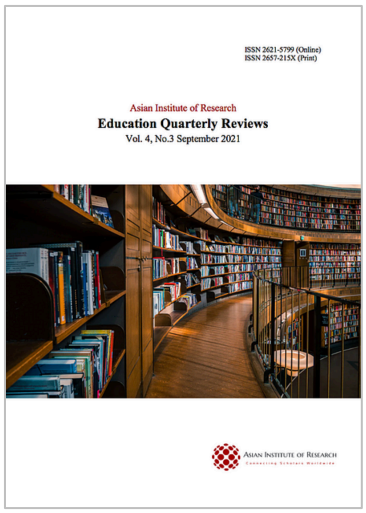

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Students' Length Measuring Estimation Skills Related to The Daily Life Objects*

Ömer F. Çetin[1], Himmet Akkuşçi[2]

[1] Education Faculty, The University of Erzincan Binali Yıldırım, Erzincan, Turkey
[2] Math Teacher, M.E.B., Yozgat, Turkey

Correspondence: Ömer F. Çetin, Education Faculty, The University of Erzincan Binali Yıldırım, Erzincan, 24030, Erzincan. Tel: -. E-mail: ofaruk@erzincan.edu.tr

Abstract
This research aims to explore the secondary school sixth and seventh graders' length measuring estimation skills developing activities related to the daily life objects. The study is in a qualitative multiple case study model. The universe of the research consisted of the sixth and seventh graders. The sample of the research consisted of 85 students, who were studying at a secondary school in sixth and seventh classes in 2 (two) state schools determined with the purposive sampling method in the 2018-2019 educational year. The maximum variety was ensured for the class level, gender, and mathematics achievement scores; voluntariness for the easily accessible situation. The data were obtained with the scales and semi-structured interview forms prepared during the research process and analyzed descriptively. The research results suggest that the length measuring estimation skills of the secondary school sixth and seventh graders relevant to the daily life objects can be developed with the activities that will develop the students' prior knowledge and skills.

Keywords: Measuring Estimation, Estimation, Estimation Skill, Length

1. Introduction

Although mathematics comes into existence in line with the needs of society with simple counting and measuring operations, it has a significant place among the other sciences consisting of primary technology today (Işık et al.,2010).

Those, who can use or understand mathematics, have more possibility to shape their future in the world that is in rapid change. Today's mathematics is not only about arithmetic and geometry. The current mathematics is

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relevant to the data, measurement, reaching results with scientific researches, finding evidence, and proving. Using mathematics is, rather than calculating, looking for a relationship, testing and estimating the results (Sulak, 2008).

As the rapid development in technology and increasing social needs are considered, it has become an obligation to teach the student to reach the information instead of transferring the information to the student since the information that needs to be transferred to students for the future cannot be predicted (Özcan, 2015). For this reason, it will be one of the basic strategies of mathematics teaching to educate students with flexible thinking, reasoning, problem-solving, and estimation skills in order for them to cope with situations they have not encountered before (Umay, 2003). It is claimed that the skill of estimation, which is one of the mentioned skills, makes our life easy (Çetin & Köse, 2015), useful in problem-solving (Sevgi & Çağlıköse, 2020; Aktaş, Bulut & Aktaş, 2018), and brings conceptual understanding fore in some issues (Erdem, Özçelik & Gürbüz, 2018). In addition, estimation skill is in reflective thinking and critical thinking (Eğmir & Ocak, 2018) and is related to the number sense (Karabey & et al., 2019). Although the estimation skill took place in the basic purposes of mathematics in the mathematics curriculum before 2005, it could not be applied in the practices (Çilingir & Türnüklü, 2009). In the 2018 secondary school mathematics curriculum, the estimation skill was referred and the gains relevant to this skill were included in this curriculum. While the gains relevant to the measuring estimation skill were included in the curriculum at the level of primary school, at the secondary school level, the gains relevant to the conceptual estimation skill were mentioned (MEB, 2018).

1.1. Significance of the study

The measuring estimation skills are the significant skills that students will apply in solving real-life problems and developing several different activities that students will use in acquiring these skills (Bulut & Şener, 2017). As it is considered that there is significant progress in the estimation skill with the in-class activities (Civelek & Akamca, 2018), it is useful for teachers to include real-life situations in their lessons (Yakar & Yılmaz, 2017). As it is taken into account that the pre-service teachers prefer applying the activities aiming to measure the estimation skill-less (Öztürk & Işık, 2018), do not feel adequately equipped about the types of activities that can be applied and do not believe these sorts of activities are efficient (Boz-Yaman & Bulut, 2017), that there is a limited number of studies on the topic of estimation in Turkey (Boyraz & Aygün, 2016), it is worth exploring the necessary prior knowledge and skills for the length measuring estimation skills relevant to the daily life objects of the sixth and seventh graders and the activities that will gain these skills.

The problem of the research consists of "what are the prior knowledge and skills that are necessary for the length measuring estimation skill relevant to the daily life objects of secondary school sixth and seventh graders and what can be the activities to be used in gaining this knowledge and skills and how these activities affect the length estimation skill relevant to the daily life objects." This problem is divided into the sub-problems below.

1. Which prior knowledge and skills are necessary for the length measuring estimation skills related to the daily life objects of the secondary school sixth and seventh graders?
2. What can be activities that will gain the prior knowledge and skills which are necessary for the length measuring estimation skills related to the daily life objects of the secondary school sixth and seventh graders?
3. How does applying the activities that will gain the prior knowledge and skills which are necessary for the length measuring estimation skills related to the daily life objects of the secondary school sixth and seventh graders affect the length measuring estimation skills relevant to the daily life objects?

In the research, it is aimed to determine what are the prior knowledge and skills that are necessary for the length measuring estimation skills related to the daily life objects of the secondary school sixth and seventh graders, how the activities that are thought to gain this knowledge and skills affect the participants' length estimation skills of daily life objects (relationships between the estimations before and after the activity). The findings

reached at the end of the study are thought to guide teachers and curriculum developers in teaching length estimation skills of daily life objects.

2. Method

This study aims to explore the comparing the length measuring estimation skills related to the daily life objects deeply according to the students' current length measuring estimation skills related to the daily life objects and given training. As it can be understood from the purpose of the study, this study is a qualitative (recommended for the estimation skill (Boyraz & Aygün, 2016)), multiple case study model. Mc Millan (2000) defines case studies as "a method which enables to explore one or more events, environments, programs, social groups, or other interconnected systems in depth" (cited by Büyüköztürk et al., 2015). Eisenhardt (1989) defined case studies as research that synthesizes and expands research and adds depth to existing theory opinions. Therefore, the research that enables to explore of an event or a situation in depth is evaluated within the scope of the case study. Eisenhardt (1989) suggests the multiple case study in the research in which the differences between individuals are investigated.

2.1 Research Universe and Sample

The universe of the research consisted of the secondary school sixth and seventh graders in Turkey. The sample of the research consisted of 85 sixth and seventh graders, who were selected with the purposive sampling method from 2 (two) secondary schools' sixth and seventh class levels from the secondary schools of the Ministry of National Education in Sorgun district of Yozgat province in the 2018-2019 educational year. For the easy accessibility in the sample, voluntariness was taken as the base (Yıldırım & Şimşek, 2013).

2.2 Data Collection Tools

The research data were obtained with the "1st length measuring estimation scale" and "2nd length scale measuring estimation scale" and semi-structured interviews.

2.2.1 1st Length Measuring Estimation Scale

The objects to determine the prior knowledge and skills that may affect the participants' length measuring estimation scales related to the daily life objects were determined as short (shorter than 25cm), medium (longer than 25 cm, shorter than 2 m), long (longer than 2m) and objects that do not create a sense of space-volume, have space, have volume.

The objects stated in the scale questions are the objects that the participants use or encounter continually in daily life. The lengths in the scale and the characteristics of these objects relevant to these lengths are presented in Table 1.

Table 1. 1st length measuring estimation scale questions and the characteristics of these objects relevant to these lengths

Lengths	**Characteristics of the Lengths**
Length 1	Short, with no sense of space-volume
Length 2	Medium, with no sense of space-volume
Length 3	Long, with no sense of space-volume
Length 4	Short, with space
Length 5	Orta, with space
Length 6	Long, with space
Length 7	Short, with volume
Length 8	Medium, with volume
Length 9	Long, with volume

As it is seen in Table 1, 9 (nine) questions were asked to the participants to estimate the lengths of 9 (nine) objects. They consisted of the objects which were short (shorter than 25cm), with no sense of space and volume and with space; medium (longer than 25 cm, shorter than 2 m), with no sense of space and volume, and with volume; long (longer than 2m), with no sense of space-volume and with volume. There is an "explanation" part in the scale to enable the participants to write the reasons for their estimations.

2.2.2 2nd Length Measuring Estimation Scale

After applying the 1st length measuring estimation scale, from the data in the “explanation” part, the prior knowledge and skills that may affect the length estimation skills related to the daily life objects were determined. The activities that were thought to be gained this prior knowledge and skills were performed. To determine how these activities affect the participants' length estimation skills related to daily life objects, the 2nd scale was developed by using different objects that had the same characteristics as the objects in the 1st scale.

2.2.3 Interviews

To determine how did the students, who did not have any explanations in the 1st length measuring estimation scale or whose explanations were not understood, made length measuring estimation related to the daily life objects, the semi-structured interviews were performed. An example of the interviews is given in the result section.

2.3 Data Collection Process

The data were collected with the written documents and interviews in the research. The research was started after the approval of the ethics committee and the necessary permissions from the Directorate of National Education. The students and parents who were in the study groups were informed and included with their permission and voluntariness. The written documents and interview processes are described below.

2.3.1 Written Documents

The written documents were used in two stages and for two measurements.

1st Measurement: After the sixth and seventh students, in the two secondary schools in which the measurements would be done, had been informed about the measurements, the 1st measurement was applied totally to the 85 students, 49 of them were seventh-graders, 36 were sixth-graders, participated voluntarily. During the measurement, the students were asked to write on the scale whose one copy was given to them in order not to affect each other by expressing their estimations vocally and they were asked to explain the reasons for their estimations. The measurement continued about a course time.

2nd Measurement: One week after the 1st measurement, the non-standard length measurements (fathom, span, step, foot, finger) were explained to the students. These non-standard length measurements were determined by measuring the equivalent in standard length measurements. On the same day, length measurement estimation strategies such as using fixed point or reference point, unit repetition strategy, using previous knowledge, mental metering, comparison, fragmentation-stacking, compression, random estimation (Kılıç & Olkun, 2013)) is explained practically during the two lessons. One week after the explanations, the 2nd measurement was done. During this measurement, the students were asked to write on the scale whose one copy was given to them in order not to affect each other by expressing their estimations vocally and they were asked to explain the reasons for their estimations. The measurement continued for about one-course duration.

2.3.2 Interviews

At the end of the 1st scale applied to the students, 8 (10%) of the students, who did not give any explanations or whose explanations were not understood, were interviewed. After the 2nd scale was applied, a second interview was held with the same students to determine how the activities that were thought to improve prior knowledge and skills had an effect. The interview durations are given in Table 2.

Table 2: The interviewed students and duration of the interviews

Code Name	1st Interview Duration (min./sec.)	2nd Interview Duration (min./sec.)
S1	04.46	04.49
S2	05.01	04.37
S3	04.13	04.44
S4	03.06	02.27
S5	02.46	02.39
S6	02.45	03.09
S7	03.22	03.19
S8	03.00	02.55

As it is seen in Table 2, the arithmetic means of the interviews with the 8 students is about 3.5 minutes. The interviews were held in a silent environment and all the interview periods were spent with data collection. To prevent data loss, the interviews were audio-recorded. The audio recording process was carried out with the knowledge of the students.

2.4 Data Analysis

The study started to with the application of the first scale to the students. In this stage, in the first measurement held to investigate the existing length estimations of students, the answers for the lengths of the objects given under the headings of short, medium, and long and the arithmetic means of the differences between the real lengths of these objects were found. The frequencies and rates were calculated and described under the themes and sub-themes to examine the explanations of the estimations in depth. In this scale applied to the students, a semi-structured interview was held with eight students who did not explain their estimations or make an understandable explanation, the interviews were recorded and analyzed with the content analysis to reach the concepts and relationships that would explain the data (Yıldırım & Şimşek, 2013).

In the second section of the study, the second scale was applied to the students at the end of the activities that were thought to develop the students' length measuring estimation skills. In this scale, the lengths of the objects were found with the arithmetic means of the answers given by the students and the differences between real lengths of the objects. To investigate the explanations of the estimations in-depth, the frequencies and rates were calculated and described under the themes and sub-themes. 8 (eight) students, who were interviewed in the first interview, were interviewed again and the interviews were recorded.

3. Results

3.1. Findings

In this section, the findings of the research are given under two headings as the written documents and findings obtained from the interviews.

3.1.1 Findings obtained from the written documents

3.1.1.2 Findings related to the first sub-problem.

As the class levels of the sixth and seventh graders are taken into account, the students are expected to gain the function stated in the 2018 MEB 5th class curriculum as "M.5.2.3.1. Recognizes length measurement units, converts meters-kilometers, meters-decimeters-centimeters-millimeters to each other and solves related problems"

As it is seen in Table 4, that the number of students who made "no explanation" or "blindness" explanation was higher than the number of students who made other explanations, except for the "long" theme, "one edge length of an object with volume" sub-theme created the impression among the researchers that the standard and non-standard units of measurement were not fully understood and there was a difficulty in converting these units of measurement to each other. In this section, an interview was held with the students who did not make any explanation. The interviews have the feature to confirm the impression. This situation demonstrated for the length measurement estimation skill of contemporary life objects that it was necessary to know "standard and non-standard measurement units" and "convert them to each other" fully. In addition, there are no acquisitions for length measuring estimation skill strategies in the MEB primary and secondary curriculum (MEB, 2018). The researchers thought that students' knowledge of length measuring estimation skills would positively affect their length estimation skills of daily life objects, and these strategies were explained in the activity.

3.1.1.3 Findings related to the second sub-problem.

According to the findings obtained from the 1st sub-problem of the research, it was determined by the researchers that the activities, which would positively affect the length measuring estimation skills of sixth and seventh class students, were the "recognizing standard and non-standard length measuring units, converting them to each other" and "describing length measuring estimation strategies" activities.

3.1.1.4 Findings related to the third sub-problem.

The arithmetic means demonstrating the difference between the estimations of the sixth and seventh class students related to the lengths of the objects in the first and second measurements and the real lengths of the objects are presented in Table 3 below.

Table 3: The arithmetic means demonstrating the difference between the estimations of the sixth and seventh class students related to the lengths of the objects in the first and second measurements and the real lengths of the objects

Lengths	**First Measurement Arithmetic Mean**	**Second Measurement Arithmetic Mean**
Length 1	3,78 cm	2,21 cm
Length 2	15,17 cm	6,6 cm
Length 3	8,31 m	0,79 m
Length 4	5,67 cm	3,39 cm
Length 5	49,72 cm	22,32cm
Length 6	1,31 m	0,44 m
Length 7	4,44 cm	1,2 cm
Length 8	30,1 cm	14,72 cm
Length 9	0,38 m	0,7 m

As it is seen in Table 3, the 2nd measurement means in the "length 9" is higher than the arithmetic means in the 1st measurement. In other lengths, the 2nd measurement arithmetic means are lower than the 1st measurement arithmetic means.

The explanations expressed by the sixth and seventh class students for the length estimations for the objects given with the "short," "medium" and "long" themes in the first and second measurements are presented in tables below.

Table 4: The sixth and seventh class students' explanations for the length estimations for the objects given with the "short" theme in the first and second measurements

Themes	Sub-themes	Common Responses	1st measurement (f)	1st measurement (%)	2nd measurement (f)	2nd measurement (%)
SHORT	Lengths with no sense of space or volume	I measured with my hand span	25	29	58	68
		No explanation	17	20	10	12
		Eye estimation	21	25	7	8
		I measured with my finger	–	–	7	8
		I compared it with the pencil lead box	8	9	3	4
		Total			85	100
	The length of one side of the object with the area	I measured with my hand span	14	17	61	72
		I measured with my finger	3	4	11	13
		No explanation	25	29	7	8
		As it is short	7	8	3	4
		Eye estimation	20	24	2	3
		With the compression method	–	–	1	1
		Total			85	100
	The length of one edge of an object with volume	I measured with my finger	2	3	62	73
		I measured with my hand span	10	12	8	9
		Eye estimation	18	21	6	7
		No explanation	32	39	6	7
		As it is short	9	11	2	3
		I compared it with the pencil lead box	–	–	1	1
		Total			85	100

As it is seen in Table 4, there were 25 (%29) students who made the explanation "I measured with my hand span" as an explanation in the first measurement and 58 (%68) students in the second measurement for short lengths that do not create a sense of area-volume. In the first measurement, there were 21 (%55) students who made an explanation of "eye estimation" and there were 7 (%8) students in the second measurement. There were 17 (%20) students who did not "explain" in the first measurement, and 10 (%12) students in the second measurement.

For the side lengths of a short, area-filled object, there were 14 (%17) students who made the explanation "I measured with my hand span" as an explanation in the first measurement and 61 (%72) students in the second measurement. In the first measurement, there were 20 (%24) students, who estimated with eye estimation, and 2

(%3) students in the second measurement. There were 25 (%29) students, who did not make an explanation in the first measurement, and 7 (%8) students in the second measurement.

There were 10 (%12) students who explained "I measured with my hand span" as an explanation for the edge length of a short, object with the volume in the first measurement, and 8 (%9) students in the second measurement. There were 2 (%3) students who explained: "I measured with my finger" in the first measurement and 62 (%73) students in the second measurement. In the first measurement, 18 (%21) students estimated it with eye estimation, while in the second measurement, there were 6 (%7) students. There were 32 (%39) students who did not make an explanation in the first measurement, and 6 (%7) students in the second measurement.

Table 5: Explanations by the sixth and seventh class students for their length estimations for the objects given with the "medium" theme in the first and second measurements

Themes	Sub-themes	Common Responses	1st measurement (f)	1st measurement (%)	2nd measurement (f)	2nd measurement (%)
MEDIUM	Lengths with no sense of space or volume	I measured with my hand span.	1	1	61	71
		No explanation	29	34	12	14
		Eye estimation	19	22	4	5
		I measured with my finger	–	–	4	5
		I measured with my arm span	6	7	2	3
		I measured with my height	3	4	2	3
		Total			85	100
	The length of one side of the body with the area	I compared with my height	7	8	42	49
		I measured with my arm span	13	15	20	24
		No explanation	27	32	14	16
		Eye estimation	18	21	4	5
		I measured with my hand span	4	5	4	5
		As it is long	–	–	1	1
		Total			85	100
	The length of one edge of an object with volume	I compared with my height	18	21	58	68
		I measured with my arm span	–	–	11	13
		No explanation	33	38	7	8
		I measured with my hand span	–	–	5	6
		Eye estimation	20	23	4	5
		Total			85	100

As it is seen in Table 5, there was 1 (%1) student who explained "I measured it with my hand span" as an explanation for the length, which does not create a medium, area-volume feel, in the first measurement, and 61 (%71) students in the second measurement. In the first measurement, there were 19 (%22) students who estimated "eye estimation," and 7 (%8) students in the second measurement. In the first measurement, there were

no students who used I measured with my finger as an explanation, while there were 4 (%5) students in the second measurement and the second measurement. While there were 29 (%34) students who did not make any explanation in the first measurement, there were 12 (%14) students in the second measurement.

There were 7 (%8) students who explained that the length of one side of the object with the area and medium and used 'I compared with my height' as an explanation in the first measurement, and there were 42 (%49) students in the second measurement. In the first measurement, there were 18 (%21) students who estimated with "eye estimation," and 4 (%5) students in the second measurement. In the first measurement, while there were 13 (%15) students who made the explanation that I measured with my arm span, there were 20 (%24) students in the second measurement. There were 27 (%32) students who did not make an explanation in the first measurement, and 14 (%16) students in the second measurement.

There were 18 (%21) students who explained "I compared it with my height" as an explanation for the edge length of an object which was medium, with volume in the first measurement, and 58 (%68) students in the second measurement. In the first measurement, while there were no students who made an explanation of "I measured with my arm span," there were 11 (%13) students in the second measurement. In the first measurement, while there were 20 (%23) students who estimated "eye estimation," there were 4 (%5) students in the second measurement. There were 33 (%38) students who did not make an explanation in the first measurement, and 7 (%8) students in the second measurement.

Table 6: Explanations by sixth and seventh class students for the length estimations for the objects given with the "long" theme in the first and second measurements

Themes	**Sub-themes**	**Common Responses**	**1st measurement (f)**	**1st measurement (%)**	**2nd measurement (f)**	**2nd measurement (%)**
LONG	Lengths with no sense of space or volume	I compared with my height	20	23	61	71
		No explanation	22	26	11	13
		I measured it with my arm span	–	–	8	9
		Eye estimation	16	19	4	5
		It is too long	23	27	1	1
		Total			85	100
	The length of one side of the body with the area	I measured with my arm span	5	6	37	44
		I measured with my hand span	–	–	21	25
		I compared with my height	14	16	14	16
		No explanation	28	33	9	11
		Eye estimation	19	22	4	5
		Total			85	100
	The length of one edge of an object with volume	I compared with my height	45	53	48	56
		Eye estimation	15	18	21	25
		No explanation	18	21	7	8
		I measured with my arm span	–	–	5	6
		As it is long	7	8	3	4
		Total			85	100

As it is seen in Table 6, there were 20 (%23) students who explained "I compared with my height" for the long, with no sense of space-volume in the first measurement, and 61 (%71) students in the second measurement. In the first measurement, there were 19 (%22) students who estimated with "eye estimation," and 4 (%5) students in the second measurement. There were 22 (%26) students who did not make an explanation in the first measurement, and 11 (%13) students in the second measurement.

There were 14 (%16) students who explained "I compared it with my height" as an explanation to the side length of a long object with area in the first measurement and 14 (%16) students in the second measurement. In the first measurement, there were 19 (%22) students who estimated with "eye estimation," and 4 (%5) students in the second measurement. In the first measurement, while there were 5 (%6) students who made the explanation "I measured with my arm span," there were 37 (%44) students in the second measurement. In the first measurement, while there were no students who made an explanation of "I measured it with my hand span," there were 21 (%25) students in the second measurement. There were 28 (%33) students who did not make an explanation in the first measurement, and 9 (%11) students in the second measurement.

There were 45 (%53) students who explained "I compared it with my height" as an explanation for the edge length of a long, object with volume in the first measurement, and 48 (%56) students in the second measurement. In the first measurement, while there were no students who made an explanation of "I measured with my arm span," there were 5 (%6) students in the second measurement. In the first measurement, while 15 (%18) students estimated it with “eye estimation,” there were 21 (%25) students in the second measurement. There were 18 (%21) students who did not make an explanation in the first measurement, 7 (%8) students in the second measurement.

3.1.2 Findings obtained from the interviews

A semi-structured interview was held with the students who did not make any explanation in the first length measuring estimation scale or whose explanations were not understood, to determine how did the activities that would provide prior knowledge and skills that are necessary for the secondary school sixth and seventh class students’ length measuring estimation skills related to the daily life objects affect the daily life objects length measuring estimation skills. The data obtained after the first and second interviews were gathered under the categories of “estimation with non-standard units of measure,” “random estimation” and “estimation with metric estimation strategies” and are presented in Table 6 and Table 7. In addition, an example (the interview with the S6) of the interviews is given below for the readers.

Table 6: Distribution of the data obtained from the first interview according to the categories “estimation with non-standard units of measure,” “random estimation” and “estimation with metric estimation strategies”

	Estimation with non-standard units of measure	**Random estimation**	**Estimation with metric estimation strategies**
Lenght 1	S1,S2,S4,S5,S6,S8	S3	S7
Lenght 2	S2,S6,S8	S5	S1,S3,S4,S7
Lenght 3		S2,S5,S6,S7	S1,S3,S4,S8
Lenght 4	S3,S5,S6,S8	S2,S4	S1,S7
Lenght 5	S2,S3,S5,S6,S7,S8		S1,S4
Lenght 6	S1,S2,S5,S8	S3,S6	S4,S7
Lenght 7	S2,S6,S8	S7	S1,S3,S4,S5
Lenght 8	S2,S6,S8	S3,S5	S1,S4,S7
Lenght 9	S2,S4,S8		S1,S3,S5,S6,S7

As it is seen in Table 6, except for the "length 3", the students were grouped under the categories of "estimation using non-standard units of measurement" and "estimation using measurement estimation strategies". There are

no students in “length 5” and “length 9” in the “random estimation” category. In addition, most students in the "random estimation" category are in the "length 3."

Table 7: The distribution of the data obtained from the second interview according to the categories of “using non-standard measurement units”, “random estimation” and “estimation with metric estimation strategies”

	Estimation with non-standard units of measure	**Random Estimation**	**Estimation with metric estimation strategy**
Length 1	S1,S2,S3,S4,S5,S6,S8		S7
Length 2	All		
Lenght 3	S3,S7,		S1,S2,S4,S5,S6,S8
Lenght 4	All		
Length 5	All		
Lenght 6	S1,S2,S3,S5,S6,S7,S8	S4	
Lenght 7	All		
Lenght 8	S1,S3,S5,S6,S7,S8	S4	S2
Lenght 9	S3,S6		S1,S2,S4,S5,S7,S8

As it is seen in Table 7, except for "length 3" and "length 9", the students were mostly gathered under the category of "estimation with non-standard measurement units". Under the "random estimation" category, there are only S4 coded students, one of which is "length 6" and the other is "length 8."

While there are mostly "length 3" and "length 9" students under the "metric estimation strategy" category, there are no students in "length 4", "length 5", "length 6" and "length 7."

The first interviews for the length measuring estimation skills of the daily life objects and the second interviews after the activities that are thought to improve the length measuring estimation skills of the daily life objects are given below.

The first interview with S6:

A: What is the pen’s length approximately? Can you write and explain the result you estimated? I said. And you found 15cm. Can you explain why do you think so?
S6: I measured with my finger.
A: “How long is the rod approximately? Can you write and explain your estimation?” I said. You found 100cm. Can you explain why do you think so?
S6: I measured it with my arm span first, as it is too long, I used my hand span.
A: What is the approximate length of the flagpole? Can you write and explain the result by writing? I said. You found 4m. Can you explain why do you think so?
S6: I measured with my eye estimation as I think of my arm span.
A: How long is the long side of the phone approximately? Can you write and explain your estimation? I said. You found 20cm. Can you explain why do you think so?
S6: I measured it with my fingers one by one because it's short.
A: How long is the long side of the student desk approximately? Can you write and explain the result that you estimated? I said. And you found 50cm. Can you explain why do you think so?
S6: I measured with my hand span.
A: How long is the long side of the smart board approximately? Can you write and explain the result you estimated? I said. You found 1m. Can you explain why do you think so?
S6: I miscalculated as I don't know my arm span sizes.
A: How tall is the height of the box? Can you write and explain the result you estimated? I said. And you found 47cm. Can you explain why do you think so?
S6: I measured with my fingers.

A: How tall is the height of the teacher's desk approximately? Can you write and explain the result you estimated? I said. You found 60cm. Can you explain why do you think so?
S6: I measured with my hand span.
A: How tall is the height of the bookshelves approximately? Can you write and explain the result you estimated? I said. And you found 1,50cm. Can you explain why do you think so?
S6: I estimated it as I thought of my height.

The second interview with S6:

A: How long is the pen approximately? Can you write and explain the result you estimated? I said. And you found 18cm. Can you explain why do you think so?
S6: As the length of a finger is 1.5 cm, I measured it with my fingers.
A: How long is the rope approximately? Can you write and explain the result your estimated? I said. And you found 34cm. Can you explain why do you think so?
S6: I estimated it so as it was shorter than my arm span.
A: How height is the basketball hoop approximately? Can you write and explain the result you estimated? I said. And you found 3,30m. Can you explain why do you think so?
S6: I estimated with eye estimation thinking of my arm span.
A: How long is the short side of the A4 paper approximately? Can you write and explain the result you estimated? I said. And you found 24cm. Can you explain why do you think so?
S6: I measured it with my finger.
A: How long is the long side of the classroom board approximately? Can you write and explain the result you estimated? I said. And you found 370cm. Can you explain why do you think so?
S6: I measured with my arm span. I thought a little wrong.
A: How long is the long side of the table tennis approximately? Can you write and explain the result you estimated? I said. And you found 271cm. Can you explain why do you think so?
S6: I measured it with my arm span as it was longer than my hand span.
A: What is the height of the intelligence cube approximately? Can you write and explain the result you estimated? I said. And you found 14cm. Can you explain why do you think so?
S6: I did it according to my finger sizes.
A: What is the height of the car approximately? Can you write and explain the result you estimated? I said. And you found 143cm. Can you explain why do you think so?
S6: My arm span is 1.5m. As it is shorter than my arm span...
A: What is the height of the classroom approximately? Can you write and explain the result you estimated? I said. And you found 3m. Can you explain why do you think so?
S6: I tried to measure with my hand span. When I could not, I measured with my arm span.

4. Discussion

4.1. Discussion and recommendations handled from the interviews.

It is understood from the contents of the first interview and the findings given in Table 6 constituted as a result of this interview that some of the students had difficulties in converting non-standard measurement units such as hand span and arm span to standard units of measurement. For instance, after the first and second interviews, while the S1 coded student explained as below in the first interview:
"A: How long is the pen approximately? Can you write and explain your estimation? I said. And you found 6cm. Can you explain why did you think so?"
The answer to this question;
"S1: As my three fingers are 4,5cm, I think that the pen is about 6 cm."
In the second interview after the activities:
"A: How long is the pen approximately? Can you write and explain the result you estimated? I said. And you found 18cm. Can you explain why do you think so?

The answer to the question is as;
"S1: My measurement was bad in the first estimation. I measured the pen by the span after you taught me the hand span and arm span..."

The reason for this result maybe because of the deficiencies in the prior knowledge of the students. This result demonstrates similarity with the result as 'the 2nd graders found few acceptable estimations in non-standard units' that was reached in the study by Boyraz (2017).

In addition, the second measurement and second interview held after the activities carried out to correct the learning deficiencies after the first measurement supports the result reached by Köse (2007) suggesting that "Educating to complete learning deficiencies was found to be significantly effective in the unit of measurements in the mathematics lesson."

In his study by Boyraz (2017), it is observed that the acceptable estimations of all the 2nd class students participating in the study are more in the items in which the units related to "foot" are used, and less in the items in which the unit related to "finger" is used. These findings demonstrate similarity with the results of our study.
It is recommended that teachers should do activities related to converting non-standard measurement units to standard measurement units before starting the subject of length measurement.

4.2. Discussion and recommendations related to the first sub-problem.

From the findings with the same headings, that the 6th and 7th class students' knowing non-standard units of measurement and measurement estimation strategies, which they gained about standard length measurement units for length measurement estimation skills of daily life objects are determined as the prior knowledge and skills that they should know.

4.3. Discussion and recommendations related to the second sub-problem.

From the findings with the same headings, it is understood that it is necessary for the sixth and seventh class students to know the length measurement units for the length measuring estimation skills related to daily life objects.

It was determined that explaining this gain by the course teacher for the students who could not achieve it at the previous levels, converting these length measurement units to non-standard length measurement units, and making measurements together with the students using estimation strategies after knowing the units of length measurement will develop the missing prior knowledge and skills among the students.

In short, the activities of "recognizing standard and non-standard units of length measurement, converting them to each other" and "describing length measurement estimation strategies" activities are determined as practical activities. In the study by Boyraz (2017), it was claimed that the estimation skill, like other skills, is the skill that can be developed through education, and it is significant to carry out various studies to improve this skill in basic education.

Artut & Aslan (2014) suggested that they encountered difficulties in the activities applied to gain the estimation skill. Teachers, who had difficulties during the application of the activities aiming to gain the estimation skill to students, attributed this to "lack of time, socio-economic differences, the individual differences between students, the inconsistency of the activities with the level of the student, the problems of students in expressing themselves about how they did the activities at the end of the activities, and the crowded classrooms."

4.4. Discussion and recommendations related to the third sub-problem.

After the first measurement was held to determine the length estimation skills related to the daily life objects in students, the activities that would gain the prior knowledge and skills to the students were carried out. To observe how these activities affect the length measurement estimation skill of contemporary life objects a second measurement was held. These results were reached after the second measurement:

In the second measurement, as the arithmetic averages of the differences between the estimations for the lengths of the objects and the actual lengths of the objects were explored, except for the “length 9”, at all lengths, the arithmetic means were significantly lower than the arithmetic means in the first measurement (for example, 49.72cm to 22.32cm for “length 5”). There is an increase in the first and second measurement arithmetic means (from 0.38m to 0.7m) for the “length 9”. This shows that the activities, that were carried out, do not have a positive effect on estimating the length of an edge of objects with volume under the "long" theme.

As the explanations of the estimations were analyzed, while the majority of the students did not make any explanations or made an “eye estimation” explanation, a few of them made explanations with “non-standard units of measurement” and “estimation strategies” in the first measurement. In the second measurement, the number of students, who made explanations with "non-standard units of measure" and "forecasting strategies", increased (for instance, the number of students expressing “I measured with my hand span” increased from 25 to 58).

Similarly, the number of students who made “no explanation” or “eye estimation” decreased (for instance, the number of students who gave “no explanation” decreased from 17 to 10.) Consequently, carrying out the activities, that would gain prior knowledge and skills, had a positive effect on the length measuring estimation skill of daily life objects.

As the literature was reviewed, no study similar to the present study was encountered. However, in the study by Boyraz (2017) named "The Investigation of the Primary School 1st and 2nd Class Students' Estimation Skills" conducted for the 1st and 2nd classes with little or no prior knowledge, it was suggested that the 1st and 2nd class students' estimation skills of were quite low.

Köse (2007) claimed in his study that the method of completing the learning deficiency has more positive effects on the academic achievement of the students than the method without completing the learning deficiency. He stated that the mathematics course is cumulative and that when a subject is deficient, the other subject, which accepts that subject as a prerequisite, achievement cannot be reached completely, achievement will increase if the task is performed to eliminate the deficiencies. The results of this study and the results reached within the scope of our study demonstrate similarity.

As well as many skills, the estimation skill can be developed through training. Therefore, conducting various studies will enable the development of existing length estimation skills to develop this skill in basic education which is compulsory.

Similar to this study that was conducted for the length measurement estimation skill of daily life objects, other studies can be conducted for the measuring estimation skills such as area, volume, weight, liquid, etc.

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