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Examination of Number Sense Skills of Primary School 1st and 4th Grade Students*

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ABSTRACT

The aim of this study is to determine the number sense skills of primary school 1st and 4th grade students. For this purpose, survey design, which is one of the quantitative research methods, was used in the study. The research was carried out in a total of 9 primary schools in the city center of Tunceli in the 2020-2021 academic year. The study population of the research consists of a total of 305 students, 148 1st grade and 157 4th grade students studying in these schools. Data collection tools used in the study are "Primary School Number Sense Tests" developed by researchers. These tests have been developed for each grade level of primary school. In the analysis of the data, the items in the number sense test; The correct answer obtained by using number sense skills, the correct answer obtained by using rule and operation-based methods, the wrong answer obtained by using number sense skills, the wrong answer obtained by using rule-operation-based solutions, and the blank answer were coded. As a result of the analyzes made, it was determined that primary school students used rule- and operation-based solutions more in solving questions, and it was seen that they resorted to number-sense-based solutions less.

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1. Introduction

In the past, students' success in mathematics was primarily evaluated based on their ability to memorize the multiplication table and perform the four basic operations correctly. However, in the current era, there is a consensus that simply memorizing and practicing math facts may not adequately prepare students for modern life, as stated by Anghileri (2006). As a result, significant changes have been made in mathematics education as part of educational reforms. The goals, standards, and principles of mathematics education that will prepare students for real-life situations have been identified in various sources, with the concept of number sense taking a prominent role, as highlighted by the National Council of Teachers of Mathematics (NCTM) in 2000. The NCTM, which sets the principles and standards for mathematics education, emphasizes understanding numbers and mathematical operations, developing number sense, and facilitating arithmetic operations as the core of mathematics education.

The concept of number sense is not yet well understood in our country as it is a relatively new topic of study. There are various definitions of number sense in literature. However, a common definition that can be reached by combining these definitions is that number sense refers to the ability to understand and make sense of all the relationships related to numbers, such as quantity, magnitude, part-whole,

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and the relationship between numbers and measurement results, rather than just knowing numbers (Olkun and Toluk Uçar, 2018). An individual with number sense can use numbers flexibly to make numerical expressions more meaningful and understandable, transition between different representations of numbers, and establish relationships among numbers, operations, and symbols (Markovits and Sowder, 1994). The ability of students with number sense to manage situations related to mathematics more comfortably and flexibly highlights the importance of this concept in mathematics education, which has been revealed through research (NCTM, 2000). With the increasing importance of the concept of number sense in mathematics education, efforts are made to equip students with skills such as mental computation, analysis of mathematical patterns, estimation of the nearest result of a problem, and speaking about emerging relationships, rather than teaching them how mathematical operations are performed (Anghileri, 2006). Therefore, by helping students develop flexible thinking skills, they are encouraged to generate different solution methods without relying solely on mathematical rules and paper-pencil methods.

Rational counting is a cognitive activity that requires children to have knowledge of counting principles and number words before they can apply it. The development of rational counting skills is closely related to hand-eye coordination, language, and memory, which children need to use simultaneously. The foundations of number concepts start to form in the early years of children's experiences. However, before the cognitive development of the concept of number, children acquire experiences related to comparisons such as increase-decrease, part-whole, which do not involve quantitative perception and are considered as play (Griffin, 2004). Individuals are born with counting skills from birth, so children start using number words as they begin to speak (Nelson, 2007). Verbal counting in children usually begins around the age of 2 and develops over the years. By the time children reach the age of 2-3, they have the capacity to count numbers, but the counting sequence is generally not correct. For example, they may count in an incorrect sequence such as 1-4-6-5. In this context, children's counting order can vary each time. The alignment of counting with the correct number order depends on the child's age and the experiences they have gained. For example, a 3-year-old child may not have full competence in understanding the conceptual meaning of the number 3. In a study on this topic, it was concluded that counting behavior of children in the 3-4-year age group is more related to imitation rather than understanding the numerical equivalent, meaning it is recited from memory (Young-Loveridge, 2004).

The concept of numbers is important for children's understanding abilities. In this context, research has shown that the development of counting skills during childhood affects an individual's arithmetic skills in later stages of life. Counting skills form the foundation for the four basic mathematical operations of addition, subtraction, multiplication, and division. Therefore, the concept of counting is crucial for children's lives (Stock, Desoete, and Roeyers, 2009). The act of counting initially starts as a play dimension in children but progresses over time in terms of symbolizing numbers and associating them with objects (Baroody, 2004). Children's association of numbers with symbols indicates that they are gaining experience in counting (MEB, 2006). Children in the age group of 6 years can group and count objects with the same texture from 6 to 10, associating object groups with numbers, and sequencing numbers from 1 to 10. They are also able to use quantity indicating expressions such as "at least" and "most".

Gelman and Gallistel (1986) state that counting skills to develop in children, certain principles need to be followed. In this context, counting words should be spoken in an organized sequence for children to be able to count any set of objects. They named this skill the "one-to-one principle". However, children can also acquire counting skills through different methods outside of this principle. This phenomenon is associated with children's lack of conceptual understanding of counting (Olkun and Toluk Uçar, 2018). Children need to use a single counting word for each object in a set to count the elements in that set. Children's ability to count in this way indicates that they have acquired the "one-to-one principle". Additionally, children's knowledge that the last count in a set indicates the total number of elements in that set signifies that they have acquired the "cardinality principle" (Olkun, Çelik, Sönmez and Can, 2014).

The prerequisites for elementary school 1st grade students to learn natural numbers are expressed under the following items: (Baykul, 2016; Olkun and Toluk Uçar, 2018; Tertemiz, 2017):

Rhythmic Counting: At this stage, students count numbers by memorization. However, they do not know the objectual meanings of the numbers. Students begin to learn the semantic meaning of the number sequence based on their experiences.

One-to-One Correspondence: Students realize that each object should be associated with only one number when expressing number words. Students at this stage gain the ability to count quantities and find the desired amount in a quantity.

Meaningful Counting: Students at this stage perform counting of objects with number words together and develop their perception of quantities.

Conservation of Number: Students understand that the number indicating the quantity of an object group will not change if the object group does not undergo any operations.

More-Less: Students at this stage could compare numbers in terms of magnitude. Students at this stage can express how much bigger or smaller one number is compared to another number.

In addition to number words, the use of non-numerical comparative language such as "less, more, same" is also necessary. This helps children understand that quantities can be expressed without numbers. Through these concepts, children's language and counting skills develop (McDonald, 2007).

Literature frequently emphasizes the importance of number sense, and studies show that students' achievement in mathematics is significantly related to their number sense skills (Çekirdekçi, 2015; Harç, 2010; Mohamed and Johnny, 2010; Yang, Li and Lin, 2008). However, research indicates that students' levels of using number sense are low, and students tend to rely on rule-based strategies and written algorithms rather than using number sense-based strategies (Reys, Reys, McIntosh, Emanuelsson, Johansson and Yang, 1999; Yang, Li and Lin, 2008).

The concept of number sense is a relatively new topic of research in our country, and the number of studies conducted on this topic is limited. Moreover, a significant portion of the studies conducted both domestically and internationally focus on middle school students. These studies investigate the relationship between students' number sense levels and their performance (Cheung and Yang, 2018; Cheung and Yang, 2020; Lemonidis and Kaiafa, 2014; Li and Yang, 2010; Öztürk, Durmaz, and Can, 2019; Ulusoy, 2020; Yang, 2019; Yang and Li, 2016; Yang, Li, and Li, 2008; Yang and Lin, 2015; Yang and Sianturi, 2020), the relationship between number sense and mathematics achievement (Alsawaie, 2012; Bayram and Duatepe Paksu, 2014; Bütünler, 2018; Günkaya, 2018; Kyaw and Thein, 2018; Marga, Kusmayadi and Fitriana, 2020), the effects of number sense-based instruction on students' self-efficacy and performance in mathematics (Sevgi and Alpaslan, 2020; Yazar, Es and Güreffe, 2018), and the relationship between number sense components and gender and grade level (Akkaya, 2015; Günkaya, 2018; Singh, Rahman, Ramly and Hoon, 2019; Yapıcı, 2013; Yenilmez and Yıldız, 2018).

It is considered as a significant gap in the literature that there are limited studies conducted on the topic of number sense, particularly at the elementary school level, both domestically and internationally (Can, 2019; Çekirdekçi, 2015; Korb, 2009; Ruter, 2015; Sarı and Olkun, 2021; Yang and Li, 2008; Zanzali and Ghazali, 2002). Based on this point, it has been concluded that there is a need for a research study to determine the number sense skills of elementary school students, considering the increasing importance of number sense in mathematics education, and a study has been planned accordingly.

1.1. Purpose of Research

The aim of this study is to investigate the number sense skills of 1st and 4th grade elementary school students.

1.2.1. Problem of the Study

The research problem is formulated as "What are the number sense skills of elementary school students?"

1.2.1.1. Sub-problems of the study

The sub-problems of the research are as follows:

- 1) What are the number sense skills of 1st grade students?
- 2) What are the number sense skills of 4th grade students?

2. Method

2.1. Research Model

This study aimed to determine the number sense skills of 1st and 4th grade elementary school students using a survey design, which is a quantitative research method. The survey design allows data collection from a large group of participants and helps reveal the characteristics of the study group in terms of their knowledge, skills, opinions, and other attributes (Fraenkel and Wallen, 2006). In other words, a survey design involves collecting data from a large group of participants to uncover the characteristics of the study group (Büyüköztürk, Kılıç Çakmak, Akgün, Karadeniz and Demirel, 2014).

2.2. Study Group

This research was conducted in a total of 9 primary schools, including all primary schools in the central district of Tunceli province. Initially, all students were planned to be included in the study; however, due to the Covid-19 pandemic during the data collection period, there were some losses in terms of students attending school, and efforts were made to reach all the remaining students. The research was carried out during the 2020-2021 academic year, and a total of 305 primary school students (148 students from 1st grade and 157 students from 4th grade) were included in the study. The reason first and fourth-grade students were selected for this study was to determine how effective grade level is in developing number sense skills.

2.3. Data Collection Tool and Data Analysis

In this study, "Elementary Number Sense Tests" developed specifically for each grade level of elementary school were used. During the development of the number sense tests, the stages of test development were considered, and the number sense components introduced to the literature by McIntosh, Reys and Reys (1992) and Reys, Reys, McIntosh, Emanuelsson, Johansson and Yang (1999) were used in the preparation of the questions. As a result of the analyses conducted, the mean item difficulty index of the 1st grade number sense test was determined to be 0.70, and the mean item discrimination index was found to be 0.49. The KR-20 reliability coefficient of the test was found to be 0.878. Similarly, the mean item difficulty index of the 4th grade number sense test was found to be 0.66, and the mean item discrimination index was determined to be 0.45. The KR-20 reliability coefficient of the test was found to be 0.817. Based on these results, it can be stated that number sense tests with high reliability and discrimination power were developed.

When analyzing the answers given by students to the number sense tests, first, the correctness of the answers was checked, and then the explanations provided by students in the explanation sections below the questions were examined. Based on the answers and explanations provided by students, their solution strategies were determined, and coding was done accordingly. The coding table provided below was used for this purpose.

Table 1. Coding Table for Number Sense Test

Answer Type	Strategy Type	Coding No.
Correct	Solution with Number Sense	4
	Rule-Based Solution	3
Incorrect	Solution with Number Sense	2
	Rule-Based Solution	1
Blank		0

According to Table 1, the correct answer obtained using number sense skills in solving the items in the number sense tests is coded as 4, while the correct answer obtained using rule-based and computation-based methods is coded as 3. If number sense skills are used but the wrong result is obtained, it is coded as 2, and if rule-based or computation-based solutions lead to incorrect answers, it is coded as 1. If the item is left blank by the student, it is coded as 0.

3. Results

The findings regarding the question "What are the number sense skills of elementary school students?" were presented in a tabular format, showing the numbers and percentages of students who used number sense-based and rule-based solution methods. Additionally, the findings were presented based on the components addressed in the study, including Knowledge and Skills about Numbers, Knowledge and Skills about Operations - Understanding the Meaning and Effects of Operations, Understanding the Meaning and Magnitude of Numbers, Using Knowledge and Skills about Numbers in Calculation Situations, Flexible Calculation and Counting Strategies, Measurement References, and Using Equivalent Representations of Numbers.

3.1. First-Grade Students' Number Sense Skills

The findings related to the first sub-problem of the study, which is "What are the number sense skills of first-grade students?" were presented by tabulating the answers given by first-grade students to the items in the number sense test, based on the number sense components. The numbers and percentages of students who used sense-based and rule-based solution methods were presented in the table.

3.1.1. First-Grade Students' Skills in the Component of "Knowledge and Skills about Numbers"

The skills of first grade students in "Knowledge and Skills about Numbers" component of the number sense test are presented in Table 2.

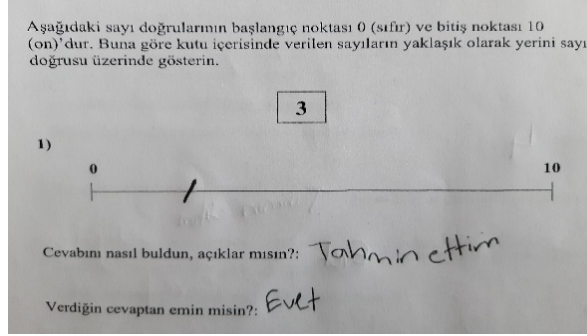
Table 2: Skills of First-Grade Students in the "Knowledge and Skills about Numbers" Component

Strategy Types	Questions							
	Q1		Q2		Q3		Q4	
	n	%	n	%	n	%	n	%
Number Sense Based Solution - Correct Answer	42	28.4	41	27.7	38	25.7	42	28.4
Number Sense Based Solution – Incorrect Answer	0	0.0	0	0.0	0	0.0	0	0.0
Rule-Based Solution- Correct Answer	52	35.1	53	35.8	51	34.5	61	41.2
Rule-Based Solution- Incorrect Answer	51	34.5	42	28.4	44	29.7	27	18.2
Blank	3	2.0	12	8.1	15	10.1	18	12.2
Total	148	100	148	100	148	100	148	100

According to the data presented in Table 2, the skills of first-grade students in the "Knowledge and Skills about Numbers" component are as follows:

According to the data, 42 students (28%) answered the first question correctly using sense-based solutions, while 52 students (35.1%) used rule-based solutions. 51 students (34.5%) who answered incorrectly used rule-based solutions, and 3 students (2.0%) left the question blank. For the second question, 41 students (27.7%) answered correctly using number sense-based solutions, while 53 students (35.8%) used rule-based solutions. 42 students (28.4%) who answered incorrectly used rule-based solutions and provided the wrong answer, while 12 students (8.1%) left the question blank. For the third question, 38 students (25.7%) answered correctly using number sense-based solutions, while 51 students (34.5%) used rule-based solutions. 44 students (29.7%) who answered incorrectly used rule-based solutions and provided the wrong answer, while 15 students (10.1%) left the question blank. For the fourth question, 42 students (28.4%) answered correctly using number sense-based solutions, while 61 students (41.2%) used rule-based solutions. 27 students (18.2%) who answered incorrectly used rule-based solutions and provided the wrong answer, while 18 students (12.2%) left the question blank. Based on these findings, it was determined that first-grade students used more rule-based and procedural strategies in solving the questions in this component of number sense. Below are two different student responses as examples for the first and third questions in this component.

Number Sense Based Correct Solution Example



Rule Based Correct Solution Example

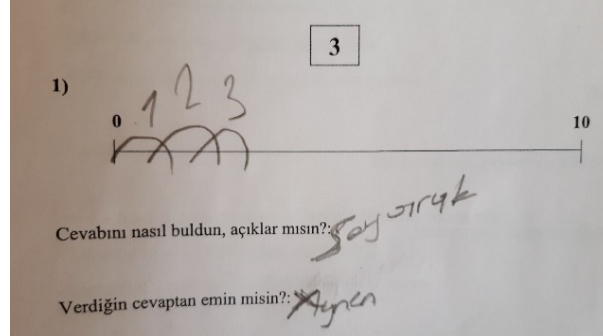
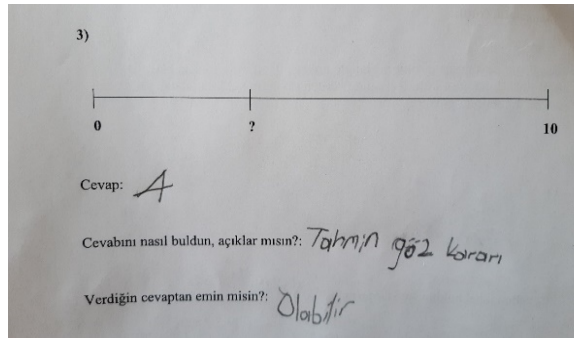


Figure 1. Sample Student Answers - First Grade Number Sense Test Question-1

Number Sense Correct Based Solution Example



Rule Based Correct Solution Example

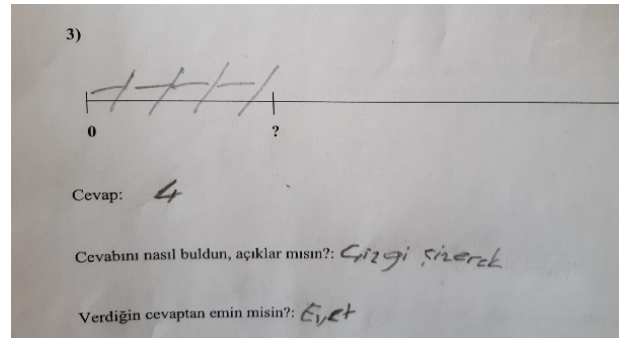


Figure 2. Sample Student Answers - First Grade Number Sense Test Question-3

3.1.2. First-Grade Students' Skills in the Component of "Understanding the Meaning and Effects of Operations - Knowledge and Skills about Operations"

The skills of first grade students in "Understanding the Meaning and Effects of Operations - Knowledge and Skills about Operations" component of the number sense test are presented in Table 3.

Table 3. Skills of First Grade Students in "Understanding the Meaning and Effects of Operations - Knowledge and Skills about Operations" Component

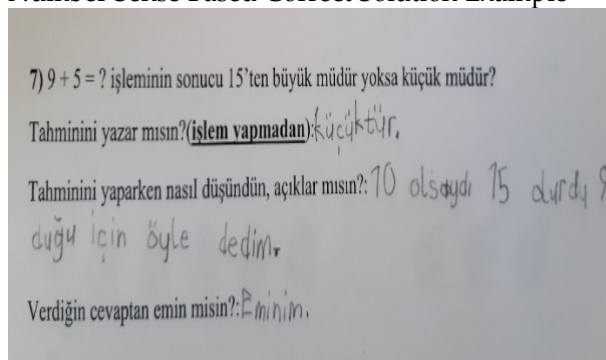
Strategy Types	Questions							
	Q5		Q6		Q7		Q8	
	n	%	n	%	n	%	n	%
Number Sense Based Solution - Correct Answer	18	12.2	13	8.8	12	8.1	8	5.4
Number Sense Based Solution - Incorrect Answer	0	0.0	0	0.0	0	0.0	0	0.0
Rule-Based Solution- Correct Answer	109	73.6	112	75.7	107	72.3	116	78.4
Rule-Based Solution- Incorrect Answer	13	8.8	14	9.5	20	13.5	13	8.8
Blank	8	5.4	9	6.1	9	6.1	11	7.4
Total	148	100	148	100	148	100	148	100

According to the data in Table 3, the skills of first-grade students in the "Understanding the Meaning and Effects of Operations - Knowledge and Skills about Operations" component of number sense are as follows:

According to the data obtained, it has been determined that first-grade students use more rule-based and procedural solution methods in solving questions related to the numerical sense component. Two different student responses to the 7th question in this component are provided below as examples. 12 students (8.1%) who answered the question correctly used numerical sense-based reasoning. 107 students (72.3%) who answered the question correctly used rule-based reasoning. 20 students (13.5%) who answered the question incorrectly used rule-based reasoning and gave the wrong answer. 9 students (6.1%) who answered the question incorrectly left the answer blank. 8 students (5.4%) who answered the question correctly used numerical sense-based reasoning. 116 students (78.4%) who

answered the question correctly used rule-based reasoning. 13 students (8.8%) who answered the question incorrectly used rule-based reasoning and gave the wrong answer. 11 students (7.4%) who answered the question incorrectly left the answer blank.

Number Sense Based Correct Solution Example



Rule Based Correct Solution Example

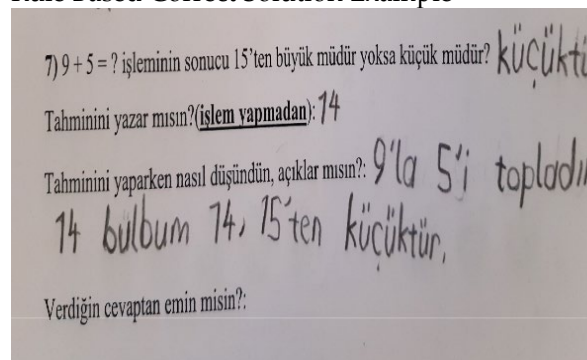


Figure 3. Sample Student Answers - First Grade Number Sense Test Question-7

3.1.3. First-Grade Students' Skills in the Component of "Understanding the Meaning and Magnitude of Numbers"

The skills of primary school 1st grade students in the "Understanding the Meaning and Magnitude of Numbers" component of the number sense test are presented in Table 4.

Table 4. Skills of First Grade Students in "Understanding the Meaning and Magnitude of Numbers" Component

	Questions					
	Q9		Q10		Q11	
Strategy Types	n	%	n	%	n	%
Number Sense Based Solution - Correct Answer	0	0.0	0	0.0	0	0.0
Number Sense Based Solution- Incorrect Answer	0	0.0	0	0.0	0	0.0
Rule-Based Solution- Correct Answer	135	91.2	136	91.8	137	92.5
Rule-Based Solution- Incorrect Answer	3	2.0	2	1.4	0	0.0
Blank	10	6.8	10	6.8	11	7.4
Total	148	100	148	100	148	100

According to the data presented in Table 4, the skills of first grade students in the "Understanding the Meaning and Magnitude of Numbers" component are as follows:

According to the data obtained, it has been determined that first grade students use more rule-based and procedural solution strategies in solving the questions in this component of number sense. 135 students (91.2%) who answered the ninth question correctly used rule-based solutions, while 3 students (2.0%) who answered incorrectly used rule-based solutions and provided incorrect answers. 10 students (6.8%) left the question blank. 136 students (91.8%) who answered the tenth question correctly used rule-based solutions, while 2 students (1.4%) who answered incorrectly used rule-based solutions and provided incorrect answers. 10 students (6.8%) left the question blank. 137 students (92.5%) who answered the eleventh question correctly used rule-based solutions, while 11 students (7.4%) left the question blank. No students were identified as providing incorrect answers to this question.

3.1.4. First-Grade Students' Skills in the Component of "Understanding Information and Skills about Numbers and Using them in Calculation Situations"

The skills of first grade students in "Understanding Information and Skills about Numbers and Using them in Calculation Situations" component, as related to the test items in the number sense test, are presented in Table 5.

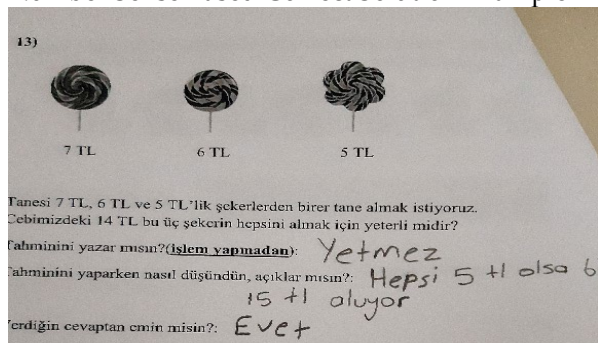
Table 5. Skills of First Grade Students in "Understanding Information and Skills about Numbers and Using them in Calculation Situations" Component

Strategy Types	Questions					
	Q12		Q13		Q14	
	n	%	n	%	n	%
Number Sense Based Solution- Correct Answer	9	6.1	4	2.7	6	4.1
Number Sense Based Solution- Incorrect Answer	0	0.0	0	0.0	0	0.0
Rule-Based Solution- Correct Answer	112	75.7	101	68.2	118	79.7
Rule-Based Solution- Incorrect Answer	7	4.7	27	18.2	13	8.8
Blank	20	13.5	16	10.8	11	7.4
Total	148	100	148	100	148	100

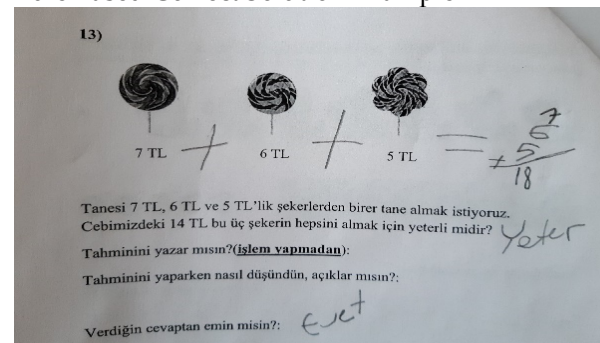
According to the data presented in Table 5, the skills of first grade students in the "Understanding Information and Skills about Numbers and Using them in Calculation Situations" component are as follows:

According to the data obtained, it has been observed that first grade students use more rule-based and procedural solution methods in solving the questions in this component of number sense. Below are two sample student responses for the 13th question in this component. For the students who answered the 12th question correctly, 9 of them (6.1%) provided a number sense-based answer, while 112 of them (75.7%) provided a rule-based answer. 7 students (4.7%) who answered incorrectly used a rule-based approach and provided a wrong answer, while 20 students (13.5%) left the answer blank. For the students who answered the 13th question correctly, 4 of them (3.4%) provided a sense-based number answer, while 101 of them (68.2%) provided a rule-based answer. 27 students (18.2%) who answered incorrectly used a rule-based approach and provided a wrong answer, while 16 students (10.8%) left the answer blank. For the students who answered the 14th question correctly, 6 of them (4.1%) provided a sense-based answer, while 118 of them (79.7%) provided a rule-based answer. 13 students (8.8%) who answered incorrectly used a rule-based approach and provided a wrong answer, while 11 students (7.4%) left the answer blank.

Number Sense Based Correct Solution Example



Rule Based Correct Solution Example

**Figure 4.** Sample Student Answers - First Grade Number Sense Test Question-13

3.1.5. First-Grade Students' Skills in the Component of "Flexible Calculation and Counting Strategies"

Skills of first grade students in "Flexible Calculation and Counting Strategies" components are presented in Table 6 in the number sense test.

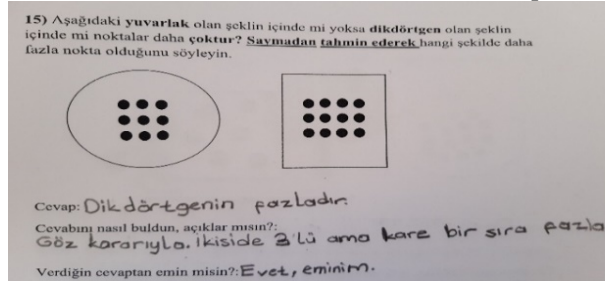
According to the data presented in Table 6, the skills of first grade students in the "Flexible Calculation and Counting Strategies" component are as follows: According to the data obtained, it has been observed that first grade students use more rule-based and procedural solution methods in solving the questions in this number sense component. Below are two different student responses as examples for the 15th question in this component. 36 of the students who answered the 15th question correctly used number sense-based responses (%24.3), while 103 of them used rule-based responses (%69.6). Among the students who answered the 16th question correctly, 40 of them used number sense-based responses (%27.0), while 97 of them used rule-based responses (%65.5). Among the students who answered the

17th question correctly, 40 of them used number sense-based responses (%27.0), while 96 of them used rule-based responses (%64.9). In addition, 3 students who answered incorrectly used rule-based solutions and gave wrong answers (%2.0), while 6 students left the question blank (%4.1) in the 15th question. Similarly, 1 student used a rule-based solution and gave a wrong answer (%0.7), while 10 students left the question blank (%6.8) in the 16th question. In the 17th question, 3 students used a rule-based solution and gave a wrong answer (%2.0), while 9 students left the question blank (%6.1).

Table 6. Skills of First Grade Students in "Flexible Calculation and Counting Strategies" Component

Strategy Types	Questions					
	Q15		Q16		Q17	
	n	%	n	%	n	%
Number Sense Based Solution - Correct Answer	36	24.3	40	27.0	40	27.0
Number Sense Based Solution- Incorrect Answer	0	0.0	0	0.0	0	0.0
Rule-Based Solution- Correct Answer	103	69.6	97	65.5	96	64.9
Rule-Based Solution- Incorrect Answer	3	2.0	1	0.7	3	2.0
Blank	6	4.1	10	6.8	9	6.1
Total	148	100	148	100	148	100

Number Sense Based Correct Solution Example



Rule Based Correct Solution Example

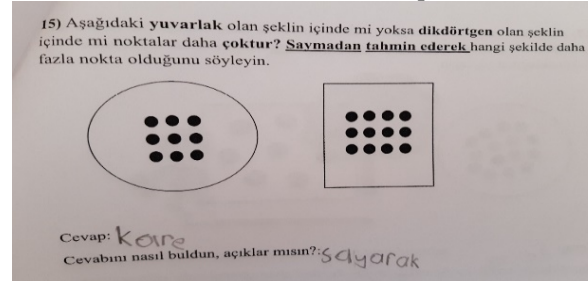


Figure 5. Sample Student Answers - First Grade Number Sense Test Question-15

3.1.6. First-Grade Students' Skills in the Component of "Measurement References"

The skills of first grade students in the "Measurement References" component of the number sense test are presented in Table 7.

Table 7. Skills of First Grade Students in "Measurement References" Component

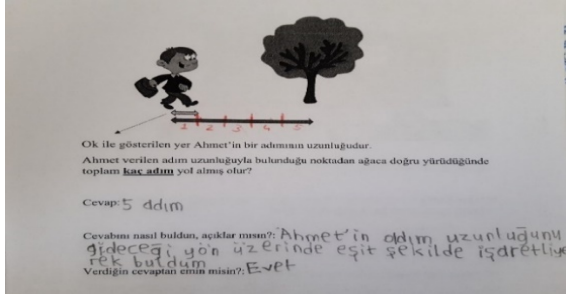
Strategy Types	Questions					
	Q18		Q19		Q20	
	n	%	n	%	n	%
Number Sense Based Solution - Correct Answer	36	24.3	45	30.4	39	26.4
Number Sense Based Solution- Incorrect Answer	16	10.8	5	3.4	10	6.8
Rule-Based Solution- Correct Answer	49	33.1	48	32.4	55	37.2
Rule-Based Solution- Incorrect Answer	32	21.6	39	26.4	30	20.3
Blank	15	10.1	11	7.4	14	9.5
Total	148	100	148	100	148	100

According to the data presented in Table 7, the skills of first grade students in the "Measurement References" component, are as follows:

The students who answered the 18th question correctly, 36 of them (24.3%) used number sense-based approach, while 49 of them (33.1%) used rule-based approach. Among the students who answered incorrectly, 32 of them (21.6%) used rule-based approach but gave wrong answers, while 16 of them (10.8%) gave wrong answers using number sense-based approach. 15 students (10.1%) left the question blank. The students who answered the 19th question correctly, 45 of them (30.4%) used number sense-based approach, while 48 of them (32.4%) used rule-based approach. Among the students who answered incorrectly, 39 of them (26.4%) used rule-based approach but gave wrong answers, while 5 of them (3.4%) gave wrong answers using number sense-based approach. 11 students (7.4%) left the

question blank. The students who answered the 20th question correctly, 39 of them (26.4%) used number sense-based approach, while 55 of them (37.2%) used rule-based approach. Among the students who answered incorrectly, 30 of them (20.3%) used rule-based approach but gave wrong answers, while 10 of them (6.8%) gave wrong answers using number sense-based approach. 14 students (9.5%) left the question blank. Based on these findings, it was determined that first grade students use more rule-based and procedural approaches in solving the questions in this number sense component. Below, two different student responses for questions 18, 19, and 20 in this component are given as examples.

Rule Based Incorrect Solution Example



Number Sense Based Incorrect Solution Example

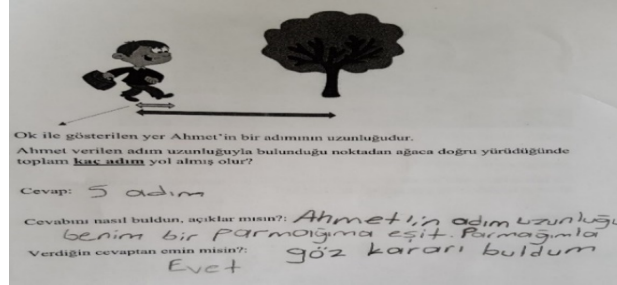
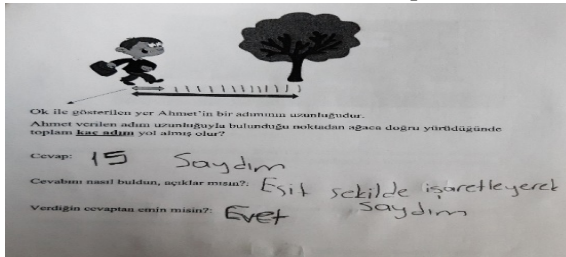


Figure 6. Sample Student Answers - First Grade Number Sense Test Question-18

Rule Based Correct Solution Example



Number Sense Based Correct Solution Example

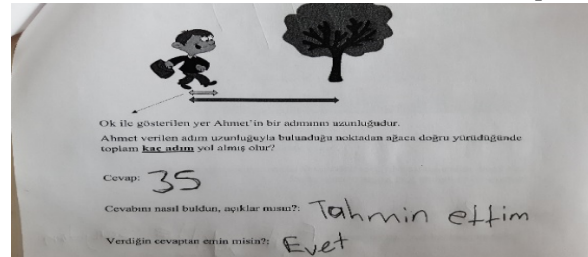
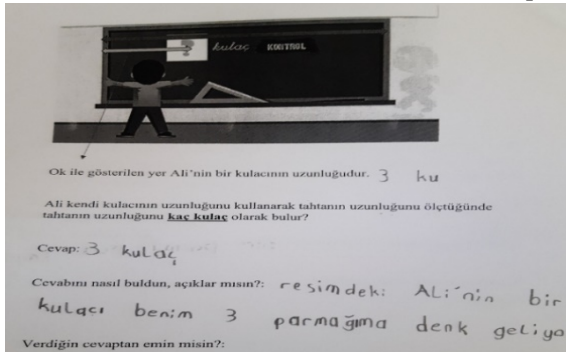


Figure 7. Sample Student Answers - First Grade Number Sense Test Question-18

Number Sense Based Correct Solution Example



Rule Based Correct Solution Example

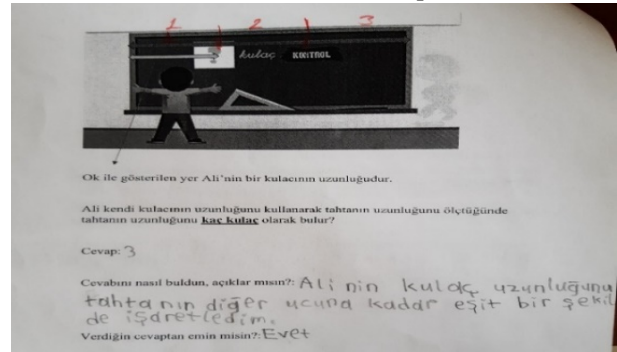
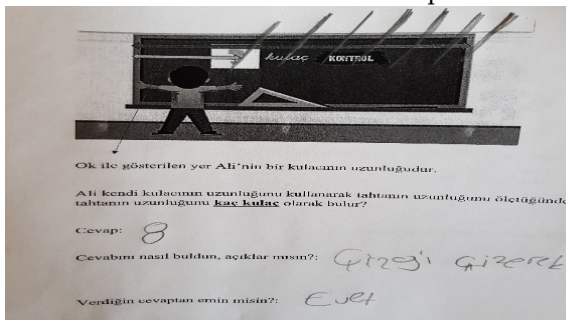


Figure 8. Sample Student Answers - First Grade Number Sense Test Question-19

Rule Based Incorrect Solution Example



Number Sense Based Incorrect Solution Example

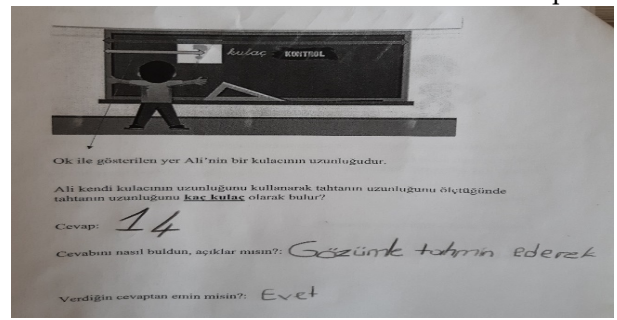
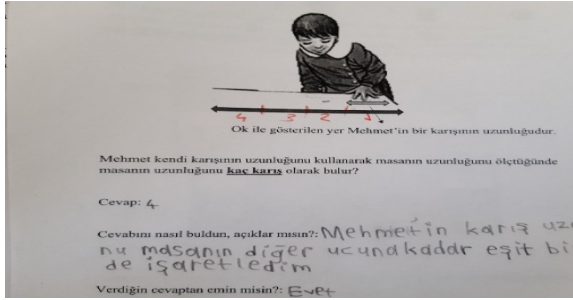


Figure 9. Sample Student Answers - First Grade Number Sense Test Question-19

Rule Based Correct Solution Example



Number Sense Based Correct Solution Example

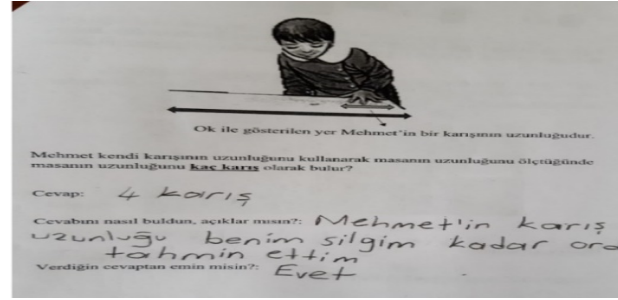
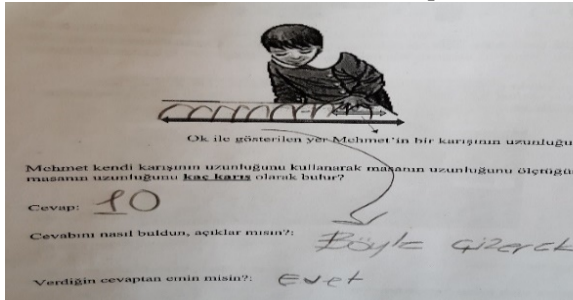


Figure 10. Sample Student Answers - First Grade Number Sense Test Question-20

Rule Based Incorrect Solution Example



Number Sense Based Incorrect Solution Example

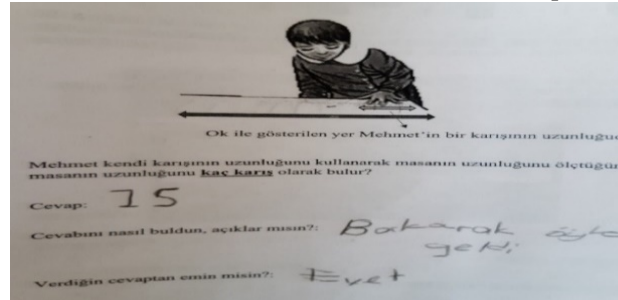


Figure 11. Sample Student Answers - First Grade Number Sense Test Question-20

3.1.7. First Grade Students' Skills in the Component of "Using Equivalent Representations of Numbers"

The skills of first grade students in the "Using Equivalent Representations of Numbers" component in the number sense test are presented in Table 8.

Table 8. Skills of First Grade Students in "Using Equivalent Representations of Numbers" Component

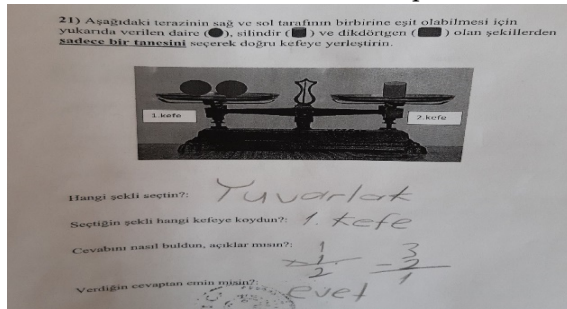
Strategy Types	Questions					
	Q21		Q22		Q23	
	n	%	n	%	n	%
Number Sense Based Solution - Correct Answer	14	9.5	12	8.1	13	8.8
Number Sense Based Solution- Incorrect Answer	0	0.0	0	0.0	0	0.0
Rule-Based Solution- Correct Answer	66	44.6	58	39.2	59	39.8
Rule-Based Solution- Incorrect Answer	32	21.6	40	27.0	38	25.7
Blank	36	24.3	38	25.7	38	25.7
Total	148	100.0	148	100.0	148	100

According to the data presented in Table 8, the skills of first grade students in the "Using Equivalent Representations of Numbers" components are as follows:

According to the data obtained, it has been determined that first grade students use more rule-based and procedural solution methods in solving the questions in the "Using Equivalent Representations of Numbers" component. Below, two different student responses for the 21st question in this component are provided as examples. 14 of the students who answered the 21st question correctly (9.5%) provided a response based on number sense, while 66 of them (44.6%) provided a response based on rules. 32 students (21.6%) who answered the question incorrectly used a rule-based approach and provided incorrect answers, while 36 students (24.3%) left the question blank. 12 of the students who answered the 22nd question correctly (8.1%) provided a response based on number sense, while 58 of them (39.2%) provided a response based on rules. 40 students (27.0%) who answered the question incorrectly used a rule-based approach and provided incorrect answers, while 38 students (25.7%) left the question blank. 13 of the students who answered the 23rd question correctly (8.8%) provided a response based on number sense, while 59 of them (39.8%) provided a response based on rules. 38 students (25.7%) who

answered the question incorrectly used a rule-based approach and provided incorrect answers, while 38 students (25.7%) left the question blank

Rule Based Correct Solution Example



Number Sense Based Correct Solution Example

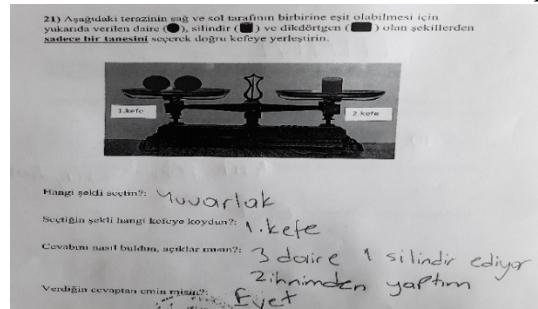


Figure 12. Sample Student Answers - First Grade Number Sense Test Question-21

According to these results, it has been determined that first-grade students use rule-based and procedural strategies much more frequently in solving the questions, while they rely less on number sense-based strategies. Rule-based solution was used the most in the entire set of 7 number sense components. The component where number sense strategies were most frequently used was the "Measurement References" component with a rate of 34.1%, while the component where rule-based solution was most frequently used was the "Understanding the Meaning and Magnitude of Numbers" component with a rate of 92.9%. The component with the highest rate of blank answers was the "Using Equivalent Representations of Numbers" component with a rate of 25.2%. When examined on a question-by-question basis, the question where students used number sense-based strategies the most was question 18 with a rate of 35.1% (correct answer 24.3%, incorrect answer 10.8%), while the questions where it was used the least were questions 9, 10, and 11 with a rate of 0.0%. The question where number sense-based solution was most frequently used to arrive at the correct answer was question 19 with a rate of 30.4%. The questions where rule-based solution was used the most were question 9 and question 10, both with a rate of 93.2% (correct answer 91.2%, incorrect answer 2.0%), and question 10 with a rate of 93.2% (correct answer 91.8%, incorrect answer 1.4%). The questions with the highest rate of blank answers were question 22 and question 23 with a rate of 25.7%.

3.2. Number Sense Skills of Fourth Grade Students

The findings obtained regarding the research question "What are the number sense skills of fourth grade students?" as the second sub-problem of the study, based on the components of number sense in the number sense test (Knowledge and Skills about Numbers, Knowledge and Skills about Operations, Understanding the Meaning and Magnitude of Numbers, Using Knowledge and Skills about Numbers in Calculation Situations, Flexible Calculation and Counting Strategies, Using Measurement References and Equivalent Representations of Numbers), were presented in tables by categorizing the answers given by fourth grade students to the test items according to their use of number sense-based solution and rule-based solution methods, along with the numbers and percentages of students using each method.

3.2.1. Fourth-Grade Students' Skills in the Component of 'Knowledge and Skills about Numbers'"

The skills of fourth grade students in the component of 'Knowledge and Skills about Numbers' in the number sense test are presented in Table 9."

Table 9. Skills of Fourth Grade Students in the Component of 'Knowledge and Skills about Numbers'"

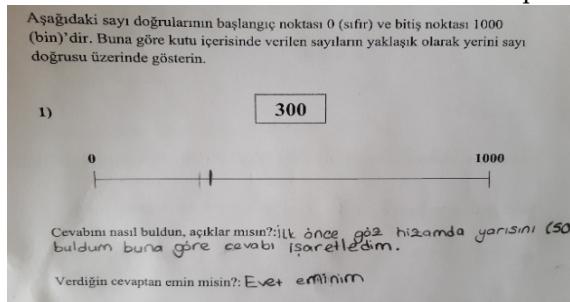
Strategy Types	Questions							
	Q 1		Q 2		Q 3		Q 4	
	n	%	n	%	n	%	n	%
Number Sense Based Solution- Correct Answer	87	55.4	93	59.2	101	64.3	101	64.3
Number Sense Based Solution- Incorrect Answer	24	15.3	28	17.8	20	12.7	22	14.0
Rule-Based Solution - Correct Answer	28	17.8	22	14.0	24	15.3	20	12.7

Rule-Based Solution - Incorrect Answer	18	11.5	14	8.9	12	7.6	14	8.9
Blank	0	0.0	0	0.0	0	0.0	0	0.0
Total	157	100	157	100	157	100	157	100

According to the data presented in Table 9, the skills of fourth grade students in the component of 'Knowledge and Skills about Numbers' are as follows:

Translation: "According to the data obtained, it has been observed that fourth grade students use a higher number of intuitive-based solution strategies in solving the questions included in the component of 'Knowledge and Skills about Numbers'. Out of the students who answered the first question correctly, 87 of them (55.4%) used an intuitive-based approach, while 28 of them (17.8%) used a rule-based approach. Among the students who answered the question incorrectly, 18 of them (11.5%) used a rule-based approach but gave the wrong answer, while 24 of them (15.3%) gave a wrong answer using an intuitive-based approach. No blank answers were detected in this question. For the second question, out of the students who answered correctly, 93 of them (59.2%) used an intuitive-based approach, while 22 of them (14.0%) used a rule-based approach. Among the students who answered the question incorrectly, 14 of them (8.9%) used a rule-based approach but gave the wrong answer, while 28 of them (17.8%) gave a wrong answer using an intuitive-based approach. No blank answers were detected in this question. For the third question, out of the students who answered correctly, 101 of them (64.3%) used an intuitive-based approach, while 24 of them (15.3%) used a rule-based approach. Among the students who answered the question incorrectly, 12 of them (7.6%) used a rule-based approach but gave the wrong answer, while 20 of them (12.7%) gave a wrong answer using an intuitive-based approach. No blank answers were detected in this question. For the fourth question, out of the students who answered correctly, 101 of them (64.3%) used an intuitive-based approach, while 20 of them (12.7%) used a rule-based approach. Among the students who answered the question incorrectly, 14 of them (8.9%) used a rule-based approach but gave the wrong answer, while 22 of them (14.0%) gave a wrong answer using an intuitive-based approach. No blank answers were detected in this question. Based on these findings, it has been determined that fourth grade students tend to use more intuitive-based solution strategies in solving the questions included in this component. Two different examples of student answers for the first and second questions in this component are given below as samples."

Number Sense Based Correct Solution Example



Rule Based Correct Solution Example

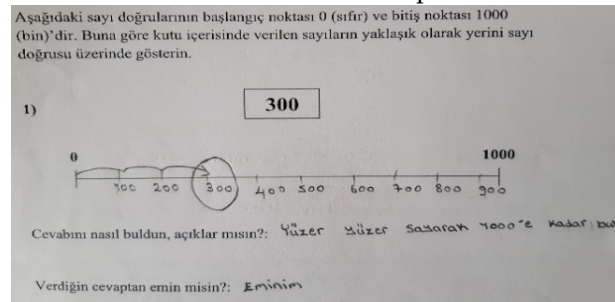
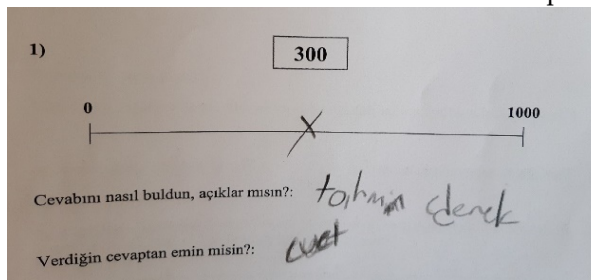


Figure 13. Sample Student Answers - Fourth Grade Number Sense Test Question-1

Number Sense Based Incorrect Solution Example



Rule Based Incorrect Solution

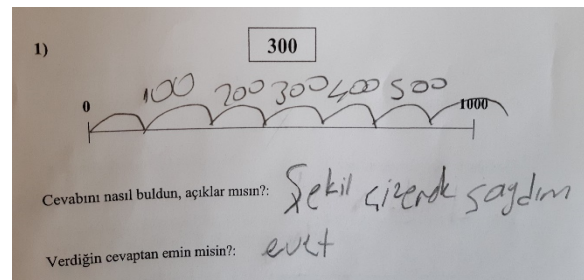
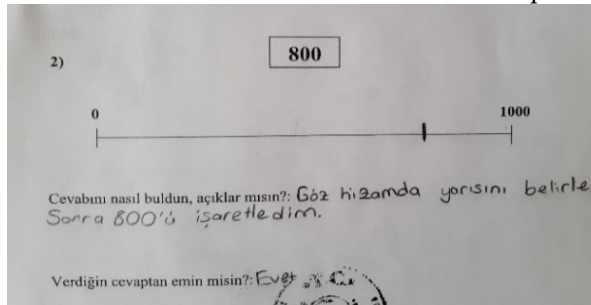


Figure 14. Sample Student Answers - Fourth Grade Number Sense Test Question-1

Number Sense Based Correct Solution Example



Rule Based Correct Solution Example

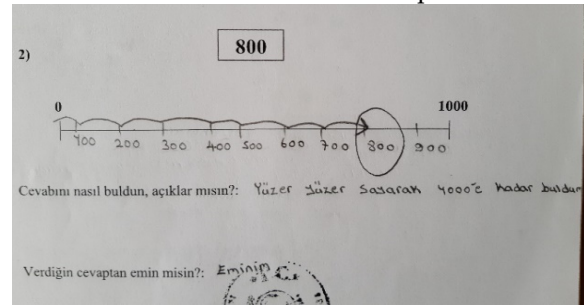
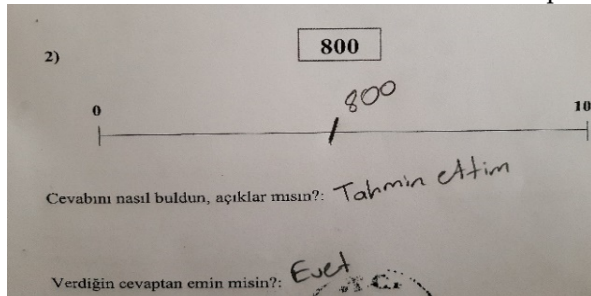


Figure 15. Sample Student Answers - Fourth Grade Number Sense Test Question-2

Number Sense Based Incorrect Solution Example



Rule Based Incorrect Solution Example

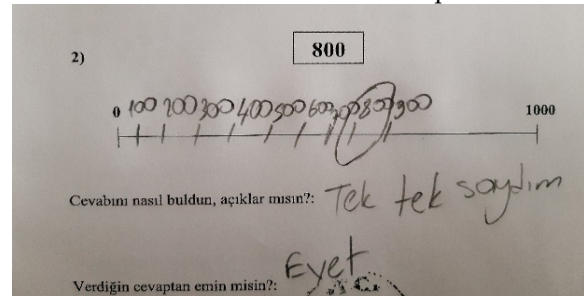


Figure 16. Sample Student Answers - Fourth Grade Number Sense Test Question-2

3.2.2. Fourth-Grade Students' Skills in the Component of "Flexible Calculation and Counting Strategies"

The skills of elementary school 4th grade students in the "Flexible Calculation and Counting Strategies" component of the number sense test are presented in Table 10.

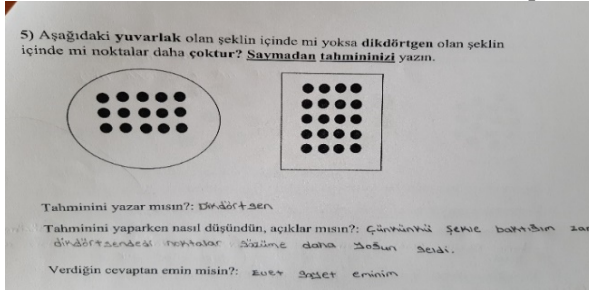
Table 10. Skills of Fourth Grade Students in the "Flexible Calculation and Counting Strategies" Component

Strategy Types	Questions					
	Q5		Q 6		Q 7	
	n	%	n	%	n	%
Number Sense Based Solution - Correct Answer	141	89.8	145	92.4	139	88.5
Number Sense Based Solution - Incorrect Answer	0	0.0	0	0.0	0	0.0
Rule-Based Solution- Correct Answer	14	8.9	10	6.4	14	8.9
Rule-Based Solution- Incorrect Answer	2	1.3	2	1.3	2	1.3
Blank	0	0.0	0	0.0	2	1.3
Total	157	100	157	100	157	100

According to the data presented in Table 10, the skills of 4th grade students in the "Flexible Calculation and Counting Strategies" component for the questions are as follows:

"Out of the students who answered the fifth question correctly, 141 of them (89.8%) used number sense-based strategies, while 14 of them (8.9%) used rule-based strategies. Among the students who answered incorrectly, 2 students (1.3%) used rule-based strategies but still provided incorrect answers, and no blank answers were detected. For the sixth question, out of the students who answered correctly, 145 of them (92.4%) used number sense-based strategies, while 10 of them (6.4%) used rule-based strategies. Among the students who answered incorrectly, 2 students (1.3%) used rule-based strategies but still provided incorrect answers, and no blank answers were detected. For the seventh question, out of the students who answered correctly, 139 of them (88.5%) used number sense-based strategies, while 14 of them (8.9%) used rule-based strategies. Among the students who answered incorrectly, 2 students (1.3%) used rule-based strategies but still provided incorrect answers, and 2 students (1.3%) left the answer blank. Based on these findings, it was determined that 4th grade students used a higher number sense-based strategies in solving the questions in this number sense component. Below, two different student responses for the 5th and 6th questions in this component are provided as examples.

Number Sense Based Correct Solution Example



Rule Based Correct Solution Example

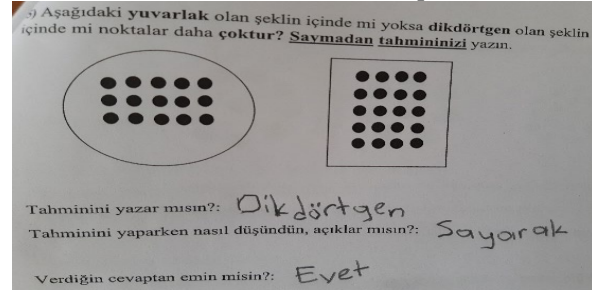
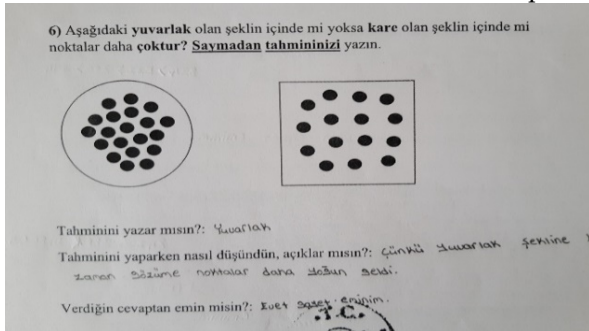


Figure 17. Sample Student Answers - Fourth Grade Number Sense Test Question-5

Number Sense Based Correct Solution Example



Rule Based Correct Solution Example

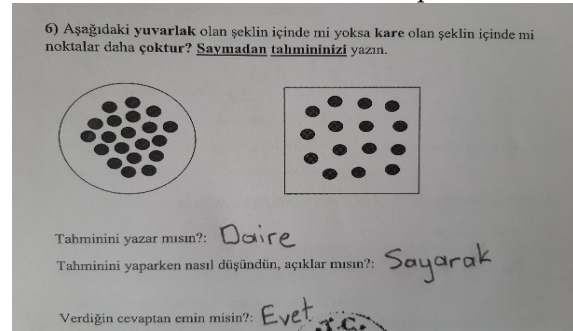


Figure 18. Sample Student Answers - Fourth Grade Number Sense Test Question-6

3.2.3. Fourth-Grade Students' Skills in the Component of 'Understanding the Meaning and Magnitude of Numbers'

The skills of primary school fourth-grade students in the component of 'Understanding the Meaning and Magnitude of Numbers' in the number sense test are presented in Table 11.

Table 11. Skills of Fourth Grade Students in the 'Understanding the Meaning and Magnitude of Numbers' Component

Strategy Types	Questions			
	Q9		Q10	
	n	%	n	%
Number Sense Based Solution- Correct Answer	0	0.0	0	0.0
Number Sense Based Solution- Incorrect Answer	0	0.0	0	0.0
Rule-Based Solution - Correct Answer	148	94.3	141	89.8
Rule-Based Solution - Incorrect Answer	9	5.7	14	8.9
Blank	0	0.0	2	1.3
Total	157	100	157	100

According to the data presented in Table 11, the skills of fourth-grade students in the component of 'Understanding the Meaning and Magnitude of Numbers' are as follows: According to the data obtained, 148 students (%94.3) provided rule-based answers while correctly answering the ninth question, while 9 students (%5.7) who answered incorrectly also used rule-based solutions. No number sense-based solutions or blank answers were detected in this question. For the tenth question, 141 students (%89.8) provided rule-based answers while correctly answering, while 14 students (%8.9) who answered incorrectly also used rule-based solutions. Only 2 students (%1.3) were identified as providing blank answers. Number sense-based solutions were not detected in this question as well. Based on these findings, it was determined that fourth-grade students tend to use more rule-based and procedural approaches in solving the questions related to this component of number sense.

3.2.4. Fourth-Grade Students' Skills in the Component of "Knowledge and Skills about Operations - Understanding the Meaning and Effects of Operations"

Skills of fourth grade students in "Knowledge and Skills about Operations - Understanding the Meaning and Effects of Operations" components are presented in Table 12.

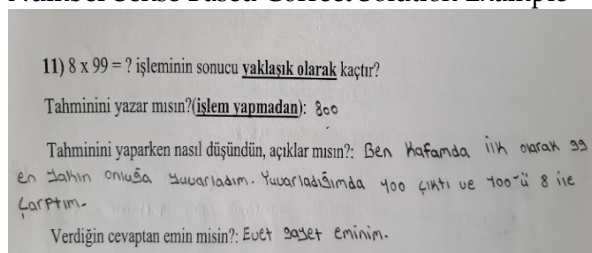
Table 12. Skills of Fourth Grade Students' Skills in "Knowledge and Skills about Operations - Understanding the Meaning and Effects of Operations" Component

Strategy Types	Questions							
	Q11		Q12		Q13		Q14	
	n	%	n	%	n	%	n	%
Number Sense Based Solution - Correct Answer	33	21.0	33	21.0	59	37.6	37	23.6
Number Sense Based Solution - Incorrect Answer	34	21.7	28	17.8	10	6.4	32	20.4
Rule-Based Solution - Correct Answer	52	33.1	64	40.8	60	38.2	48	30.6
Rule-Based Solution - Incorrect Answer	36	22.9	32	20.4	28	17.8	38	24.2
Blank	2	1.3	0	0.0	0	0.0	2	1.3
Total	157	100	157	100	157	100	157	100

According to the data presented in Table 12, the skills of fourth grade students in the "Knowledge and Skills about Operations - Understanding the Meaning and Effects of Operations" component are as follows:

The 11th question was answered correctly by 33 students (21.0%), with 52 students (33.1%) providing a rule-based response. Among the students who answered incorrectly, 36 of them (22.9%) used a rule-based approach and gave the wrong answer, while 34 of them (21.7%) provided a sense-based incorrect answer. 2 students (1.3%) left the question blank. The 12th question was answered correctly by 33 students (21.0%), with 64 students (40.8%) providing a rule-based response. Among the students who answered incorrectly, 32 of them (20.4%) used a rule-based approach and gave the wrong answer, while 28 of them (17.8%) provided a sense-based incorrect answer. No students left this question blank. The 13th question was answered correctly by 59 students (37.6%), with 60 students (38.2%) providing a rule-based response. Among the students who answered incorrectly, 28 of them (17.8%) used a rule-based approach and gave the wrong answer, while 10 of them (6.4%) provided a sense-based incorrect answer. No students left this question blank. The 14th question was answered correctly by 37 students (23.6%), with 48 students (30.6%) providing a rule-based response. Among the students who answered incorrectly, 38 of them (24.2%) used a rule-based approach and gave the wrong answer, while 32 of them (20.4%) provided a number sense-based incorrect answer. 2 students (1.3%) left the question blank."

Number Sense Based Correct Solution Example



Rule Based Correct Solution Example

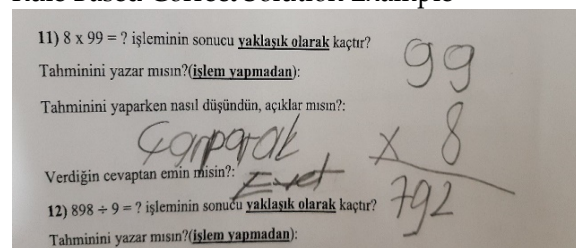
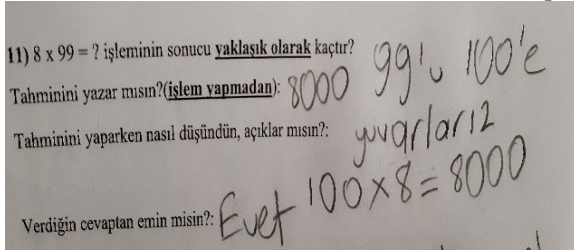


Figure 19. Sample Student Answers - Fourth Grade Number Sense Test Question-11

Number Sense Based Incorrect Solution Example



Rule Based Incorrect Solution Example

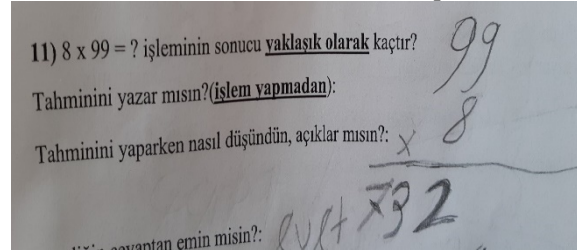
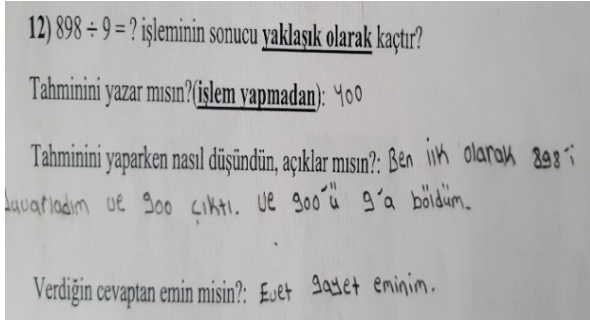


Figure 20. Sample Student Answers - Fourth Grade Number Sense Test Question-11

Number Sense Based Correct Solution Example



Rule Based Correct Solution Example

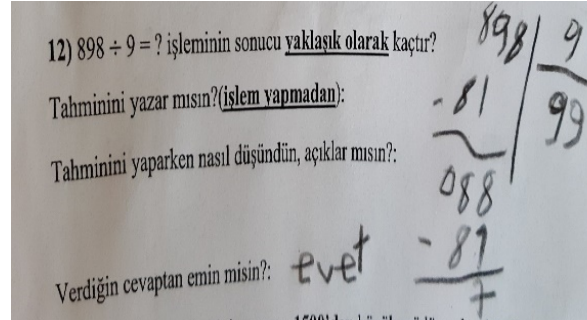
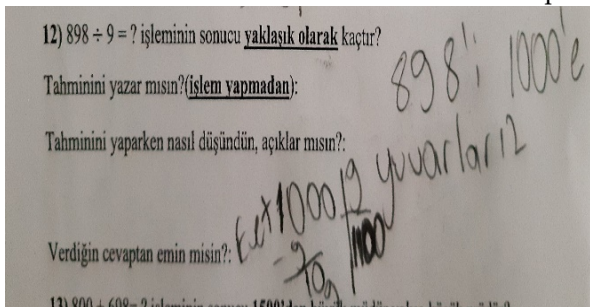


Figure 21. Sample Student Answers - Fourth Grade Number Sense Test Question-12

Number Sense Based Incorrect Solution Example



Rule Based Incorrect Solution Example

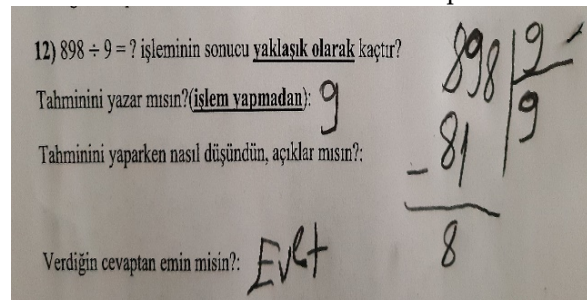


Figure 22. Sample Student Answers - Fourth Grade Number Sense Test Question-12

3.2.5. Fourth-Grade Students' Skills in the Component of "Using Knowledge and Skills about Numbers in Calculation Situations"

The skills of elementary school 4th grade students in the "Using Knowledge and Skills about Numbers in Calculation Situations" component of the number sense test are presented in Table 13.

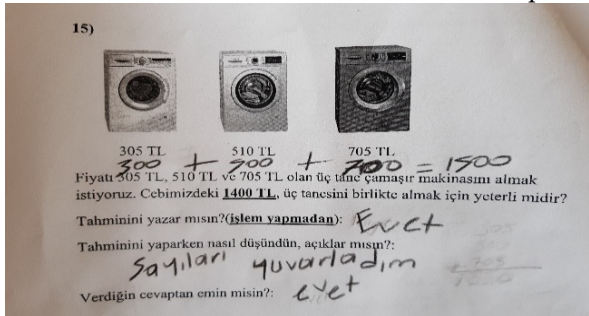
Table 13. Skills of Fourth Grade Students' Skills in "Using Knowledge and Skills about Numbers in Calculation Situations" Component

Strategy Types	Questions					
	Q15		Q16		Q17	
	n	%	n	%	n	%
Number Sense Based Solution - Correct Answer	39	24.8	29	18.5	51	32.5
Number Sense Based Solution - Incorrect Answer	24	15.3	32	20.4	20	12.7
Rule-Based Solution- Correct Answer	64	40.8	60	38.2	54	34.4
Rule-Based Solution- Incorrect Answer	30	19.1	36	22.9	32	20.4
Blank	0	0.0	0	0.0	0	0.0
Total	157	100	157	100	157	100

According to the data in Table 13, the skills of fourth-grade students in the "Using Knowledge and Skills about Numbers in Calculation Situations" component are as follows:

According to the data obtained, 39 students (24.8%) who answered the fifteenth question correctly used a number sense-based approach, while 64 students (40.8%) used a rule-based approach. Among the students who answered the question incorrectly, 30 students (19.1%) used a rule-based approach but provided the wrong answer, while 24 students (15.3%) provided a wrong answer based on number sense. No blank answers were detected for this question. For the sixteenth question, 29 students (18.5%) who answered correctly used a number sense-based approach, while 60 students (38.2%) used a rule-based approach. Among the students who answered the question incorrectly, 36 students (22.9%) used a rule-based approach but provided the wrong answer, while 32 students (20.4%) provided a wrong answer based on number sense. No blank answers were detected for this question. For the seventeenth question, 51 students (32.5%) who answered correctly used a number sense-based approach, while 54 students (34.4%) used a rule-based approach. Among the students who answered the question incorrectly, 32 students (20.4%) used a rule-based approach but provided the wrong answer, while 20 students (12.7%) provided a wrong answer based on number sense. No blank answers were detected for this question. Based on these findings, it was determined that fourth-grade students used more rule-based and procedural approaches in solving the questions in this number sense component. Two different student responses for the fifteenth and sixteenth questions in this component are provided below as examples

Number Sense Based Correct Solution Example



Rule Based Correct Solution Example

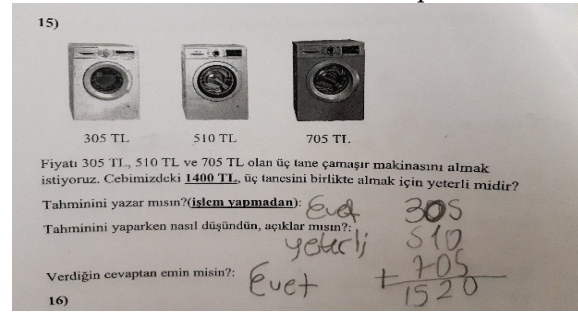
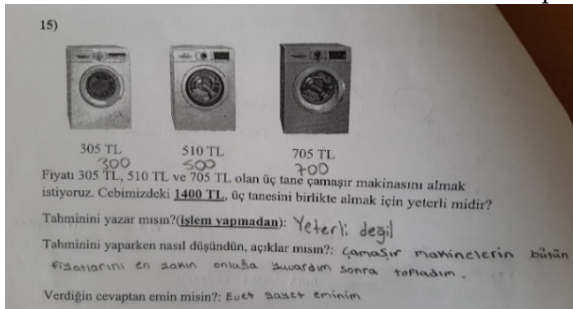


Figure 23. Sample Student Answers - Fourth Grade Number Sense Test Question-15

Number Sense Based Incorrect Solution Example



Rule Based Incorrect Solution Example

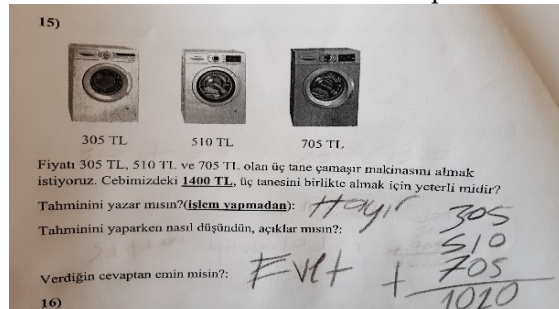
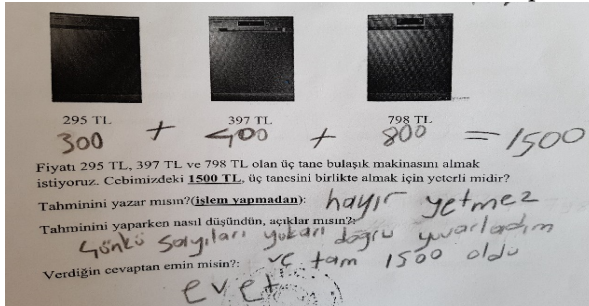


Figure 24. Sample Student Answers - Fourth Grade Number Sense Test Question-15

Number Sense Based Correct Solution Example



Rule Based Correct Solution Example

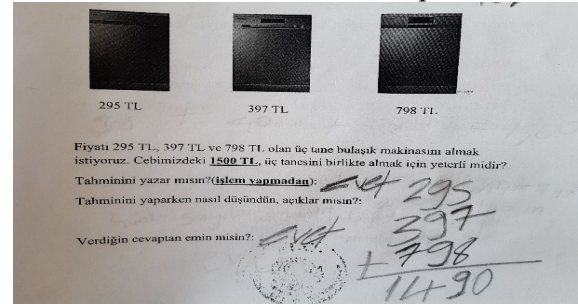
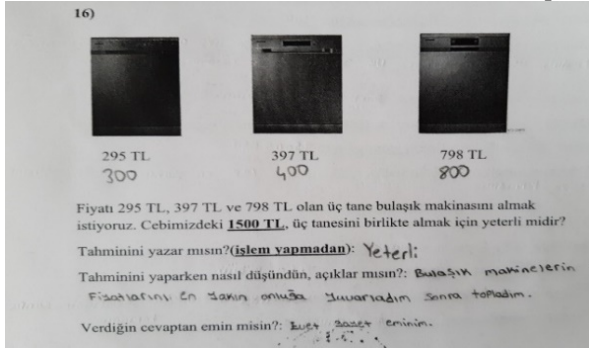


Figure 25. Sample Student Answers - Fourth Grade Number Sense Test Question-16

Number Sense Based Incorrect Solution Example



Rule Based Incorrect Solution Example

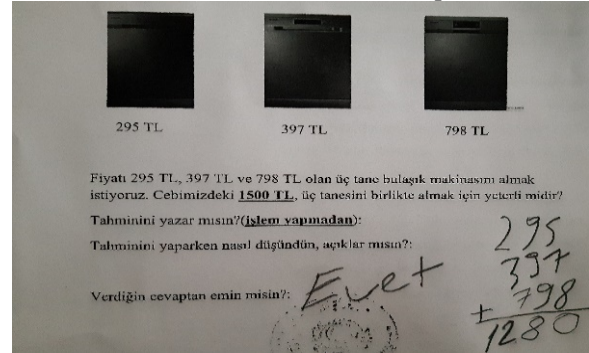


Figure 26. Sample Student Answers - Fourth Grade Number Sense Test Question-16

3.2.6. Fourth-Grade Students' Skills in the Component of "Measurement References" Component

Skills of Elementary School 4th Grade Students in the "Measurement References" Component of the Number Sense Test are presented in Table 14.

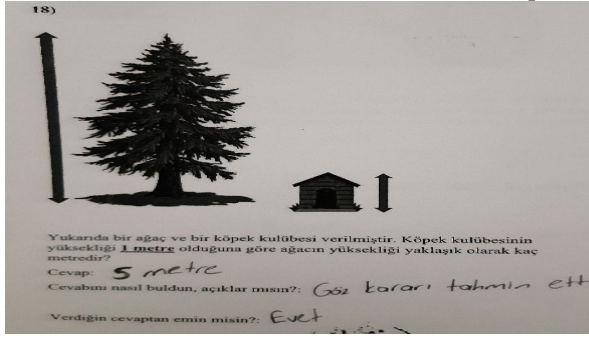
Table 14. Skills of Fourth Grade Students' Skills in "Measurement References" Component

Strategy Types	Questions							
	Q18		Q19		Q20		Q21	
	n	%	n	%	n	%	n	%
Number Sense Based Solution- Correct Answer	74	47.1	80	51.0	97	61.8	80	51.0
Number Sense Based Solution- Incorrect Answer	22	14.0	20	12.7	22	14.0	41	26.1
Rule-Based Solution - Correct Answer	53	33.8	47	29.9	34	21.7	30	19.1
Rule-Based Solution - Incorrect Answer	6	3.8	4	2.5	2	1.3	6	3.8
Blank	2	1.3	6	3.8	2	1.3	0	0.0
Total	157	100	157	100	157	100	157	100

According to the data presented in Table 14, the skills of 4th grade students in the "Measurement References" component are as follows:

Among the students who answered the 18th question correctly, 74 of them (47.1%) used number sense-based approach, while 53 of them (33.8%) used rule-based approach. Among the students who answered incorrectly, 6 of them (3.8%) used rule-based approach and gave the wrong answer, while 22 of them (14.0%) gave wrong answers based on number sense. 2 students (1.3%) left the question blank. Among the students who answered the 19th question correctly, 80 of them (51.0%) used number sense-based approach, while 47 of them (29.9%) used rule-based approach. Among the students who answered incorrectly, 4 of them (2.5%) used rule-based approach and gave the wrong answer, while 20 of them (12.7%) gave wrong answers based on number sense. 6 students (3.8%) left the question blank. Among the students who answered the 20th question correctly, 97 of them (61.8%) used number sense-based approach, while 34 of them (21.7%) used rule-based approach. Among the students who answered incorrectly, 2 of them (1.3%) used rule-based approach and gave the wrong answer, while 22 of them (14.0%) gave wrong answers based on number sense. 2 students (1.3%) left the question blank. Among the students who answered the 21st question correctly, 80 of them (51.0%) used number sense-based approach, while 30 of them (19.1%) used rule-based approach. Among the students who answered incorrectly, 6 of them (3.8%) used rule-based approach and gave the wrong answer, while 41 of them (26.1%) gave wrong answers based on number sense. No blank answers were detected for this question. Based on these findings, it was determined that 4th grade students used number sense-based approaches more frequently in solving the questions in this number sense component. Examples of two different student answers for the 18th and 20th questions in this component are provided below.

Number Sense Based Correct Solution Example



Rule Based Correct Solution Example

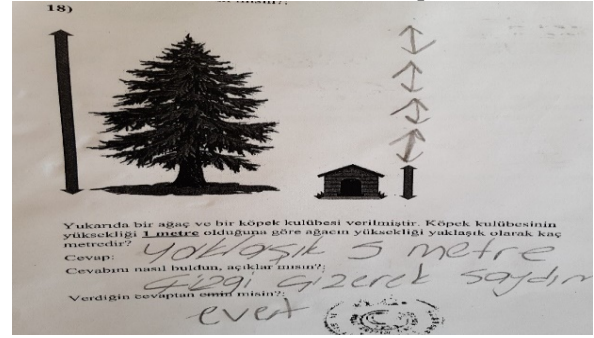
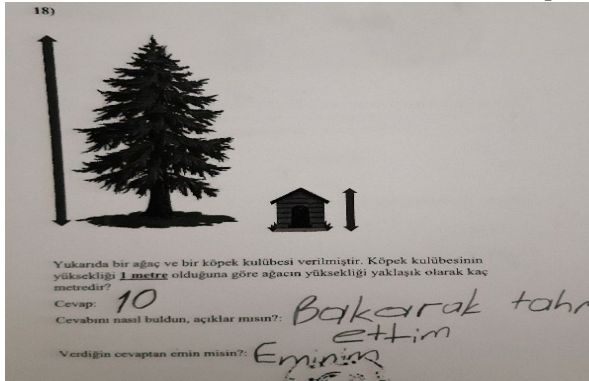


Figure 27. Sample Student Answers - Fourth Grade Number Sense Test Question-18

Number Sense Based Incorrect Solution Example



Rule Based Incorrect Solution Example

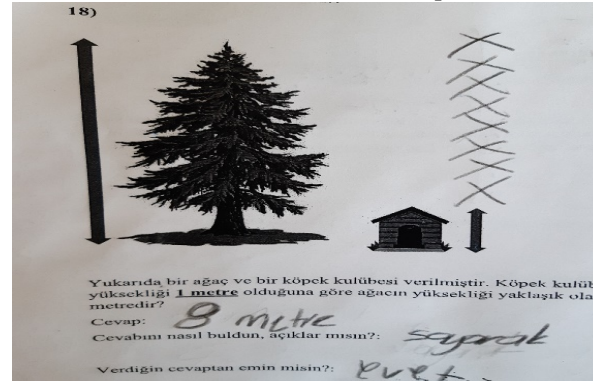
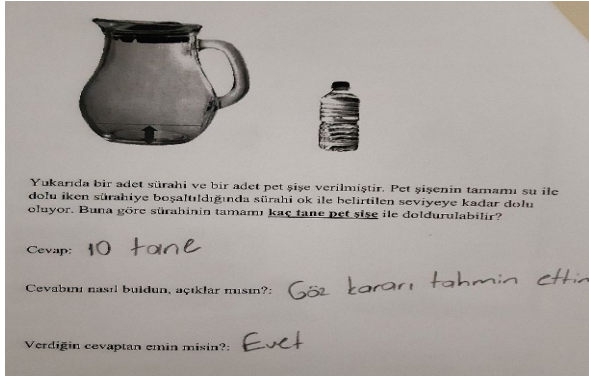


Figure 28. Sample Student Answers - Fourth Grade Number Sense Test Question-18

Number Sense Based Correct Solution Example



Rule Based Correct Solution Example

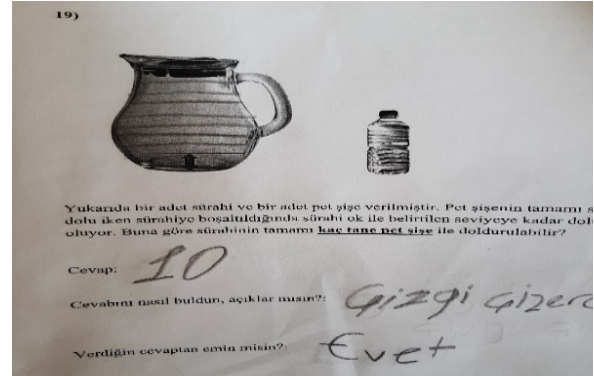
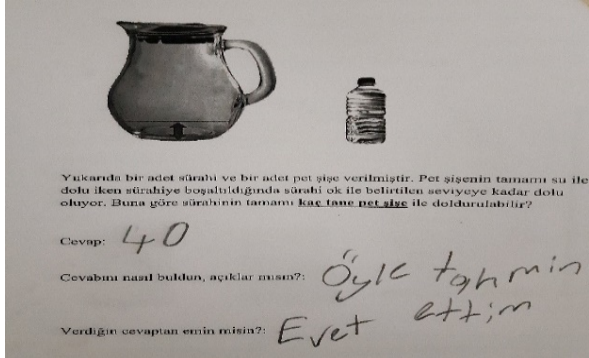


Figure 29. Sample Student Answers - Fourth Grade Number Sense Test Question-20

Number Sense Based Incorrect Solution Example



Rule Based Incorrect Solution Example

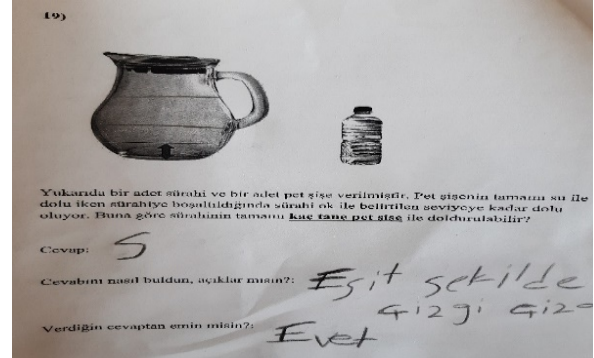


Figure 30. Sample Student Answers - Fourth Grade Number Sense Test Question-20

3.2.7. Fourth-Grade Students' Skills in the Component of "Using Equivalent Representations of Numbers"

The skills of elementary school fourth grade students in the "Using Equivalent Representations of Numbers" component of the number sense test are presented in Table 15.

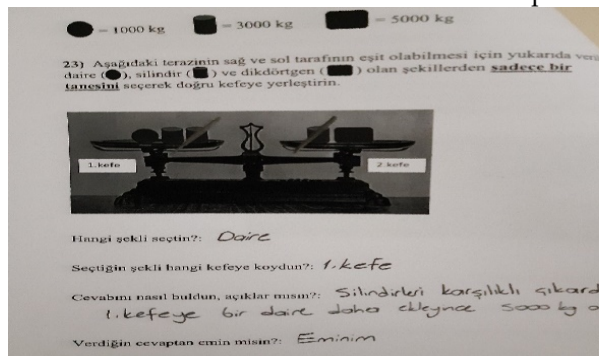
Table 15. Skills of Fourth Grade Students' Skills in "Using Equivalent Representations of Numbers" Component

Strategy Types	Questions					
	Q22		Q23		Q24	
	n	%	n	%	n	%
Number Sense Based Solution - Correct Answer	34	21.7	24	15.3	26	16.6
Number Sense Based Solution- Incorrect Answer	0	0.0	0	0.0	0	0.0
Rule-Based Solution- Correct Answer	77	49.0	103	65.6	103	65.6
Rule-Based Solution- Incorrect Answer	38	24.2	22	14.0	20	12.7
Blank	8	5.1	8	5.1	8	5.1
Total	157	100	157	100	157	100

According to the data presented in Table 15, the skills of fourth grade students in the "Using Equivalent Representations of Numbers" component are as follows:

According to the data obtained, 34 students (21.7%) who answered the 22nd question correctly used a number sense-based approach, while 77 students (49.0%) used a rule-based approach. Among the students who answered the question incorrectly, 38 students (24.2%) used a rule-based approach but gave the wrong answer, and 8 students (5.1%) left the question blank. For the 23rd question, out of the students who answered correctly, 24 students (15.3%) used a number sense-based approach, while 103 students (65.6%) used a rule-based approach. Among the students who answered incorrectly, 22 students (14.0%) used a rule-based approach but gave the wrong answer, and 8 students (5.1%) left the question blank. For the 24th question, out of the students who answered correctly, 26 students (16.6%) used a number sense-based approach, while 103 students (65.6%) used a rule-based approach. Among the students who answered incorrectly, 20 students (12.7%) used a rule-based approach but gave the wrong answer, and 8 students (5.1%) left the question blank. Based on these findings, it was determined that 4th grade students used more rule-based and procedural approaches in solving the questions in this number sense component. Below are two different student responses as examples for the 23rd question in this component.

Number Sense Based Correct Solution Example



Rule Based Correct Solution Example

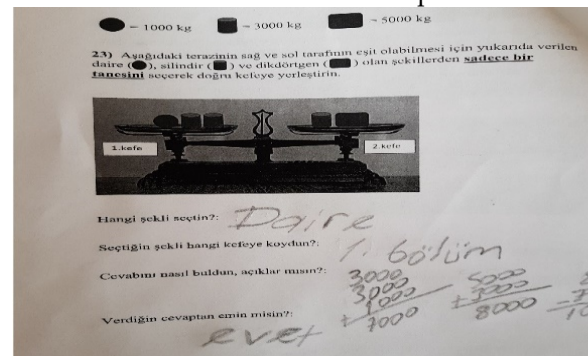


Figure 32. Sample Student Answers - Fourth Grade Number Sense Test Question-23

According to these results, fourth-grade students use rule-based and procedural-based solution methods and number sense-based solution methods at a similar level in solving the questions. Among the 7 number sense components in the test, number sense-based solution methods were used more frequently in 3 components (Knowledge and Skills About Numbers - Flexible Calculation and Counting Strategies - Measurement References), while rule-based and procedural-based solution methods were preferred more in the other 4 number sense components. The component where number sense strategies were used the most in solving was determined to be the "Flexible Calculation and Counting Strategies"

component with a rate of 90.2%, and the component where rule-based solution was used the most was the "Understanding the Meaning and Magnitude of Numbers" component with a rate of 99.3%. The component with the highest rate of blank responses was the "Using Equivalent Representations of Numbers" component with a rate of 5.1%. When examined on a question basis, the questions where students used number sense-based solution methods the most were determined to be the 6th question with 92.4% and the 5th question with 89.8%. The questions where they used this method the least were the 9th and 10th questions with 0.0% usage. The questions where rule-based solution method was used the most were the 9th question with 100% (94.3% correct answers, 5.7% incorrect answers) and the 10th question with 98.7% (89.8% correct answers, 8.9% incorrect answers). The questions with the highest rate of blank responses were the 22nd, 23rd, and 24th questions with 5.1%.

4. Discussion and Conclusion

When looking at the results obtained in this research, it can be concluded that elementary school (grades 1-4) students predominantly preferred rule-based and procedural-based methods over number sense-based methods in solving questions related to number sense components. Therefore, it can be inferred that students have lower number sense skills.

When reviewing the research conducted on number sense, similar findings have been obtained at the elementary school level (Çekirdekçi, 2015; Cheung and Yang, 2018; Lemonidis and Kaiafa, 2014; Yang, 2019; Yang, Li and Li, 2008) and middle school level (Akkaya, 2015; Alsawaie, 2012; Bayram and Duatepe Paksu, 2014; Bütüner, 2018; Can, 2019; Facun and Nool, 2012; Harç, 2010; İymen, 2012; İymen and Duatepe Paksu, 2015; Kayhan Altay, 2010; Lin, Yang and Li, 2016; Markovist and Sowder, 1994; Mohamed and Johnny, 2010; Singh, Rahman, Ramly and Hoon, 2019; Şengül and Gülbağcı, 2012; Takır, 2016; Yang, 2005; Yang, 2018; Yang and Li, 2008; Yang and Sianturi, 2019; Yang and Sianturi, 2020; Yapıcı, 2013; Yapıcı and Altay, 2017; Yenilmez and Yıldız, 2018) which indicate that students tend to use rule-based and procedural-based methods more frequently and have lower performance in number sense.

According to the findings of the research, students tend to use rule-based and procedural methods more often, and their number sense performance is lower. Similar results have been found in studies conducted at the elementary school level (Çekirdekçi, 2015; Cheung and Yang, 2018; Lemonidis and Kaiafa, 2014; Yang, 2019; Yang, Li and Li, 2008) and middle school level (Akkaya, 2015; Alsawaie, 2012; Bayram and Duatepe Paksu, 2014; Bütüner, 2018; Can, 2019; Can, 2017; Facun and Nool, 2012; Harç, 2010; İymen, 2012; İymen and Duatepe Paksu, 2015; Kayhan Altay, 2010; Lin, Yang and Li, 2016; Markovist and Sowder, 1994; Mohamed and Johnny, 2010; Singh, Rahman, Ramly and Hoon, 2019; Şengül and Gülbağcı, 2012; Takır, 2016; Yang, 2005; Yang, 2018; Yang and Li, 2008; Yang and Sianturi, 2019; Yang and Sianturi, 2020; Yapıcı, 2013; Yapıcı and Altay, 2017; Yenilmez and Yıldız, 2018). Another result obtained in the study is that the number sense skills of 4th grade students are better than those of 1st grade students. In other words, as the grade level increases, students' number sense skills also show improvement. Various studies (McIntosh et al., 1992; Reys et al., 1999) have shown that when students' number sense skills are supported, they have a better understanding and application of mathematics. According to the results obtained in this study, it was determined that students' number sense performance increases proportionally with their grade level. Students' number sense performance was found to be very low at the preschool and first grade levels, and much higher at the third and fourth grade levels. Many studies have also concluded that number sense skills develop during the elementary school years and strongly predict mathematics achievement in the later years up to high school (Griffin, 2004). Furthermore, the development of number sense is influenced by both the formal knowledge taught in schools about numbers and quantities, and the informal knowledge acquired through children's everyday experiences (Tsao, 2004). Based on these two points, the relationship between the increase in grade level and the improvement of students' number sense performance can be explained. Moreover, the more diverse children's experiences are outside of school, the more informal knowledge they acquire, which can positively contribute to their relationship with numbers and their number sense

skills (Tsao, 2004). This suggests that as age or grade level increases, children's relationship with numbers and their number sense performance may improve.

When examining the performance of primary school students (grades 1-4) in number sense tests based on the components of number sense, it was found that students demonstrated the highest performance in the components of "Knowledge and Skills about Numbers" and "Measurement References". In the component of "Flexible Calculation and Counting Strategies", the use of number sense-based solution strategies and rule-based solution strategies showed a more balanced distribution, indicating that students' number sense performance was moderate. In the remaining components of number sense, namely "Knowledge and Skills about Operations", "Understanding the Meaning and Magnitude of Numbers", "Using Knowledge and Skills about Numbers in Calculation Situations", and "Using Equivalent Representations of Numbers", it was determined that students predominantly used rule-based solution strategies in solving the questions, and their performance in these components of number sense was quite low. In a study conducted by Kyaw and Thein (2018), they found that 7th grade students used number sense the most in the component of "Multiple Representations" and the least in the component of "Effects of Operations". The researchers also revealed different classifications in the definition of number sense and the naming of number sense components in their studies. Therefore, although different studies may use different component names, similar question types can be included in different components. Hence, despite the different naming of the component "Knowledge and Skills about Operations, Skills - Understanding the Meaning and Effects of Operations" in this study and the "Effects of Operations" component in Kyaw and Thein's (2018) study, as they included approximately the same question types, there is no problem in comparing the findings obtained. In this study, it was also found that students' number sense performance was low in the component of "Knowledge and Skills about Operations, Skills - Understanding the Meaning and Effects of Operations", and the results obtained support each other in terms of their consistency. The study conducted by Harç (2010) found that 6th grade students primarily used the "Measurement References" component for their number sense, and demonstrated majority of rule-based and procedural solutions in the "Understanding Equivalent Representations of Numbers" component with high accuracy. In this study, it was also observed that students performed well in the "Measurement References" component, but had low performance in the "Using Equivalent Representations of Numbers" component. Similarly, Mohamed and Johnny (2010) identified the components "Understanding the Relative Effects of Operations on Numbers" and "Judging the Reasonableness of Operational Results" as the ones where 4th grade students performed the poorest in terms of number sense. In this study as well, it is observed that students had low performance in the "Knowledge, Skill, and Understanding of Operations - Understanding the Meaning and Effects of Operations" component. In their research, Yenilmez and Yıldız (2018) found that 7th grade students primarily used the "Effects of Operations on Numbers" component for their number sense. In this study, it was observed that students had low performance in the "Knowledge, Skill, and Understanding of Operations - Understanding the Meaning and Effects of Operations" component. This difference in performance can be attributed to the fact that the sample groups in Yenilmez and Yıldız's (2018) study consisted of 7th grade students, whereas the sample group in this study consisted of preschool (kindergarten) and elementary school (grades 1-4) students. Çekirdekçi (2015) conducted a study where it was determined that 4th grade students used their number sense the most in the component of "Understanding the Meaning of Numbers and Flexible Thinking," and the least in the component of "Knowing the Equivalents of Numbers." In this study, it was also found that students had a significantly lower performance in the component of "Using Equivalent Representations of Numbers" in terms of their number sense. However, when comparing the performance of students in the components of "Understanding the Meaning and Magnitude of Numbers" and "Flexible Calculation and Counting Strategies" in this study with the component of "Understanding the Meaning of Numbers and Flexible Thinking" in Çekirdekçi's (2015) study, it was observed that students showed moderate performance in the component of "Flexible Calculation and Counting Strategies," but low performance in the component of "Understanding the Meaning and Magnitude of Numbers." Thus, it was determined that the results related to these components were

different between the two studies. In the study conducted by İymen and Duatepe Paksu (2015), it was found that 8th grade students used their number sense the most in the component of "Equivalent Representation." However, in this study, it was determined that students had a low performance in the component of "Using Equivalent Representations of Numbers" in terms of their number sense, and this difference can be attributed to the different sample groups at different grade levels where the studies were conducted.

In summary, when the results of this study were evaluated in terms of the components of number sense, similar results were obtained to the studies conducted by Harç (2010), Kyaw and Thein (2018), and Mohamed and Johnny (2010). Partially similar results were obtained compared to Çekirdekçi's (2015) study, while different results emerged compared to the studies conducted by İymen and Duatepe Paksu (2015) and Yenilmez and Yıldız (2018). The difference in results can be attributed to the different grade levels of the sample groups where the studies were conducted. The sample group in Yenilmez and Yıldız's (2018) study consisted of 7th graders, while in Duatepe Paksu's (2015) study, it consisted of 8th graders.

When examining the studies, the low performance of students in number sense could be a result of the Mathematics Curriculum and textbooks used in Turkey, which may make students more inclined to use rule-based methods. The lack of explicit inclusion of number sense as a concept in the Mathematics Curriculum, the indirect relationship of the learning outcomes with number sense, and the limited number of activities related to number sense in textbooks may affect students' levels of number sense usage (Çekirdekçi, 2015). In this context, the insufficient performance of students in number sense may be related to the presence or absence of learning outcomes related to number sense in the preschool and primary school curriculum in Turkey, the adequacy of activities and learning outcomes related to number sense in textbooks, and the level of knowledge of teachers about number sense. These are the areas that need to be investigated further

Based on the findings of the research, the following suggestions can be made:

- Students can be encouraged to develop flexible thinking, logical estimation, and different problem-solving strategies to improve their number sense skills, considering that their number sense may be low.
- Qualitative analyses can be conducted through interviews based on the answers given to questions to obtain more detailed data for a better understanding of the current status of students' number sense.
- Experimental studies can be conducted to improve children's number sense performance.

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