education.

Gliner, G. S. (1991). Factors contributing to success in mathematical estimation in preservice Teachers: Types of problems and previous mathematical experience. *Educational Studies in Mathematics, 22*(6), 595-606.

Gooya, Z., Leyla G. Khosroshahi, L. G. & Teppo, A. R. (2011). Iranian students' measurement estimation performance involving linear and area attributes of real-world objects. *ZDM Mathematics Education*, 43, 709–722.

Hanson, S.A., & Hogan P.T., (2000). Computational estimation skill of college students. *Journal for Research in Mathematics Education, 31*(4), 483–499. DOI**:** https://doi.org/10.2307/749654**.**

Aydın-Karaca, Ö.(2014). *8. sınıf öğrencilerin uzunluk, alan ve hacim ölçme kavramlarını anlamaya ilişkin yeterliliklerinin incelenmesi* (Yüksek Lisans Tezi). Karadeniz Teknik Üniversitesi Eğitim Bilimleri Enstitüsü. Trabzon.

Kılıç, Ç., & Olkun, S. (2013). İlköğretim öğrencilerinin gerçek yaşam durumlarındaki ölçüsel tahmin performansları ve kullandıkları stratejiler. *Elementary Education Online, 12*(1), 295-307.

Köklü, N., Büyüköztürk, Ş. & Çokluk Bökeoğlu, Ö. (2006). *Sosyal bilimler için istatistik.* Ankara: Pegem Yayınları.

Köse, K. (2013). *Sekizinci sınıf öğrencilerinin işlemsel ve ölçümsel tahmin becerileri ile matematik okuryazarlıkları arasındaki ilişki*. (Yüksek Lisans Tezi). Erzincan Üniversitesi, Erzincan.

LeFevre, J. A., Greenham, S. L., & Waheed, N. (1993). The development of procedural and conceptual knowledge in computational estimation. *Cognition and Instruction, 11*(2), 95-132.

Levine, D. J., (1982). Strategy use, and estimation ability of college students. *Journal for Research in Mathematics Education, 13*(5), 350–359. DOI: https://doi.org/10.595/jresematheduc.13.5.0350

Millî Eğitim Bakanlığı (MEB) (2013). *6-8.Sınıflar öğretim programı*. Ankara: Talim ve Terbiye Kurulu Başkanlığı.

Milli Eğitim Bakanlığı (2009). *6-8.Sınıflar öğretim programı*. Ankara: Talim ve Terbiye Kurulu Başkanlığı.

Milli Eğitim Bakanlığı. (2009). *İlköğretim matematik dersi 1-5. sınıflar matematik öğretim programı.* Ankara: Talim ve Terbiye Kurulu Başkanlığı

Milli Eğitim Bakanlığı (2018). Matematik Dersi Öğretim Programı (İlkokul ve Ortaokul 1, 2, 3, 4, 5, 6, 7 ve 8. Sınıflar). Ankara: MEB Yayınları

Mottram, D. R., (1995). *A comparative study of computational estimation ability and strategies used in estimation problems*. (Doktora Tezi). Colorado University, Colorado.

Mohamed, M., & Johnny, J., (2010). Investigating number sense among students. *Procedia Social and Behavioral Sciences, 8* (2010), 317–324.

Munakata, M. (2002), *Relationships among estimation ability, attitude toward estimation category width and gender in student of grades 5–11*. (Yayınlanmamış Doktora Tezi). Columbia University. Columbia.

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

O'Daffer, P. (1979). A case and techniques for estimation. Estimation eperiences in elementary school mathematics- essential, not extra! *Arithmetic Teacher, 26* (6), 236-241.

Orhan, N. (2013), *In partial fulfillment of the requirements for the degree of master of scıence in the department of elementary education.* (Yüksek Lisans Tezi). Ortadoğu Teknik Üniversitesi. Ankara.

Özdamar, K. (1999) Paket programlar ile istatistiksel veri analizi 1. Eskişehir: Kaan Kitabevi.

Pallant, J. (2007). *SPSS survival manuel a step by step guide to data analysis using the SPSS program.* New York: McGraw Hill Open University Press.

Reys, B. J., Reys, R. E., & Penafiel, A. F. (1991). Estimation performance and strategy use of mexican 5th and 8th grade student sample. *Educational Studies in Mathematics, 22*, 353-375.

Reys, B. J. (1986). Teaching computational estimation: Concepts and strategies. In H. L. Schoen & M. J. Zweng (Eds.), Estimation and mental computation: 1986 yearbook (pp. 31-45). Reston, VA: National Council of Teachers of Mathematics.

Siegel, A. W., Goldsmith, L. T., & Madson, C. R. (1982). Skill in estimation problems of extent and numerosity. *Journal for Research in Mathematics Education, 13*(3), 211- 232.

Sowder, J. (1992). Estimation and number sense. In D, A, Grouws (Ed.), *Handbook Of Research On Mathematics teaching and learning*, (ss. 371–389), New York: Macmillan.

Tan-Şişman G., & Aksu, M.(2009). Yedinci sınıf öğrencilerinin alan ve çevre konularındaki başarıları. *İlköğretim Online, 8*(1), 243-253.

Taylor, P. M., Simms, K., Kim, O.K., & Reys, R. E. (2001). Do your students measure up metrically? *Teaching Children Mathematics, 7*(5), 282-287.

Tekinkır, D. (2008*). İlköğretim 6–8. sınıf öğrencilerinin matematik alanındaki tahmin stratejilerini belirleme ve tahmin becerisi ile matematik başarısı arasındaki ilişki* (Yüksek Lisans Tezi) Dokuz Eylül Üniversitesi Eğitim Bilimleri Enstitüsü. İzmir.

Türk Dil Kurumu (TDK). (n.d.). Güncel Türkçe Sözlük. Türk Dil Kurumu Sözlükleri. Erişim tarihi: Temmuz, 2020. Erişim adresi: https://sozluk.gov.tr/

Walsh, W. B., & Betz, N. E. (1995). Tests and assessment. Englewood Cliffs, NJ: Prentice Hall, Inc.

Van De Walle, J.A., Karp, K.S., & Bay-Williams, J.M. (2014). *Elementary and middle school marhematics.* (S. Durmuş, Çev.) Ankara: Nobel Akademik Yayıncılık.

Yıldırım, A., & Şimşek, H. (2018). *Sosyal bilimlerde nitel araştırma yöntemleri* (10.baskı). Ankara: Seçkin Yayıncılık.

APPENDICES

Attachment: Measurement Estimation Skills Test

Dear Students, this test was prepared to measure your estimation ability in mathematics classes. By the term "estimation" in the test, it is meant to find an approximate result without performing a mathematical operation or measurement. For example, the estimation here refers to considering the approximate value of a multiplication operation instead of calculating the actual result, or considering the approximate length of a book instead of measuring its length. After carefully reading each item below, make an estimation and justify your estimation. Do not forget to express your estimation using the related units (such as cm, m^2). Thank you for your participation.

Name-surname:	Grade/Section:
School:	Gender: ( ) Female ( ) Male

1) Estimate the length of the index finger of an adult woman.

Estimation:	**Justification:**

2) Estimate how many meters you would have walked in **one full lap** around a basketball court.

Estimation:	**Justification:**

3) Estimate the lengths of the following objects.

Object	**Estimation (cm or m)**	**Justification**
The width of a door 		
The size of a matchstick		
The length of a truck bed 		
The height of a flagpole		
The height of newborn baby		

4)

What is the length of the rope above?

Estimation:	**Justification:**

5) Estimate the perimeters of the shapes below and then sort them from largest to smallest.

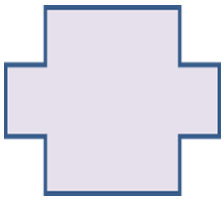


Figure 1

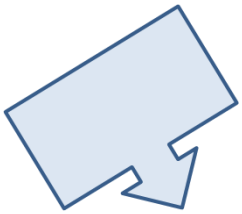


Figure 2

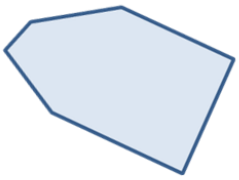


Figure 3

Estimation:	**Justify:**

6) Match the items with the measurement units below and provide a justification to your estimation.

Estimation:		**Justification:**
1) The height of a fridge	A. 20 cm	
2) The length of a fork	B. 2 m	
3) The length of a teaspoon	C. 600 km	
4) The distance between two cities	D. 10 cm	
5) Height of a two-story building	E. 10 m	

7) Estimate how many A4 papers are needed to cover the floor of your classroom.

Estimation:	**Justification:**

8) Estimate the surface area of the following. Please use of the units, namely **$\underline{\text{cm}^2 \text{ or } \text{m}^2}$**, which is proper for the case.

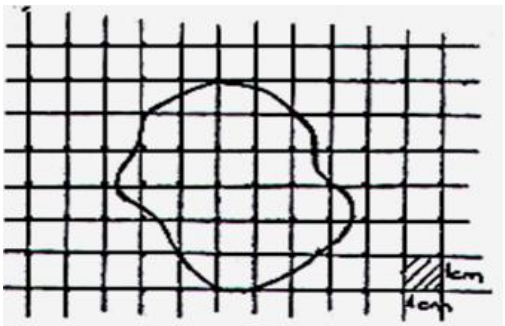
	Estimated area (cm^2 or m^2)	Justification
10 Turkish lira		
The floor of the schoolyard		
The surface of the teacher's desk		

9) Estimate how many puzzle pieces will be needed to cover the entire area of the rectangle given below.

Justify your estimation.

Estimation:	**Justification:**

10) Given that the area of each square below is $1cm^2$, what is the area of the shape given below in cm^2?



Estimation:	**Justification:**

TÜRKÇE GENİŞLETİLMİŞ ÖZET

Giriş

Tahmin, matematik ile günlük yaşam arasında ilişki kurulmasına yardım eden bir beceri olduğu gibi matematiğin anlaşılarak öğrenilmesine de yardımcı olmaktadır (Van De Walle, Karp ve Bay-Williams, 2014). Genel anlamda tahmin, bir konu veya durum hakkında karar verirken mümkün olduğunca gerçek cevaba yakın cevaplar üretme süreci olarak tanımlanabilir (Reys,1986). Bu alana yönelik yapılan araştırmalar sonucunda bu becerinin önemi anlaşılmış ve hem yurt içinde hem de yurt dışında tahmin becerisine matematik öğretim programlarında daha fazla yer verilmeye başlanmıştır (Milli Eğitim Bakanlığı, 2013; Mohamed ve Johnny, 2010; NCTM, 2000). Ölçmede tahmin günlük yaşamda sıkça kullanılan bir beceridir ve ölçme aracı olmadığında veya ölçme için elverişsiz durumlarda çevremizdeki nesnelerin uzunluğunu, yüksekliğini, kütlesini veya kapasitesini belirlemeye yardımcı olur (O'Daffer, 1979). Ancak, araştırmalar her yaş grubundaki bireylerin ölçmede tahmin konusunda zorlandıklarını ve yaptıkları tahminlerin çoğunlukla gerçek ölçüm değerine yakın olmadığını göstermiştir (Bulut vd., 2017; Munakata, 2002; Sowder, 1992). Öte yandan tahmin ile ilgili duygu ve düşüncelerin tahmin performansını etkilediği ve tahmine yönelik başarıyı bilişsel faktörlerin yanısıra duyuşsal faktörlerin de etkilediği belirlenmiştir (Boz ve Bulut, 2012). Buna göre tahmin etme konusunda başarılı olmanın sadece bilişsel süreçlerle açıklanamayacağı aynı zamanda duyuşsal faktörlerin de bunda etkili olduğu belirtilmiştir (Boz ve Bulut, 2012). Ayrıca öğrencilerin tahminle ilişkili deneyimleri ile tahmine yönelik tutumlarının birlikte incelendiği herhangi bir çalışmaya rastlanmamıştır. Öğrencilerin okulda ve günlük yaşamlarında tahmine yönelik deneyimlerinin öğrenilmesi, deneyim faktörünün bu beceri üzerinde bir etkisi olup olmadığı hakkında bilgi sahibi olunmasını sağlayacaktır. Bu sebeple bu çalışmada sınıf içi ve sınıf dışında tahmin deneyimine sahip olunmasının tahmin performansında bir fark oluşturup oluşturmadığı da incelenmeye çalışılmıştır. Yurt içinde bu konuda yapılan çalışmaların çoğunlukla işlemsel tahmin üzerine yoğunlaştığı, ölçmede tahmin konusunda yapılan çalışmaların az olduğu görülmüştür. Bu sebeple bu çalışmada ortaokul öğrencilerinin ölçmede tahmin performansına odaklanılmış, tahmin performansına etkisi açısından ortak bir sonuca varılmayan değişkenler (cinsiyet, sınıf seviyesi, tutum) ele alınmıştır. Bu açıdan çalışmanın alan yazına katkı sağlayacağı düşünülmektedir.

Yöntem

Nicel araştırma yaklaşımlarından ilişkisel desen ve nedensel karşılaştırma deseni kullanılmıştır. Çalışmanın katılımcıları Ankara'daki devlet okullarında 5., 6., 7. ve 8. sınıfa devam eden öğrencilerdir. Çankaya ilçesinde bulunan, sosyoekonomik düzey açısından orta ve orta düzeyin üzeri olarak tanımlanabilecek üç tane devlet okulunda okuyan 490 öğrenciye ulaşılmıştır. Örneklemde yer alan kız ve erkek öğrencilerin sayısı yaklaşık olarak eşittir. Araştırma verilerinin toplanması amacıyla araştırmacılar tarafından üç tane veri toplama aracı geliştirilmiştir. Bu araçlar; Ölçmede Tahmin Beceri Testi (alan ve uzunluk tahmini), Tahmin Tutum Ölçeği ve Tahmin Deneyim Ölçeği'dir. Ölçme araçlarının içerik ve yapı geçerliliğini sağlamak için "Uzman Görüş Formu" hazırlanmış olup sekiz matematik eğitimcisinin uzman görüşüne sunulmuştur. Test ve ölçeklere son şekli verildikten sonra 270 ortaokul öğrencisi ile

pilot çalışma yapılmıştır. Pilot çalışma sonucu ölçme araçlarına son şekli verilip uygulama öğrencilerin kendi sınıflarında bir ders satinde uygulanmıştır. Veri analizi için iki faktörlü varyans analizi (ANOVA), korelasyon analizi ve betimsel istatistik yöntemleri kullanılmıştır.

Sonuç Tartişma ve Öneriler

Araştırma verilerinden elde edilen bulgulara göre öğrencilerin büyük bir kısmının tahmin performansı orta düzeydedir. Yani katılımcıların yaklaşık üçte ikisi beceri testinden tam puan olan 35 üzerinden 10-22 arası bir puan almıştır. Araştırmanın bu bulguları, öğrencilerin tahmin performanslarının genel olarak zayıf olduğunu belirten çalışmalarla paralellik göstermektedir (Bulut vd., 2017; Münakata, 2002). Elde edilen bulgular, sınıf seviyesinin artmasıyla, yüksek düzey öğrenci yüzdesinin arttığını ve düşük düzey öğrenci yüzdesinin ise azaldığını göstermiştir. 6. ve 7. sınıf öğrencileri için ölçmede tahmin performans puanlarından elde edilen ortalamalar arasında bir farklılık görülmezken, 8. sınıf öğrencileri için ölçmede tahmin performans puan ortalamaları 5., 6., ve 7. sınıflarda okuyan öğrencilerin performanslarına göre daha yüksek bulunmuş ve bu farkın istatistiksel açıdan anlamlı olduğu belirlenmiştir. Alan yazında bu sonuçları destekleyen çalışmalar mevcuttur (Munakata, 2002; Tekinkır, 2008). Öte yandan, cinsiyet ile sınıf seviyesi arasında istatistiksel açıdan anlamlı bir etkileşim olmadığı görülmüştür. Öğrencilerin uzunluk tahminine kıyasla alan tahmininde daha düşük başarıya sahip olduğu görülmüştür. Bu durum yapılan çalışmaların bulguları ile paralellik göstermektedir (Forrester ve Pike, 1998). Cinsiyet değişkeni açısından istatistiksel olarak anlamlı bir fark bulunmazken, artan sınıf seviyesi ile birlikte tahminlerin gerçek değere yakınlığının arttığı görülmüştür.

Tahmin üzerine yapılan çalışmalarda, cinsiyet tahmin becerisi üzerine etkili bir değişken olarak ele alınmıştır. Alan yazında cinsiyet faktörüyle ilgili anlamlı sonuçlar bulanlar olduğu gibi (Dowker ve diğerleri, 1996; Reys ve diğerleri, 1991), istatistiksel açıdan anlamlı bir fark olmadığı sonucuna ulaşan çalışmalar da vardır (Boz, 2004; Forrester ve diğerleri, 1998; Tekinkır, 2008). Bu çalışmanın bulguları anlamlı fark olmadığını belirten alan yazını desteklemektedir. Bu çalışmada öğrencilerin tahmin performansları ile tahmine yönelik tutumları arasında istatistiksel olarak anlamlı pozitif yönde bir ilişki bulunurken aynı durum tahmin performansı ile tahmine ilişkilin deneyimler arasında bulunmamıştır. Öte yandan, Munakata (2002) çalışmasında tahmin beceri testi ile tutum arasında anlamlı bir ilişki olmadığı sonucuna ulaşmıştır. Çalışmanın sonucunda öğrencilerle ölçmede tahmine yönelik çalışmaların yapılması önerilmektedir.