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Abstract

This study is a descriptive survey model which aims to reveal the measurement estimation abilities of secondary school students. The sample of the study consisted of 91 secondary school students at 5th, 6th, 7th and 8th grades in the province of Adana. Measurement estimation ability test was used as the data collection tool. This test is comprised of 10 items which include five measurement estimation abilities as measurement of length, area, volume, liquid and weight. The data obtained from the data collection tool was analyzed by quantitative analysis methods. The analysis results showed that the students' measurement estimation abilities differed according to their gender and that difference was not statistically significant. It was also observed that the students' levels of measurement estimation abilities were at "acceptable low estimation" level, their general performances in the measurement estimation test differed according to their grade levels and that difference was not significant. Moreover, it was concluded that the length and weight estimation levels of the students regarding length, area, volume, liquid, weight estimation scores were better than the estimation levels of area, volume, fluid. Although their levels increased according to their grade levels, it was not significant according to grade level.

Introduction

The importance of information in the world is increasing rapidly, the concept of "knowledge" and understanding of "science" are changing accordingly, technology advances, and the concepts of democracy and management are differentiated. The rapid change, which is experienced in science and technology, has also changed the expectations from individuals in society in terms of the abilities. The change about the expectations from individuals in terms of the abilities has also led the countries to review and renew their education reforms (Tekinkır, 2008).

"Estimation ability" has been emphasized in the mathematics curriculum of primary schools along with the educational reforms in our country; the acquisitions about this ability are included in the program correspondingly. Significant competence areas have been added to the mathematics curriculum of primary education which was updated in 2018. There are eight key competencies that each individual is expected to acquire within the frame of these competencies. These competencies are ordered as communication in the

mother tongue, communication in foreign languages, mathematical competence, basic competencies in science / technology, digital competence, learning to learn, competencies about society and citizenship, perception of handling the priority and entrepreneurship, cultural awareness and expression. These key competences are all equally important because each can contribute to a successful life in the information society. Many of these competencies match, cover and support each other.

Individuals who have mathematical competence are expected to acquire the problem solving and posing abilities in the Ministry of National Education (MoNE) (2018).Individuals who have competencies of taking initiative and entrepreneurship are also expected to achieve the acquisitions of estimating, comparing the estimation with the calculated result, and doing the operations mentally. It is also seen that estimation and problem solving abilities are important within the framework of competencies.

Estimation is a concept which is always used both in daily life and scientific studies, and it is not a random action. It is anability which is developed through the experiences gained in mathematics. The term “estimation” refers to finding the most appropriate approximate value that can be substituted for an exact number corresponding to a certain context alone (Van De Walle et al., 2016). According to the definitions of Reys and Bestgen (1981), estimation is finding the approximate result of an operation or problem based on mental calculation, and Reys (1986) defined it as the process of reaching an answer which is as close as possible to the real answer.

There are three types of estimations in mathematics education: computational estimation, quantity estimation (cumulative estimation) and measurement estimation (measurement estimation) (O'Daffer, 1979; Sowder, 1992; LeFevre, Greenham, &Waheed, 1993; Hanson & Hogan, 2000).Computational estimation is the process of finding the number that gives the approximate result of a calculation that we cannot or do not want to determine precisely. For example, if we consume 15 liters of fuel to travel 325 km by our car, we may want to determine the approximate amount of fuel that we consume per kilometer. Some researchers consider cumulative estimation as a subset of measurement estimation (Hogan &Brezinski, 2003). The difference between the cumulative estimation and the measurement estimation arises from the fact that the feature, which is looked for in the estimation of the object’s amount to be measured, is continuous and discontinuous (Segoiva& Castro, 2009).Cumulative estimation is the determination of the approximate number of pieces in a batch. On the other hand, measurement estimation is the determination of a measurement without making a precise measurement. For example, when the number of oranges in a bag is asked, this type of estimation is considered to be cumulative estimation as discontinuity is discussed here. However, when the weight of oranges in kilogram is asked, this type of estimation is considered to be a measurement estimation as weight is a unit that contains continuity.

Computational estimation is the process of finding the number that gives the approximate result of a calculation that we cannot or do not want to determine precisely. For example, if we consume 15 liters of fuel when we travel 325 km by our car, we may want to determine the approximate amount of fuel that we consume per kilometer. Some researchers have seen cumulative estimation as a subset of measurement estimation (Hogan

&Brezinski, 2003).Another example for a cumulative estimation can be given as estimating the number of students in a concert hall or small candies in a guess bowl. On the other hand, estimating the length of a room or the weight of a watermelon in a grocery store is considered as measurement estimation (Van De Walle et al., 2016). Measurement estimation ability is one of the abilities that are needed to be used frequently in daily life. Determining the weight while shopping from the market, estimating how long it will take to cover a certain distance, estimating the surface area of a building and determining the amount of material that may be required accordingly, estimating how many liters of liquid a glass can take can be given as examples in which we use measurement estimations in our daily life.

When the related literature is reviewed, it is seen that there are some researches which were conducted to determine students' measurement estimation performances and estimation strategies they used (Gooya, Khosroshahi, & Teppo 2011; Kılıç&Olkun, 2013; Sowder, 1992; Forrester, Latham, Shire, 1990; Taylor, Simms, Kim. and Reys, 2001; Corle, 1960; Corle, 1963).Furthermore, there are also studies on the development of measurement estimation ability(Swan & Jones, 1971; Swan & Jones, 1980), studies in which computer-assisted games were used (Bright, 1985), studies in which students' performances in computational, measurement and cumulative estimation abilities and the strategies they used were investigated (Tekinkır, 2008); Crawford and Zylstra, 1952; Clayton, 1988).

When the literature was reviewed, it was seen that there were studies, which dealt with mostly computational estimation ability. There were no studies focusing on secondary school students' estimation abilities of length, area, volume, fluid and weight at all grade levels at the same time within the available resources. In this context, this study has been designed to find answers to the following research questions:

- Is there a statistical difference between the students' performances of measurement estimation abilities according to their genders?
- How are the students' performances of measurement estimation according to their grade levels?
- Is there a statistical difference between the students' performances of measurement estimation abilities according to their grade levels?
- How are the students' performances of estimating length, area, volume, fluid and weight according to their grade levels?
- Is there a statistical difference between the students' performances of length, area, volume, fluid and weight according to their grade levels?

Method

This study aimed to determine the current situation of secondary schools students' measurement estimation abilities and it was designed as a descriptive survey study. In descriptive research, it is only aimed to describe and introduce the sample or the study group (Gliner, Morgan, Leech, 2015). In this study, the measurement estimation abilities of secondary school students were described.

Participants

The sample of this research consisted of 5th, 6th, 7th and 8th grade secondary school students in the province of Adana. The reason of using convenience sampling method in this research is that the students who were selected were studying in the central districts of Adana and were voluntary to participate in the research. In the convenience sampling method, the researcher determines a situation which is close and easy to access. Thus, it gives speed and practicality to the research. Although it is widely used, this sampling method is less generalizable to the results (Yıldırım & Şimşek, 2008). The distribution of the students in the sample of the study according to their grade levels and genders is shown in Table 1.

Table 1. The Distribution of the Students According to their Grade Levels and Genders

Gender	5th grade	6th grade	7th grade	8th grade	Total
Female	14	12	17	9	52(57.1%)
Male	10	5	16	8	39(42.9%)
Total	24(26.4%)	17(18.7%)	33(36.3%)	17(18.7%)	91

When Table 1 is considered, it is seen that 91 students in total participated in the study. 52 of them are females and 39 of them are males. It is observed that approximately 26.4% of 91 students are 5thgrade students, 18.7% are 6th grade students, 36.3% are 7thgrade students and 18.7% are 8thgrade students.

Data Collection Tool

Measurement Estimation Test Form (METF) which was developed by the researchers and which consisted of open-ended items was used. The test which was developed was presented to 2 mathematics educators who were specialized in mathematics education for their opinions. According to their feedback, the form was revised and finalized. There are a total of 10 questions related to measurement estimations of length, area, volume, liquid and weight in the test.

Data Collection and Analysis

METF was administered to the students individually. It was informed in the instruction of the data collection tool that the students should spend about 30-45 seconds on each item in the test to guide them to use their estimation abilities instead of calculating. Before the data obtained within the scope of the study were analyzed in the computer environment, it was checked whether all items were answered according to the instructions in the measurement estimation test and whether there were any unanswered items.

Data analysis was conducted via SPSS 15.0 program. In the literature, Van de Walle (2016) states that estimations in the range of 10% in length and even 30% in volume and weight are considered as acceptable estimations. On the other hand, Baroody and Gatzke (1991) consider estimation acceptable when estimation is between 25% less or more than the correct answer. Many researchers have used this 50% interval in their

researches (Barody&Gatzke, 1991; Crites, 1992; Boz, 2004).Levine (1982) carried out studies on making approximate and effective predictions and gave 3 points if the prediction was 10% close to the exact answer, 2 points if it was between 10-20% less or more, 1 point if it was between 20-30% less or more and 0 points if it was far from 30% less or more. In this particular study, Levine's (1982) evaluation criteria were used while evaluating the students' responses to the measurement estimation ability test.

0<item score<1 was considered as “acceptable low estimation”,

1≤item score<2was considered as “acceptable moderate estimation”,

2≤item score<3 was considered as “acceptable good estimation”

3=item score was considered as “acceptable very good estimation”.

T test (independent groups T-Test) was conducted so as to test the significance of the scores which the students got from the METF according to gender. A single factor analysis of variance (One-way ANOVA) was conducted to find out whether there was a significant difference between the scores of the measurement estimation test of the students according to their grade levels. In addition, MANOVA was performed to test whether the students’ scores about the estimation of length, area, volume, liquid, weight in the measurement estimation test were significantly different according to their grade levels.

Finding

In this part, findings and interpretations which were obtained throughout the research process in line with the research problems are presented.

Findings and Interpretations about Measurement Estimation Test Performances of the Students according to Gender

t test (independent groups t-Test) was conducted so as to test the significance of the scores which the students got from the measurement estimation test according to gender. Table 2 shows the results.

Table 2.T-test Results of the Students’ Measurement Estimation test Scores According to Gender

Gender	N	$\bar{X}$	SD	Sd	t	P
Female	52	6.90	4.52	89	0.748	0.469
Male	39	6.25	3.71			
Total	91	6.62	4.18			

As seen in Table 2, the average score obtained from the measurement estimation test is 6.90 for female students and 6.25 for male students. Besides, the standard deviation calculated for female students is higher than the standard deviation calculated for male students. This fact suggests that males have a more homogeneous structure and females show a more heterogeneous distribution. The independent groups t-test results which was performed to determine whether the difference between the students' measurement estimation abilities according to gender showed that there was no significant difference according to gender ($t(91) = 0.469$ $p > 0.01$).

Findings and Interpretations about Measurement Estimation Test Performances of the Students according to their Grade Levels

The mean and standard deviation values of the measurement estimation test performances of the students according to their grade levels are presented in Table 3.

Table 3. The Students' Measurement Estimation Test Performances According to their Grade Levels

Grade Level	$\overline{X}$ (Max.30)	SD
5th grade	5.25	3.46
6th grade	7.11	3.78
7th grade	7.00	4.69
8th grade	7.35	4.35
Total	6.62	4.18

According to Table 3, the highest average score belongs, 7.35, to the eighth grade students and the lowest average score, 5.25, belongs to the fifth grade students. When it is considered that the highest score that can be obtained from the measurement estimation test is 30, it can be said that the students' measurement estimation abilities are in the "acceptable low estimation" range. After the basic information about the average and distribution characteristics of the grade levels which are presented above, a one-way analysis of variance (one-way ANOVA) was performed for independent samples to see whether there was a significant difference between the scores of the measurable estimation test of students according to their grade levels. The findings are presented in Table 4. When Table 4 is considered, it is seen that there is not a significant difference between the students' measurement estimation abilities according to their grade levels($F(17, 90) = 0.858$ $p > 0.01$).

Table 4. ANOVA Results of the Students' Measurement Estimation Test Scores According to Their Grade Levels

Source of the Variance	Total of Squares	Sd	Mean of Squares	F	P
Between-group	17.440	17	1.026	.858	.623
Within-group	87.241	73	1.195		
Total	104.681	90			

Findings and Interpretations about Length, Area, Volume, Liquid and Weight Measurement Estimation Abilities of the Students according to their Grade Levels

Findings and Interpretations about Length Estimation

Frequency and percentage distributions of the students' estimation levels according to the scores they got from the answers to the items about length estimation are presented in Table 5. When Table 5 is considered, it is seen that most of the answers (53.7%) of secondary school students which they gave for the length estimation are at

the acceptable moderate estimation level. Besides, it was concluded that the majority of 5th grade students (29.2%) are at the unacceptable estimation level, the majority of the 6th grade students (35.3%) are at the acceptable moderate estimation level, the majority of the 7th grade students (27.3%) are at the unacceptable estimation level and the majority of the 8th grade students (47%)are at the acceptable moderate estimation level.

Table 5. Frequency and Percentage Distributions of the Students' Estimation Levels about Length Estimation

Grade Level	Unacceptable Estimation Level	Acceptable Low Estimation Level	Acceptable Moderate Estimation Level	Acceptable Good Estimation Level	Acceptable Very Good Estimation Level
5th grade	7(29.2%)	9(37.5%)	6(25.0%)	1(4.2%)	1(4.2%)
6th grade	4(23.5%)	4(23.5%)	6(35.3%)	3(17.4%)	0
7th grade	9(27.3%)	5(15.2%)	14(42.4%)	4(12.3%)	1(3%)
8th grade	2(11.8%)	3(17.6%)	8(47%)	4(5.9%)	0
Total	22(24.2%)	21(23.1%)	34(53.7%)	11(13.2%)	2(2.2%)

Findings and Interpretations about Area Estimation

Frequency and percentage distributions of the students' estimation levels according to the scores they got from the answers to the items about area estimation are presented in Table 6. Table 6 shows that most of the answers (60.4%) of secondary school students which they gave for the area estimation are at the unacceptable estimation level. Moreover, it was concluded that the majority of 5th grade students (66.7%), the majority of the 6th grade students (52.9%), the majority of the 7th grade students (60.6%) and the majority of the 8th grade students (58.8%)are at the unacceptable estimation level.

Table 6. Frequency and Percentage Distributions of the Students' Estimation Levels about Area Estimation

Grade Level	Unacceptable Estimation Level	Acceptable Low Estimation Level	Acceptable Moderate Estimation Level	Acceptable Good Estimation Level	Acceptable Very Good Estimation Level
5th grade	16(66.7%)	2(%8.3%)	5(20.9%)	1(4.2%)	0
6th grade	9(52.9%)	0	5(28.4%)	2(11.8%)	1(5.9%)
7th grade	20(60.6%)	4(%12.1%)	9(27.3%)	0	0
8th grade	10(58.8%)	0	5(29.4%)	2(11.8%)	0
Total	55(60.4%)	6(%6.6%)	24(26.4%)	5(5.5%)	1(1.1%)

Findings and Interpretations about Volume Estimation

Frequency and percentage distributions of the students' estimation levels according to the scores they got from the answers to the items about volume estimation are presented in Table 7.

Table 7. Frequency and Percentage Distributions of the Students' Estimation Levels about Volume Estimation

Grade Level	Unacceptable Estimation Level	Acceptable Low Estimation Level	Acceptable Moderate Estimation Level	Acceptable Good Estimation Level	Acceptable Very Good Estimation Level
5th grade	23(95.8%)	1(4.2%)	0	0	0
6th grade	17(100%)	0	0	0	0
7th grade	31(93.6%)	0	2(6.1%)	0	0
8th grade	17(100%)	0	0	0	0
Total	88(96.7%)	1(1.1%)	2(2.2%)	0	0

In Table 7, it is seen that that most of the answers (96.7%) of secondary school students, which they gave for the volume estimation, are at the unacceptable estimation level.

Findings and Interpretations about Liquid Estimation

Frequency and percentage distributions of the students' estimation levels according to the scores they got from the answers to the items about liquid estimation are presented in Table 8.

Table 8. Frequency and Percentage Distributions of the Students' Estimation Levels about Liquid Estimation

Grade Level	Unacceptable Estimation Level	Acceptable Low Estimation Level	Acceptable Moderate Estimation Level	Acceptable Good Estimation Level	Acceptable Very Good Estimation Level
5th grade	13(54.2%)	2(8.3%)	8(33.5%)	1(4.2%)	0
6th grade	9(52.9%)	3(17.6%)	4(23.5%)	1(5.9%)	0
7th grade	17(51.5%)	1(3%)	10(33.3%)	5(12.1%)	0
8th grade	8(47.1%)	0	8(47.1%)	1(5.9%)	0
Total	47(51.6%)	6(6.6%)	30(33%)	8(8.8%)	0

When Table 8 is considered, it is seen that most of the answers (51.6%) of secondary school students, which they gave for the liquid estimation, are at the unacceptable estimation level. Furthermore, it was concluded that the majority of 5thgrade students (54.2%), the majority of the 6thgrade students (52.9%) and the majority of the 7thgrade students (51.5%) and the majority of the 8thgrade students (58.8%)are at the unacceptable estimation level.

Findings and Interpretations about Weight Estimation

Frequency and percentage distributions of the students' estimation levels according to the scores they got from the answers to the items about weight estimation are presented in Table 9.

Table 9. Frequency and Percentage Distributions of the Students' Estimation Levels about Weight Estimation

Grade Level	Unacceptable Estimation Level	Acceptable Low Estimation Level	Acceptable Moderate Estimation Level	Acceptable Good Estimation Level	Acceptable Very Good Estimation Level
5th grade	7(29.2%)	3(12.5%)	14(48.3%)	0	0
6th grade	3(17.6%)	1(5.9%)	11(64.7%)	0	2(11.8%)
7th grade	8(24.2%)	5(15.2%)	11(33.3%)	6(18.2%)	3(9.1%)
8th grade	4(23.5%)	2(11.8%)	9(63%)	1(5.9%)	1(5.9%)
Total	22(24.2%)	11(12.1%)	45(59.5%)	7(7.7%)	6(6.6%)

According to Table 9, most of the answers (59.5%) of secondary school students which they gave for the weight estimation are at the acceptable moderate estimation level. Besides, it was concluded that the majority of 5thgrade students (29.2%), the majority of the 6thgrade students (64.7%) and the majority of the 7thgrade students (33.3%) and the majority of the 8thgrade students (63%) are at the acceptable moderate estimation level.

MANOVA was performed in order to test whether the students' scores about estimation of length, area, volume, fluid, weight in the measurement estimation test made a significant difference according to the grade level. The results of the analysis presented that the students' estimation performances were not effective according to grade level (Wilks Lambda (Λ) = 0.825, F (15, 230) = 1.106, p> 0.01). The mean and standard deviation values for the estimation of length, area, volume, liquid and weight according to grade level and MANOVA results are presented in Table 10.

In Table 10, the arithmetic mean and standard deviation values of the scores that were obtained from the answers given by the students to two items about the length estimation according to the grade level are given. The maximum score that students can get from two items is 6. According to Table 10, it is seen that the mean score of the answers to the length estimation is 1.95. It is seen that the highest mean score for the estimation of length (2.35) belongs to the 8th grade students and the lowest average score (1.54) belongs to the 5th grade students. It was concluded that the length estimation abilities of the 6th, 7th and 8thgrade students were at the "acceptable moderate estimation level" and of the 5thgrade students were at the "acceptable low estimation level".

It is seen that the mean score of the students' answers to the items about area estimation is 1.02. It is also observed that the highest mean score (1.64) for the area estimation belongs to the 6thgrade students and the lowest mean score (0.73) belongs to the 7thgrade students. It was concluded that the area estimation abilities of the students at all grade levels were at the "acceptable low estimation level". It is seen that the mean score of the students' answers to the items about volume estimation is 0.07. It is observed that the highest mean score (0.18) about the volume estimation belongs to the 7thgrade students and the lowest mean score belongs to the 6thand 8thgrade students. The table suggests that the 6thand 8thgrade students are at the "unacceptable estimation level", and the 5thand 7thgrade students are at the "acceptable low estimation level".

Table 10. MANOVA Results about Length, Area, Volume, Liquid and Weight According to Grade Level

Measurement Estimation	Grade Level	$\bar{X}$	SS	Sd	F	P
Length Estimation	5th grade	1.5	1.58	3	.897	.446
	6th grade	2.0	1.62			
	7th grade	2.03	1.70			
	8th grade	2,35	1.45			
	Total	1.95	1.61			
Area Estimation	5th grade	.83	1.34	3	1.710	.171
	6th grade	1.64	2.08			
	7th grade	.72	1.00			
	8th grade	1.23	1.67			
	Total	1.02	1.49			
Volume Estimation	5th grade	.04	.20	3	.964	.413
	6th grade	.00	.00			
	7th grade	.18	.72			
	8th grade	.00	.00			
	Total	.07	.45			
Liquid Estimation	5th grade	1.08	1.41	3	.716	.545
	6th grade	1.00	1.41			
	7th grade	1.57	1.85			
	8th grade	1.47	1.58			
	Total	1.31	1.61			
Weight Estimation	5th grade	1.75	1.32	3	.924	.433
	6th grade	2.47	1.73			
	7th grade	2.48	2.04			
	8th grade	2.29	1.75			
	Total	2.25	1.76			

It is seen that the mean score of the students' answers to the items about liquid estimation is 1.31. It is observed that the highest mean score for liquid estimation (1.57) belongs to 7thgrade students and the lowest mean score (1.00) belongs to 6thgrade students. The table presents that liquid estimation abilities of students at all grade levels are at an "acceptable low estimation level". It is seen that the mean score of the students' answers to the items about weight estimation is 2.25. It is observed that the highest mean score (2.48) about the weight estimation belongs to the 7thgrade students and the lowest mean score (1.75) belongs to the 5thgrade students. It

can be said according to the table that the 6th, 7th, and 8thgrade students are at the "acceptable moderate estimation level", and of the 5thgrade students are at the "acceptable low estimation level".

Discussion

This study aimed to determine the measurement estimation abilities of secondary school students and it is based on the findings obtained from 91 secondary school students. It was observed in this study that the students' measurement estimation abilities were within the "acceptable low estimation" range, the students' general performances in the measurement estimation test differed according to their grade levels and this difference was significant. In addition, it was concluded that the length and weight estimation levels of the students were better than the area, volume and liquid estimation levels. Although the levels increased according to grade level, it was not significant according to grade level.

In this study, it was found that the measurement estimation abilities of students differed according to gender. The results of the analysis which were conducted to determine whether this difference was statistically significant or not showed that there was not a significant difference according to gender. Boz (2004) conducted a study with high school students and investigated the students' estimation and measurement estimation abilities. In his research, he analyzed school types and age variables in three different formats as numbers, answers and questions. As a result of the research, a statistically significant difference was found between male and female students in terms of estimation abilities. Thus, it can be said that the findings of this research is similar to the results of previous research.

It is seen that the highest mean score (7.35) of the students' measurement estimation test belongs to the eighth grade students and the lowest mean score (5.25) belongs to the fifth grade students. When it is considered that the highest score that can be obtained from the measurement estimation test is 30, it can be said that the students' measurement estimation abilities are in the "acceptable low estimation" range. Corle (1960) carried out a study and investigated the measurement estimation performances of the fifth and sixth grade students. He concluded that both grades had low measurement estimation levels, and performances of the sixth grade students were better than of the fifth grade students. Joram, Subrahmanyam, and Gelman (1998) conducted a study in which they investigated the measurement estimation and the data analysis showed that the estimation ability increases in parallel with age. Kumandaş and Gündüz (2014) carried out a study in which they aimed to find out how primary, secondary, high school and university students were using their measurement estimation abilities and to investigate the accuracy level of their estimations. They focused on the individual measurement estimation abilities of students at various grade levels and they tried to describe the current situation as it was. The results of their study presented that the estimation abilities of the students were not very good no matter their grade differed. Thus, it can be said that the findings of this research is similar to the results of previous research.

In this study, it was observed that the majority of secondary school students' answers (53.7%) for length estimation were at the acceptable moderate estimation level, the majority (60.4%) of their answers for area

estimation were at unacceptable estimation level, and most of their answers (96.7%) about volume estimation (96%) were at an unacceptable estimation level. In addition, it was concluded that most of the students' answers (51.6%) for liquid estimation were at unacceptable estimation level, and most of the answers (59.5%) of the secondary school students for weight estimation were at the acceptable moderate estimation level. It can be said that the length and weight estimation levels of the students are better than their area, volume and liquid estimation levels. Similarly, Taylor, Simms, Kim, and Reys (2001) investigated how 3rdand 4thgrade students use measurement estimation and how sensitive estimations they make. According to the research results, the students expressed that they made estimations when precise measurement was required, and they used it only when they were making length estimations. Few of the students used the measurement estimation strategy in making weight or volume estimations. Kumandaş and Gündüz (2014) found in their research that the length estimations at all education levels were closer to the actual value than the weight estimations. It was also concluded in their study that primary school students were weaker in making both length and weight estimations than the students at other grade levels. In the studies of Joram, Subrahmanyam, and Gelman (1998), it was observed that the participants' ability to make length estimations was better than their ability to make weight and volume estimations. In this particular study, it was found that the length estimation levels of the students were the same as their weight estimation levels, and the average of the length estimation was slightly higher than the average of the weight estimation. Thus, it can be said that the findings of this research is similar to the results of previous research.

Conclusion and Recommendations

This study aimed to determine the measurement estimation abilities of secondary school students and it is based on the findings obtained from 91 secondary school students. It was observed in this study that the students' measurement estimation abilities differed according to their genders and this difference wasn't significant. In addition, it was concluded that the measurement estimation levels of the students were at "acceptable low estimation level", the students' general performances differed according to their grade levels and this difference was not significant. Besides, it was concluded that the length and weight estimation levels of the students were better than their area, volume and liquid estimation levels. It was also derived that although it increased in parallel with their grade levels, it was not significant according to grade level. In our country, while the mathematics curriculum includes the acquisitions about estimation skill, it is seen that there are a total of three acquisitions, one at the 5th grade and one at the 6th grade. It has been observed that the acquisitions regarding dimensional estimation are mostly included at the primary school level and there are a total of five achievements at the primary school level. Despite including acquisitions intended for estimation ability, the mathematics curriculum in our country contains a total of three acquisitions intended for measurement estimation ability, two at the 5th grade and one at the 6th grade. It has been observed that the acquisitions regarding measurement estimation are mostly included at the primary school level and there are a total of five acquisitions at the primary school level. As the measurement estimation abilities of the student are low, the number of activities and acquisitions regarding this ability can be increased in the mathematics curriculum. In addition, this research can be repeated with a larger sample and a test with more items.

References

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

Boz, B. (2004). *Investigation of estimation ability of high school students* (Master's thesis).

Bright, G. W. (1985). What Research Says: Teaching Probability and Estimation of Length and Angle Measurements Through Microcomputer Instructional Games. *School Science and Mathematics*, *85*(6), 513-22.

Clayton, G. (1988). Estimation. *Mathematics Teaching, MT125* (Dec), 18-19.

Corle, C. G. (1960). A study of the quantitative values of fifth and sixth grade pupils. *Arithmetic Teacher,* 7 (3), 333-340.

Corle, C. G. (1963). Estimates of quantity by elementary teachers and college juniors. *Arithmetic Teacher, 10* (2), 347-353.

Crawford, B. M., & Zylstra, E. W (1952). A study of high school seniors [sic] ability to estimate quantitative measurements. *journal of Educational Research,* 46, 241-248.

Crites, T. (1992). Abilityed and less-abilityed estimators' strategies for estimating discrete quantities. *The Elementary School Journal, 92,* 601–615.

Forrester, M. A., Latham, J., & Shire, B. (1990). Exploring estimation in young primary school children. *Educational Psychology*, *10*(4), 283-300.

Gliner, J. A., Morgan, G. A., & Leech, N. L. (2015). Uygulamada araştırma yöntemleri: desen ve analizi bütünleştiren yaklaşım (Çev. Ed.: SelahattinTuran). *Ankara: Nobel yayındağıtım*.

Gooya, Z., Khosroshahi, L. G., & Teppo, A. R. (2011). Iranian students' measurement estimation performance involving linear and area attributes of real-world objects. *ZDM*, *43*(5), 709-722.

Hanson, S. A. ve Hogan, T. P. (2000). Computational estimation abilities of college students. *Journal for Research in Mathematics Education, 31 (4),* 483-499.

Hogan, T. P. veBrezinski, K. L. (2003). Quantitative estimation: one, two, or three abilities. *Mathematical Thinking and Learning, 5(4),* 259-280.

Joram, E., Subrahmanyam, K., & Gelman, R. (1998). Measurement estimation: Learning to map the route from number to quantity and back. *Review of Educational Research*, *68*(4), 413-449.

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

Kumandaş, H., Gündüz, Y. (2014). İlkokul, ortaokul, liseve üniversitede öğrenim gören öğrencilerin ölçüsel tahmin becerilerinin doğruluğunun incelenmesi. Kalem Uluslararası Eğitim Ve İnsanBilimleriDergisi ", 4 (1). 165-187.

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

Levine, D. R. (1982). Strategy use and estimation ability of college students. *Journal for Research in Mathematics Education*, 350-359.

O'Daffer, P. (1979). A case and techniques for estimation. *Estimation Experiences in Elementary School Mathematics- Essential, not Extra! Arithmetic Teacher 26 (6),* 236-241

Reys, R. E. (1986). Evaluating computational estimation. *Estimation and mental computation*, 225-238.

Reys, R. E., & Bestgen, B. J. (1981). Teaching and assessing computational estimation abilities. *The Elementary School Journal*, *82*(2), 117-127.

Segovia Alex, I., & Castro, E. (2009). Computational and measurement estimation: curriculum foundations and research carried out at the University of Granada, Mathematics Didactics Department.

Sowder, J. (1992). Estimation and number sense. D. A. Grouwsiçinde*, Handbook of Research on Mathematics Teaching and Learning* (s. 371-389). New York: Macmillan.

Sowder, J. (1992). Estimation and number sense. D. A. Grouwsiçinde*, Handbook of Research on Mathematics Teaching and Learning* (s. 371-389). New York: Macmillan.

Swan, M., & Jones, O. '(1971). Distance, weight, height, area, and temperature percepts of university students. *Science Education,* 55 (3),353-360.

Swan, M., & Jones, O. E. (1980). Comparison of students' percepts of distance, weight, height, area, and temperature. *Science Education,*64 (3), 297-307.

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

Tekinkır, D. (2008). *İlköğretim 6-8. Sınıf öğrencilerinin matematik alanındak itahmin stratejilerin ibelirleme ve tahmin becerisi ile matematik başarısı arasındaki ilişki* (Doctoral dissertation, DEÜ EğitimBilimleriEnstitüsü).

Van De Walle, J. A., Karp, K. S., & Bay-Williams, J. M. (2016). İlkokul ve OrtaokulMatematiği (ÇeviriEditörü: Prof. Dr. SonerDurmuş) (7. Basımdan Çeviri). *Nobel AkademikYayıncılık, Ankara*.

Yıldırım, A., &Şimşek, H. (2003). *Sosyal bilimlerde nitel araştırma yöntemleri*. Seçkin yayıncılık.

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