EKUAD JETPR
Eğitim Kuram ve Uygulama Araştırmaları Dergisi

ISSN 2149-7702
e-ISSN 2587-0718

DOI: 10.38089/ekuad.2021.40

Cilt 7 (2021) Sayı 1, 48-61

Investigation of Number Sense Strategies used by Primary School Teachers and Mathematics Teachers

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Abstract

The present study aims to investigate the strategies that are used by mathematics teachers and primary school teachers in number sense problems. This study was designed as a case study, one of the qualitative research methods. The participants of the study consisted of 30 teachers, 15 of whom were mathematics teachers and 15 of whom were primary school teachers, working in Adana. The Number Sense Test was used as the data collection tool. The Number Sense Test consists of 25 items with five number sense components. The qualitative research analysis techniques were used in the analysis of the data obtained from the data collection tool. The strategies which the teachers use while they are solving the problems are classified as number sense-based strategy, partial number sense-based strategy, rule-based strategy and no explanation. The findings showed that 58.9% of the problem solutions obtained from mathematics teachers was based on number sense-based strategies, 28.8% of them on rule-based strategies, 32.8% of primary school teachers' solutions was number sense-based strategies and 55.4% of them was rule-based strategies.

Key Words

Number Sense
Number Sense Strategies
Mathematics Teachers
Primary School teachers

About Article

Date of Sending: 21.09.2020
Date of Acceptance: 02.11.2020
Date of E-publishing: 04.02.2021

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Introduction

Number sense is considered as the individuals' ability to make mathematical interpretations, to determine the effect of numbers on operations and to use them in a flexible way, to develop strategies for numbers and operations (Courtney- Clerk 2012; Reys and Yang, 1998; Tsao, 2004). Olkun (2012), on the other hand, mentioned the number sense in short as the usage of number in a flexible and fluent way. In addition, he defined the number sense as an intuition which can develop in line with the skills of guessing and mental calculation, and it also enables the development of these skills.

It can be said that the number sense concept drew attention first through the studies of the National Council of Teachers of Mathematics (NCTM) in the USA. According to the NCTM standards (2000, p.32), pre-school, primary and secondary school students perceive numbers, relationships among numbers, representation ways, number systems. In addition, they can calculate unhaltingly, make predictions appropriately; determine the meaning of operations and their relationships with one another. It was also expressed that students' ability to meet these standards depends on the development of individuals' number sense. Thus, it can be said that an individual with a developed number sense can use daily life mathematics and school mathematics in a flexible and facilitating way in their lives.

The concept of number sense is difficult to define so it is defined in the literature together with its characteristics. This has resulted in disagreements among mathematics educators and cognitive psychologists (McIntosh et al., 1992). The same situation was also experienced in the determination of the components which make up number sense. Şengül and Dede (2013) concluded in their study about investigating the classifications of number sense components that there was no common classification for number sense components in the related literature and that the most comprehensive classification was made by McIntosh et al. (1992). This result was interpreted as the boundaries of the concept of number sense being an imprecise concept. Sighn (2009) used five basic components as understanding the number sense concept, using multiple representations, understanding the effect of the operation, using equivalent expressions, using calculation and counting strategies based on the classification made by McIntosh et al. (1992). These components are as follows:

Component of understanding the number sense concept: This component includes understanding the value that is represented by the number and understanding the size that is indicated by the number. The students know and use numbers and the relationships between the numbers (Harç, 2010). For example, the ability of knowing that there can be infinite decimal numbers between 0.5 and 0.6 is an indicator of this component. *Component of using multiple representations*: This component is related with knowing various representation ways of the numbers or the value, which the numbers represent. For example, finding the value that expresses the shaded region in a given whole best is an indicator of this component. *Component of understanding the effect of the operation:* It includes determining the value of the number or the effect of this situation on the result when the operation differs while making the calculation. Briefly, an individual who has the component of understanding the effect of the operation knows what kind of effects four operations will have on numbers. (Yang, Reys, Reys 2007). In other words, it means being able to feel that multiplication does not always make the numbers bigger or division does not always make the numbers smaller (Graeber and Tirosh, 1990; Greer, 1987; McIntosh et al., 1992). For example; when 30 is multiplied by 0.09, the ability of realizing that the result may be much smaller than 30 is an indication of this component. *Component of using equivalent expressions:* This component is related with showing the numbers in different ways, that is to say, knowing the equivalent of the numbers. For this component, being able to express the fraction 3/4 with a different equivalence or to perceive whether the results of 30 x 0.5 and 30: 2 operations are equivalent to each other can be given as an example (İymen, 2012). *Component of using calculating and counting strategies*: This component means implementing mental estimation strategies without using written calculations while solving problems (Kılıç, 2011).

There are some studies about investigating the number sense of elementary school students in the related literature (Altay & Umay, 2011; Altay, 2010; Aunio, Lim, Hautamaki, & Van Luit, 2004; Er & Artut, 2017; Er & Artut, 2018; Markovits & Pang, 2007; Markovits, and Sowder, 1994; Pike and Forrester, 1997; Reys, Kim and Bay, 1999; Sengul and Gulbagci, 2012; Zaslavsky, 2001). In addition,

some other studies investigated the number sense of pre-service teachers (Altay & Umay, 2011; Clarke 2012; Şengül, 2013; Yang, 2007; Yang, Reys, & Reys, 2009; Yaman, 2014; Tsao 2012). Moreover, there is a study (Er & Artut, 2015) which focuses on the number sense of primary school teachers and another study (Şengül & Dede, 2014) that investigated the strategy used by mathematics teachers while solving number sense problems. Among the studies that are available, no study was found on the strategies used by primary school teachers while solving number sense problems.

Teachers are the ones who are primarily responsible for bringing the students in problem solving skills. Furthermore, this becomes more important since the cognitive development levels of primary, secondary and high school students show varieties (Yılmaz, 2018). In this research, it was aimed to determine the strategies which the teachers used while solving the problems in the number sense test and to determine number senses according to the components of number sense. Being an efficient teacher and teaching mathematics effectively accompany strong subject matter knowledge. Besides, it is considered that having developed number sense skill is a significant component in order to be successful in mathematics classes. The fact that teachers are the people who carry out teaching-learning activities brings them to the forefront in making students gain the number sense concept. Therefore, it is considered significant to determine what strategies are used by the teachers who have an important role in students' gaining number sense skill while solving problems that require number sense. In this context, it was aimed to determine the strategies used by mathematics teachers and primary school teachers while solving the problems in the number sense test. In line with this background, the research questions are formulated as below:

What are the strategies that teachers use in solving the problems in the number sense test?

What are the strategies that teachers use in solving the problems in the number sense test according to the components of number sense?

Method

This study was designed as "a case study", which is one of the qualitative research designs. Case study is a qualitative approach in which information is collected thoroughly via different information sources about a situation, and then the description of the situation is presented (Creswell, 2015, p.97).

In case studies, generally more than one data collection methods are used. Thus, it is aimed to to reach data variety which is rich and which will affirm each other. In this research, the responses which the teachers gave to the Number Sense Test were investigated as documents and the teachers' opinions about their responses were received.

Study Group

The study group consists of 15 primary school teachers and 15 mathematics teachers who were selected according to the convenience sampling method and participated in the study voluntarily. The distribution of primary school teachers and mathematics teachers in the study group according to their service period and gender is shown in Table 1.

Table 1. The Distribution of the Teachers according to Teaching Experience and Genders

		1-5 years		6-10 years		11-15 years		16-20 years		21-25 years		Total	
		n	%	N	%	n	%	n	%	n	%	n	%
Primary School Teacher	Female	-	-	2	22,2	5	55,6	2	22,2	-	-	9	30
	Male	-	-	1	16,7	1	16,7	4	66,7	-	-	6	20
Mathematics Teacher	Female	1	11,1	5	55,6	3	33,3	-	-	-	-	9	30
	Male	1	16,7	4	66,7	1	16,7	-	-	-	-	6	20
Total		2	6,7	12	40	10	33,3	6	20	-	-	30	100

When Table 1 is considered, it is seen that of 30 teachers participating in the research, 18 were female and 12 were male. It is figured out that approximately 6.7% of 30 teachers had teaching

experience of 1–5 years, 40% of them had teaching experience of 6–10 years, 33.3% of them had teaching experience of 11–15 years and 20% of them had teaching experience of 16–20 years.

Data Collection

The data of the research were obtained by means of interview and document analysis techniques. In qualitative research, written and visual materials and equipment related to the research problem can be included in the research in addition to interview and observation methods so as to increase the validity in qualitative research. Documents are effective information sources (Yıldırım, Şimşek, 2008).

In line with this purpose, the teachers' answers to the number sense test were used as a document in this study. Interviews were carried out with the same teachers to determine how they thought while solving the questions in the number sense test.

NST was administered to each teacher individually. After the teachers had completed their answers to the items in the test, interviews were conducted with them to determine the strategy they used in solving the questions. During the interviews, teachers were asked to explain how they reached the answer which they gave and how they thought while solving the problem. Interviews were recorded by using a recorder upon the permission of the teachers.

The informed consent forms were taken from the participants as the data collection process of this study was in the scope of a qualitative study requiring direct communication with the individuals.

Data Collection Tool

The data collection tool was based on some questions from the number sense scale adapted by Singh (2009) from McIntosh, Reys, Reys Bana and Farrell (1997). Following the field experts' suggestions, some of the questions in the original form were excluded from NST as they were not considered appropriate for the levels of the teachers. Moreover, the views of a language specialist were taken for the purpose of controlling the translated version of NST. In line with the advice given, some measurement units such as miles and gallons which were not used in Turkey was taken out. Then, the test was finalized. There are 5 components in the test as understanding the concept of number, using the multiple representations of numbers, understanding the effect of operations, using equivalent expressions, using calculation and counting strategies. It consists of 25 items about the subjects (item numbers: 8, 9, 14, 24), decimal numbers (item numbers: 3, 4, 6, 10, 12, 13, 17, 20, 22, 23, 25), fractions (item numbers: 1, 2, 7, 11, 15, 16, 18, 19, 21, 22) and percentages (item numbers: 5, 10, 22). (Note: Item 10 is related to the concept of decimals and percentages and Item 22 is about the concepts of decimals, fractions and percentages). The components of the Number Sense Test (NST), the distribution of the questions about these components and sample items are presented in Table 2.

Table 2. Components of number sense test and distribution of questions about these components and sample items

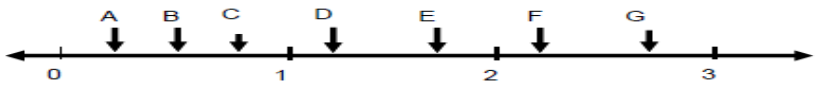
Components	Items	Sample Item
Understanding the concept of number	Number of items: 6 Item numbers: 1,6,11,16,21,25	Item 1: Is there a fraction between $\frac{2}{5}$ and $\frac{3}{5}$? If yes, how many fractions are there?
Using multiple representations	Number of items:5 Item numbers:2, 7,12,17, 22	Item 12:  Some letters are given on the numerical axis. Please, form a fraction in which the numerator may be about 2 times the denominator. Answer :_____
Understanding the effect of the operation	Number of items:5 Item number:3,8,13,18, 23	Item 23: Which of the following operations' result is correct? A) 45 x 1.05 = 39.65 B) 4.5 x 6.5 = 292.5 C) 87 x 1.076 = 93.61 D) 589 x 0.95 = 595.45

Table 2. Components of number sense test and distribution of questions about these components and sample items (Devamı)

Using equivalent expressions	Number of items:4 Item numbers:4,9,14,19	Item 4: Which of the following is the same as the result of 0.5 x 840? A) 840 ÷ 2 B) 840 + 2 C) 5 x 8400 D) 5 x 840 E) 0.50 x 84
Using calculation and counting strategies	Number of items:5 Item numbers:5,10,15, 20,24	Item 24: Choose the correct option for the result of [6 x 347] ÷ 43. A) Approximately 30 B) Approximately 50 C) Approximately 80 D) Approximately 100
Total	25 items	

Data Analysis

The data obtained from the research were analyzed by means of qualitative analysis methods. The audio recordings obtained from the interviews were transcribed and these data were analysed descriptively. Descriptive analysis is the interpretation and summarization of research data according to the themes which had been determined previously (Yıldırım & Şimşek, 1999). Identifying codes were assigned to the mathematics teachers as MT1, MT2,… and to the primary school teachers as ET1, ET2,… for the confidentiality of the interviews.

The strategies which were used while solving the number sense problems were coded under four categories: answers without any explanation (no explanation), rule-based strategy (RBS), number sense-based strategy (NSBS), and partially number sense-based strategy (PNSBS). The meanings and content of these categories are given below.

Answers without any explanation (No explanation): It includes the answers which are not responded or not explained.

Rule-based strategy (RBS): It contains reaching the results holding to the process or adhering to the rules. For example; finding the result by equalizing the denominator in the addition operation of two fractions with different denominators.

Number sense-based strategy (NSBS): It contains understanding numbers, knowing the relative size of numbers, using a reference point, estimating the result and evaluating its appropriateness, and knowing the effects of numbers on operations (Şengül, 2013). For example; ability to decide that the fraction 4/7 is greater than the fraction 2/5 without using any algorithm.

Partially number sense-based strategy (PNSBS): In this strategy, rule-based and number sense-based strategies are used together. For example; feeling the need to convert the numbers to decimals and do this by using a paper and pencil algorithm if necessary when comparing numbers, using the points 1 and 0.5 as reference points while deciding that the number 8/15 is greater than the number 0.5, (Şengül, 2013).

Findings

The findings and interpretations obtained from the research data are presented in this section

Findings and Interpretations about the strategies which the teachers used while solving the questions in the Number Sense Test

This study aimed to determine the number sense strategies used by teachers. The data were obtained from 15 primary school teachers and 15 mathematics teachers via NST. The distribution of the strategies which were used by primary school teachers and mathematics teachers in the responses to the the questions in the NST is shown in Table 3 below.

Table. 3 The Distribution of Frequency and Percentages about the strategies used by the teachers in solving the questions in the Number Sense Test

	NSBS		PNSBS		RBS		NO EXPLANATION		TOTAL	
	f	%	f	%	f	%	f	%	f	%
Primary School Teacher	123	32,8	32	8,5	208	55,4	12	3,2	375	50
Mathematics Teacher	221	58,9	43	11,4	108	28,8	3	0,8	375	50
Total	344	45,8	75	10	316	42,1	15	%2	750	100

According to Table 3, it was seen that 32.8% of the answers obtained from primary school teachers and 58.9% of the answers obtained from mathematics teachers used number sense based strategies, 8.5% of the answers obtained from primary school teachers and 11.4% of the answers obtained from mathematics teachers used partially number sense based strategies, 55.4% of answers obtained from primary school teachers and 28.8% of answers obtained from mathematics teachers used rule-based sense strategies. As seen in Table 3, it was seen that most of the answers (58.9%) obtained from mathematics teachers used number sense-based strategies while solving the problems in NST, and the majority (55.4%) of the answers obtained from primary school teachers used rule-based strategies.

Findings and Interpretations related to the Strategies used by the teachers according to the Components of Number Sense in the Number Sense Test

Findings and Interpretations about the questions related to the component of understanding the Number Concept

Table 4 presents the distribution of percentages and frequencies of the strategies used by primary school teachers and mathematics teachers in their answers to the questions about the component of understanding the number concept.

Table. 4 The distribution of percentages and frequencies of the strategies used by teachers in their answers to the questions about the component of understanding the number concept

	NSBS		PNSBS		RBS		NO EXPLANATION		TOTAL	
	f	%	f	%	f	%	f	%	f	%
Primary School Teacher	14	15,5	4	4,4	66	73,3	6	6,6	90	100
Mathematics Teacher	41	45,5	6	6,6	43	47,7	0	0	90	100
Total									180	100

When Table 4 was considered, it was seen that 15.5% of the answers obtained from primary school teachers and 45.5% of the answers obtained from mathematics teachers used number sense based strategies in the items of NST containing the understanding the number concept. It was also seen that 4.4% of the answers obtained from primary school teachers and 6.6% of the answers obtained from mathematics teachers used partially number sense based strategies and 73.3% of the answers obtained from primary school teachers and 47.7% of the answers obtained from mathematics teachers used rule-based strategies. Furthermore, some examples from the interviews with teachers and their answers to the items in the component of understanding the number concept (Figure 1, Figure 2 and Figure 3) were presented.

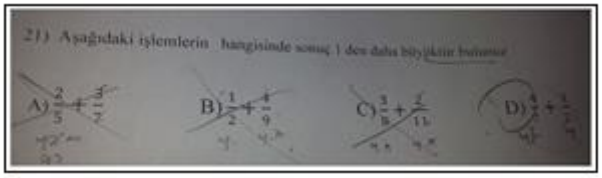


Figure 1. A Mathematics Teacher's solution by number sense based strategy

The explanation of the teacher who gave the answer for item 21 in Figure 1;

"*The fractions in choice A are both smaller than half so they are smaller than 1. In choice B, one of the numbers is half and the other one is smaller than half. In choice C, both numbers are smaller than half. In choice D, there is an addition of a number bigger than half and a half, so the result is bigger than 1 (MT4).".*

When the solution shown in Figure 1 and the views of the teacher were considered together, it can be said that MT4 used number sense based strategy while solving the problem.

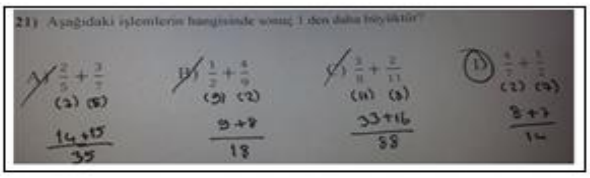


Figure 2. A Primary School Teacher's solution by rule-based strategy

The explanation of the teacher who gave the answer for item 21 in Figure 2;

"I equalized the denominators in all choices and I thought choice D is bigger than the others (ET8)".

When the solution shown in Figure 2 and the views of the teacher were considered together, it can be said that ET8 used number sense based strategy while solving the problem. ET8 solved the problem by depending on the rule which says it is needed to equalize the denominators while doing addition operation in rational numbers.

Figure 3 below shows the solution of the teacher for item 25.

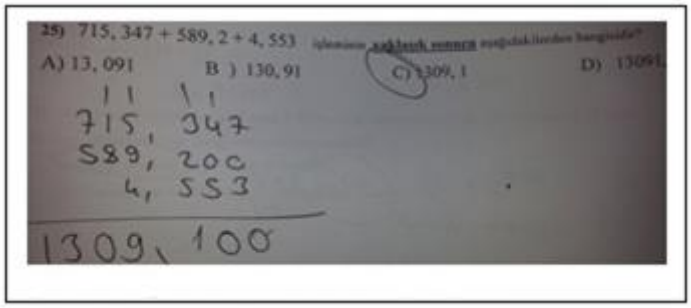


Figure 3. A primary school teacher's solution by rule based strategy

The explanation of the primary school teacher who gave the answer in Figure 3 for item 25

"*I added up all with the method we all know. I saw the result was in choice C (ET3)".*

When the solution shown in Figure 3 and the views of the teacher on this issue were considered together, ET3 depended on the rules which are used while doing addition with decimal numbers, preferred the rule writing them one under the other and adding up. Therefore, we can interpret that the teacher reached the solution by using rule based strategy.

Here are some number sense based examples given in the interviews;

" 715 +590+4 =1309 I added them up by rounding integer parts down or up (MT5)."

"*When we take 715,347 as 700, 589,2 as 600 and 4,553 as 5 and add them up, we get a number around 1300. That is to say, the integer part must have maximum 4 digits. That is in choice C (MT1)."*

"*When we add up first two numbers, we get around 1200. So, approximate answer is 1300 or something and that is in choice C (ET2)".*

Findings and Interpretations about the component of using Multiple Representations

The distribution of percentages and frequencies of the strategies used by primary school teachers and mathematics teachers in their answers to the questions about the component of using Multiple Representations were presented in Table 5.

Table. 5 The distribution of percentages and frequencies of the strategies used by teachers in their answers to the questions about the component of using multiple representations

	NSBT		PNSBT		RBT		NO EXPLANATION		TOTAL	
	F	%	f	%	f	%	f	%	f	%
Primary School Teacher	15	20	9	12	45	60	6	8	75	100
Mathematics Teacher	19	25,3	19	25,3	35	46,6	2	2,6	75	100
Total									150	100

According to Table 5, it was seen that 20% of the answers obtained from primary school teachers and 55.3% of the answers obtained from mathematics teachers used number sense based strategies in the items of NST containing the component of using multiple representations. It was also seen that 12% of the answers obtained from primary school teachers and 25.3% of the answers obtained from mathematics teachers used partially number sense based strategies and 60% of the answers obtained from primary school teachers and 46.6% of the answers obtained from mathematics teachers used rule-based strategies. In addition, some examples from the interviews with teachers and their answers to the items in the component of using multiple representations (Figure 4 and Figure 5) were presented.

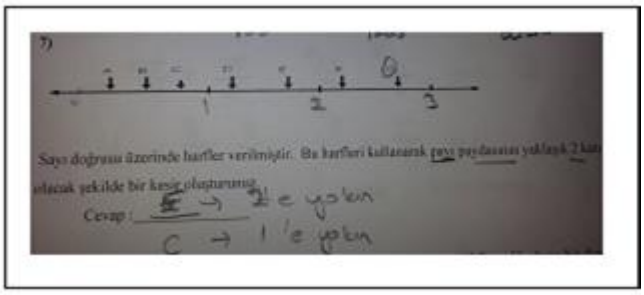


Figure 4. A Mathematics teacher's solution by number sense based strategy

The explanation of the mathematics teacher who gave the answer in Figure 4 for item 7

"I thought C was close to 1, E was close to 2 so E / C was closer (MT7)".

When the solution shown in Figure 4 and the views of the teacher were considered together, it can be said that this teacher (MT7) used number sense based strategy while solving the problem.

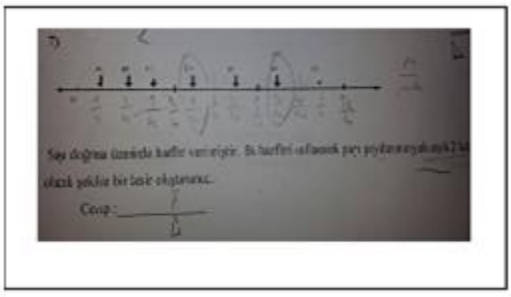


Figure 5. A primary school teacher's solution by rule based strategy

The explanation of the primary school teacher who gave the answer in Figure 5 for item 7

"I assigned some values to F and D and I divided them. I left the first fraction as it was. I turned the fraction 2 upside down and multiplied. I found a value around 2 (ET15)". When the solution shown in Figure 5 and the views of the teacher on this issue were considered together, it can be said that ET15 used rule based strategy while solving the problem.

Findings and Interpretations about the component of understanding the effect of the operation

Table 6 presents the distribution of percentages and frequencies of the strategies used by primary school teachers and mathematics teachers in their answers to the questions about the component of understanding the effect of the operation.

Table. 6 The distribution of percentages and frequencies of the strategies used by teachers in their answers to the questions about the component of understanding the effect of the operation

	NSBT		PNSBT		RBT		NO EXPLANATION		TOTAL	
	f	%	F	%	f	%	f	%	f	%
Primary School Teacher	25	33,3	10	13,3	40	53,3	*0*	*0*	*75*	*100*
Mathematics Teacher	*56*	*74,6*	*9*	*12*	*10*	*13,3*	*0*	*0*	*75*	*100*
Total									*150*	*100*

As seen in Table 6, 33.3% of the answers obtained from primary school teachers and 74.6% of the answers obtained from mathematics teachers used number sense-based strategies in the items of NST containing the component of understanding the effect of the operation. It was also seen that 13.3% of the answers obtained from primary school teachers and 12% of the answers obtained from mathematics teachers used partially number sense based strategies and 53.3% of the answers obtained from primary school teachers and 13% of the answers obtained from mathematics teachers used rule-based strategies. In addition, some examples from the interviews with teachers and their answers to the items in the component of understanding the effect of the operation (Figure 6) were presented.

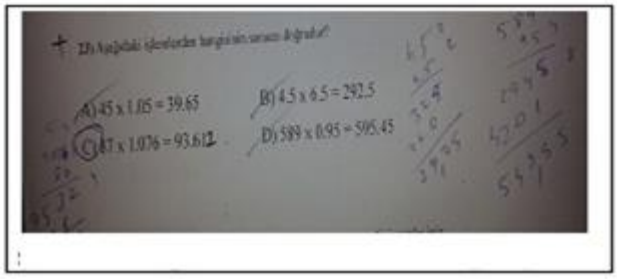


Figure 6. A Primary School Teacher's solution by rule-based strategy

The explanation of the primary school teacher who gave the answer in Figure 6 for item 23

"I made operations for all choices one by one and I concluded that choice C was right (ET4)". When the solution shown in Figure 6 and the views of the teacher on this issue were considered together, it can be said that ET4 used rule based strategy while solving the problem.

The explanation of the mathematics teacher for item 23

"I rounded the numbers. If I multiply by 1 in choice A, it makes 45 so it must be bigger with the number. In choice D, if the number 0.95 were 1, it wouldn't be correct as the number 589 was smaller. It must be smaller than 589. In choice B, the integer part must be about 24. It can't be a number like 292. (MT1).""When I multiply 45 by 1.05, I will get something bigger than 45. In choice B, if we think as 5 and 7, we get 35 so the number 292 is very big. Similarly, the result must be smaller than 589 in choice D (MT7)". When the views of MT1 and MT7 are considered, it can be interpreted they used number sense based strategies.

Findings and Interpretations about the component of using equivalent expressions

Table 7 presents the distribution of percentages and frequencies of the strategies used by primary school teachers and mathematics teachers in their answers to the questions about the component of using equivalent expressions.

Table. 7 The distribution of percentages and frequencies of the strategies used by teachers in their answers to the questions about the component of using equivalent expressions

	NSBT		PNSBT		RBT		NO EXPLANATION		TOTAL	
	f	%	f	%	f	%	f	%	f	%
Primary School Teacher	29	48,3	3	5	28	46,6	0	0	60	100
Mathematics Teacher	44	73,3	4	6,6	11	18,3	1	1,6	60	100
Total									150	100

When Table 7 was considered, it was seen that 48.3% of the answers obtained from primary school teachers and 73.3% of the answers obtained from mathematics teachers used number sense-based strategies in the items of NST containing the component of using equivalent expressions. It was also seen that 5% of the answers obtained from primary school teachers and 6.6% of the answers obtained from mathematics teachers used partially number sense-based strategies and 46.6% of the answers obtained from primary school teachers and 18.3% of the answers obtained from mathematics teachers used rule-based strategies. In addition, some examples from the interviews with teachers and their answers to the items in the component of using equivalent expressions (Figure 7 and Figure 8) were presented.

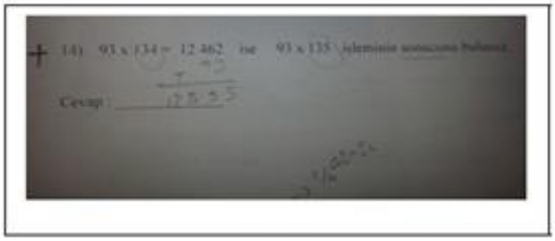


Figure 7. A Mathematics Teacher's solution by number sense based strategy

The explanation of the mathematics teacher who gave the answer in Figure 7 for item 14

"*While solving the problem, when I add a 93 to the number 12462, I can get the result of the operation 93x135 (MT1)"*.

When the solution shown in Figure 7 and the views of the teacher were considered together, it can be said that MT1 used number sense based strategy while solving the problem.

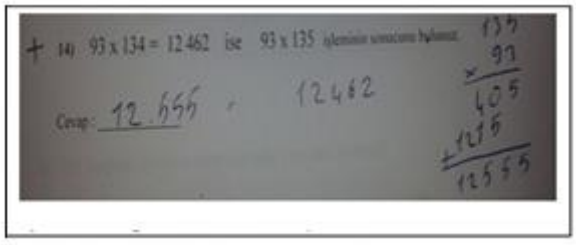


Figure 8. A Primary School Teacher's solution by rule-based strategy

The explanation of the primary school teacher who gave the answer in Figure 8 for item 14

"I wrote two number one under the other and I did multiplication that we know and I got 12555 (ET6)". When the solution shown in Figure 8 and the views of the teacher were considered together, it can be said that ET6 used rule based strategy while solving the problem.

Findings and Interpretations about the component of using calculation and counting strategies

Table 8 presents the distribution of percentages and frequencies of the strategies used by primary school teachers and mathematics teachers in their answers to the questions about the component of using calculation and counting strategies.

Table. 8 The distribution of percentages and frequencies of the strategies used by teachers in their answers to the questions about the component of using calculation and counting strategies

	NSBT		PNSBT		RBT		NO EXPLANATION		TOTAL	
	f	%	f	%	f	%	f	%	f	%
Primary School Teacher	40	53,3	6	8	29	38,6	0	0	75	100
Mathematics Teacher	61	81,3	5	6,6	9	12	0	0	75	100
Total									150	100

As seen in Table 8, 53.3% of the answers obtained from primary school teachers and 81.3% of the answers obtained from mathematics teachers used number sense-based strategies in the items of NST containing the component of using calculation and counting strategies. It was also seen that 8% of the answers obtained from primary school teachers and 6.6% of the answers obtained from mathematics teachers used partially number sense-based strategies and 38.6% of the answers obtained from primary school teachers and 12% of the answers obtained from mathematics teachers used rule-based strategies. In addition, some examples from the interviews with teachers and their answers to the items in the component of using calculation and counting strategies (Figure 9) were presented.

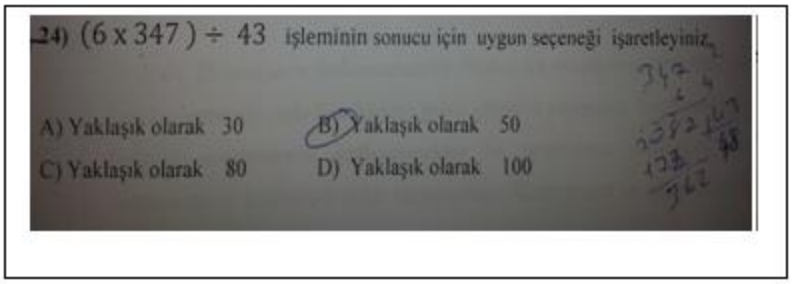


Figure 9. A Primary School Teacher's solution by rule-based strategy

The explanation of the primary school teacher who gave the answer in Figure 9 for item 24

"I multiplied the number in parenthesis first and I got 2082. When I divided this by 43, I got 48. Choice B is the closest to this result (ET4)". When the solution shown in Figure 9 and the views of the teacher were considered together, it can be said that ET64 used rule-based strategy while solving the problem. An example from the interviews on number sense based strategy;

"I rounded 347 up to 350. I took 43 as 40 and I did the operation mentally. I thought when we divide 2100 by 40, we get about 50 (MT11)".

Discussion, Conclusion and Recommendations

This study aims to determine the strategies used by teachers while solving the problems in the number sense test and the strategies they used while solving the problems in the number sense test according to the components of number sense and data were obtained from mathematics teachers and primary school teachers. All solutions obtained from primary school teachers and mathematics teachers (without considering the answers as true or false) were considered and it was seen that 32.8% of primary school teachers' solutions had number sense based strategy, 55.4% of them had rule-based strategy, and 58.9% of mathematics teachers' solutions had number sense-based strategy and 28.8% of them had rule-based strategy.

Tsao (2005) investigated the cognitive process used by pre-service primary school teachers in solving number sense problems and concluded that pre-service teachers with low number sense used rule-based solving methods rather than number sense-based methods. Yang (2007) carried out interviews with pre-service teachers to determine the strategies they used in problems involving the number sense. The results of the research showed that most of the pre-service teachers used written calculations instead of using their number sense in solving problems. Similarly, Yang, Reys, and Reys

(2007) dealt with the strategies used by pre-service primary school teachers in problem solving about real life situations. They concluded in their study that the pre-service teachers mostly preferred using rule-based strategies. Şengül (2013) found out in his research that pre-service primary school teachers had low number sense skills. It was also observed that rule-based strategies were preferred in all components of the number sense when the solution methods of pre-service teachers were reviewed. Moreover, Courtney-Clarke (2012) concluded in the study that pre-service teachers were insufficient to use number sense strategies.

The results of the literature review (Tsao, 2005; Yang, 2007; Şengül, 2013) revealed that primary school teachers preferred to use rule-based strategies more when solving number sense problems. This study provided similar results. In this study, the solutions obtained from 15 primary school teachers were investigated and it was seen that teachers used rule-based strategies in most of the solutions. Therefore, it can be said that the results of this study are parallel to the findings in the literature.

Şengül and Dede (2014) conducted a study which aimed to determine the strategies that are used by pre-service mathematics teachers while solving number sense problems and they concluded that they had moderate level of problem-solving using a number sense-based strategy.

In this study, it was revealed that the mathematics teachers preferred number sense-based strategies more than the primary school teachers do while solving problems. The fact that the mathematics teachers preferred number sense-based strategies more than the primary school teachers did may be due to the fact that they faced more mathematical situations in their educational background and they were engaged in problem solving activities more. When, however; the percentage (58.9%) of the mathematics teachers who preferred number sense based strategies was higher, it can be said that this percentage was not much high. It can be expressed here that the result obtained by Şengül and Dede (2014) and the result obtained by this research are similar to each other in this aspect.

Yang, Reys, and Reys (2007) explained that the primary school teachers used the number sense-based strategies less as their level of number sense was quite low. Altay and Umay (2011), on the other hand, concluded in their study in which they examined the relationship between number sense skills and counting skills of pre-service primary school teachers that they used calculations that take a long time to solve rather than effective practical methods, and that pre-service teachers used calculations that take a long time to solve rather than effective practical methods. They also revealed in their study that even if the calculation skills of the pre-service primary school teachers were high, their numerical skills were low. In our country, teachers have exams which require memorizing rules and solving a lot of tests during their educational lives and this may lead them to use rule-based strategy rather than number sense strategy.

When the strategies used by the teachers in this study were considered according to the components of number sense, it was concluded from the solutions obtained from primary school teachers (53.3%) and solutions obtained from mathematics teachers (81.3%) that they used the number sense-based strategy in the problems related to the component of *"using calculation and counting strategies"* more. In addition, it was observed that the component of *"understanding the number concept"* of was the lowest (15.5%) in the solutions of primary school teachers, the component of "using multiple representation" was the lowest (25.3%) in the solutions of mathematics in NSBT.

Şengül (2013) stated in his study that pre-service primary school teachers used the paper-pencil algorithm in the items related to the component of *"understanding the meaning and size of numbers"*. Yang (2007) and Tsao (2005) also obtained similar results regarding this component. In this context, it can be said that the results obtained from this study are parallel to the results obtained in Şengül (2013), Yang (2007) and Tsao (2005).

Consequently, it was seen in this study that the mathematics teachers' levels of using the number sense-based strategy was moderate, and the primary school teachers' levels of using the number sense-based strategy was low. It was also revealed that the components in which the number sense-based strategy was used the least were *"understanding the number concept"* and *"using multiple representations"*. It was also observed in some other studies conducted with primary school

students in the literature about number sense that students' number sense was low (Altay & Umay, 2011; Altay, 2010; Aunio, Lim, Hautamaki & Van Luit, 2004; Er & Artut, 2017; Er & Artut, 2018; Markovits and Pang, 2007; Markovits, and Sowder, 1994; Pike and Forrester, 1997;, Reys, Kim and Bay, 1999; Sengul and Gulbagci, 2012; Zaslavsky, 2001). Yang, Reys and Reys (2007) stated that students 'number senses were low because teachers were inadequate to help students and because teachers' number senses were low.

When the importance of number sense was considered in this context, teachers' number sense should be developed first in order for them to support the students' development of number sense. Therefore, studies on this issue can be carried out in classes at the level of undergraduate education. Moreover, in-service courses or seminars can be organized to support primary school teachers and mathematics teachers to use number sense. The effect of various teaching methods on the development of number sense can be investigated in further research and studies on number sense development can be conducted. In addition, studies investigating the relationship between number sense skill and prediction skill can be carried out.

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