



Citation: Akpınar, S., & Soybaş, D. (2025). An investigation of seventh grade students' misconceptions regarding the concept of percentages. *International Journal of Scholars in Education*, 8(2), 88-118. <https://doi.org/10.52134/ueader.1608156>

7. Sınıf Öğrencilerinin Yüzdeler Konusundaki Kavram Yanılgıları ve Nedenlerinin İncelenmesi *

Salih AKPINAR**, Danyal SOYBAŞ***

Özet: Bu araştırmada, 7. sınıf öğrencilerinin yüzdeler konusundaki kavram yanılgıları ve bu yanılgıların altında yatan nedenler incelenmiştir. Yüzdeler konusu, matematikte ve günlük yaşamda sıkça karşılaşılan, öğrencilerin çoğunlukla zorlandığı bir alan olarak öne çıkmaktadır. Araştırmanın amacı, 7. sınıf öğrencilerinin yüzdeler konusundaki kavram yanılgılarını belirlemek ve bu yanılgıların ortaya çıkma nedenlerini incelemektir. Araştırmada açıklayıcı sıralı karma desen benimsenmiş; nicel ve nitel yöntemler bir arada kullanılmıştır. Çalışmanın nitel bileşeninde durum çalışması deseni yer almaktadır. Bu kapsamda ilk aşamada, 22 sorudan oluşan teşhis testi uygulanarak nicel veriler toplanmış; ikinci aşamada ise, bu bulguların derinlemesine incelenebilmesi amacıyla yarı yapılandırılmış mülakatlar gerçekleştirilmiştir. Araştırma, Türkiye'nin Ege Bölgesi'nde sosyo-ekonomik açıdan farklılık gösteren üç okulda öğrenim gören toplam 255 yedinci sınıf öğrencisiyle yürütülmüştür. Öğrencilere iki ders saati süre verilerek 22 soruluk teşhis testi uygulanmış, ayrıca okul başarı ortalamalarına göre başarı düzeyleri farklı olan 10 öğrenciyle mülakatlar yapılmıştır. Elde edilen veriler, nicel bulgulardan da yararlanılarak nitel yöntemlerle analiz edilmiş ve içerik analiziyle yorumlanmıştır. Bulgular, öğrencilerin kavram yanılgılarının temelinde kesir ve ondalık sayı bilgisi eksiklikleri, oran-orantı kavramının hatalı yapılandırılması, yüzde sembolünün anlamlandırılmasında yaşanan güçlükler, işlemsel hatalar, önyargılar ve önceki öğrenmelerden aktarılan yanlış genellemelerin bulunduğu göstermiştir. Matematik konularının birbirini tamamlayıcı yapısı nedeniyle, önceki konulardaki kavramsal eksikliklerin yüzdeler konusunda da devam ettiği ve daha karmaşık sorunlara yol açtığı belirlenmiştir.

Anahtar Kelimeler: Yüzdeler, Kavram, Kavram yanılgıları.

An Investigation of Seventh Grade Students' Misconceptions and Their Causes Regarding the Concept of Percentages *

Abstract: This study investigates seventh-grade students' misconceptions about percentages and the underlying causes of these misconceptions. The topic of percentages stands out as a concept frequently encountered both in mathematics and in daily life, yet one that many students find difficult to comprehend. The purpose of the research is to identify students' misconceptions regarding percentages and to examine the reasons behind their occurrence. An explanatory sequential mixed-methods design was employed, integrating both quantitative and qualitative approaches. The qualitative component of the study was structured as a case study. In the first phase, quantitative data were collected through a 22-item diagnostic test, while in the second phase, semi-structured interviews were conducted to gain deeper insights into the findings. The study was carried out with 255 seventh-grade students from three schools in Turkey's Aegean region, representing different socio-economic backgrounds. Students were given two class periods to complete the diagnostic test, and ten students with varying achievement levels were selected for interviews. The collected data were analyzed using qualitative methods supported by quantitative findings and interpreted through content analysis. Results revealed that students' misconceptions stemmed mainly from deficiencies in understanding fractions and decimals, misconstrued ratio-proportion concepts, difficulties in interpreting the percent symbol, operational errors, preconceptions, and incorrect generalizations

* This study has been derived from the master's thesis prepared by the first author under the supervision of the second author.

** Teacher, Ministry of National Education, ORCID:0000-0002-3914-1885, salihakpinar38@gmail.com

***Prof. Dr., Erciyes University, Faculty of Education, ORCID:0000-0002-8140-9435 danyalsoybas@gmail.com

transferred from prior learning. The findings suggest that conceptual gaps in previous mathematical topics persist in learning percentages, leading to more complex misunderstandings.

Keywords: The percentages, Concept, The misconceptions.

Introduction

Mathematics plays an important role in individuals' processes of making sense of situations they encounter in many areas of life, producing solutions, and making decisions. Developing mathematical skills helps people solve many of the problems they face in daily life in a more systematic way (Yenilmez & Duman, 2008). Within the general education system, mathematics also holds a highly significant position as a potential that enables us to make sense of and explore the world (Erdem & Genç, 2014).

Students' ability to make sense of mathematics depends on learning mathematical concepts correctly and with minimal misconceptions. The topics in the middle school mathematics curriculum are interrelated, and any conceptual deficiency experienced in one topic may directly affect other learning domains. According to English and Halford (1995), one of the main goals of mathematics education is to ensure that students make sense of mathematical concepts through content-specific and analogical mental models.

The National Research Council (1997) stated that students' misconceptions generally arise from their prior knowledge based on everyday experiences, from sources outside of scientific education, or from the use of words in everyday language that differ from their scientific meanings. Such misunderstandings may hinder the accurate learning of scientific concepts and make it difficult for meaningful learning to occur. Misconceptions consist of beliefs and pieces of knowledge that individuals consider correct and logically sound from their own perspective (Yaşa & Yenilmez, 2008). Inspired by Bachelard's (1938) work, Brousseau (1976) and Cornu (1991) stated that the mathematical difficulties and misconceptions experienced by students may stem from three main causes: epistemological, psychological, and pedagogical. Cornu (1991) emphasized that the epistemological cause of misconceptions originates from the very nature of the concept itself. A student's misconception may result from the learner's readiness and personal competence level. Although Cornu (1991) did not classify such personal conditions as psychological factors, it is undeniable that psychological elements are among the personal situations that lead to misconceptions (Bachelard, 1938; Brousseau, 1976; Cornu, 1991, as cited in Bingölbali & Özmantar, 2012).

The concept of percentage frequently appears not only in many mathematics topics—such as rational numbers, ratio and proportion, probability, and data analysis—but also in everyday life. For example, the concept of percentage is commonly used in circle graphs in data analysis, shopping, interest rates, tax rates, software installation indicators, and profit–loss calculations. Considering that percentage changes are among the most frequently encountered numerical forms both in various numerical expressions and in daily life, the limited number of studies in this area is quite surprising (Danan & Gelman, 2018). Existing research indicates that both students and adults face various difficulties in learning and applying the concept of percentage in daily life (Allinger & Payne, 1986; Koay, 1998; Lembke & Reys, 1994; Van de Walle, Karp, & Bay-Williams, 2010, as cited in Yapıcı & Kayhan Altay, 2017). This situation reveals that when sufficient attention is not given to the teaching process, students experience problems not only in establishing relationships between in-class topics but also in applying them in everyday life (Cole & Weissenfluh, 1974).

The main purpose of this study is to identify seventh-grade students' misconceptions regarding the concept of percentage and to examine the factors that play a role in the emergence

of these misconceptions. By elaborating on misconceptions about the concept of percentage—which has been addressed to a limited extent in the existing literature—this study aims to shed light on the sources of the problems encountered in the teaching process. In this way, it seeks to contribute to understanding the difficulties students face in learning the concept of percentage within the framework of the curriculum outcomes. The study aims to make an original contribution to the literature by revealing misconceptions about percentages and addressing their causes from a multidimensional perspective.

Furthermore, the concept of percentage is included in the Ministry of National Education curriculum at the fifth- and seventh-grade levels. Students are expected to acquire skills such as expressing fractions with a denominator of 100 using the percent symbol, relating percentage expressions to fractions and decimal representations, finding a certain percentage of a quantity, and solving percentage problems (Ministry of National Education, 2018). By analyzing the misconceptions that students encounter in the process of acquiring these learning outcomes, this study aims to fill the gap in the literature in this field.

Method

In this study, the main research question was determined as: “What are the misconceptions of seventh-grade students regarding the concept of percentage, and what are their causes?” Based on this main question, answers were sought to the following subproblems:

1. What are the students’ misconceptions about percentages?
2. What are the causes of students’ misconceptions about percentages?

The study group consisted of a total of 255 seventh-grade students enrolled in three schools located in a province in the Aegean Region of Türkiye, which differed in terms of socioeconomic characteristics. The research was conducted in schools during the second semester of the 2016–2017 academic year, and a diagnostic test was administered to the students. Based on the results obtained from the diagnostic test, 10 students were selected—representing achievement levels ranging from low to very high—and semi-structured interviews were conducted with these students.

The research was carried out using a mixed-methods approach, and a case study design was employed for the qualitative component. The mixed-methods approach made it possible to examine misconceptions about percentages from both quantitative and qualitative perspectives. The overall structure of the study was planned within the framework of an explanatory sequential mixed-methods design. In this design, quantitative data were collected and analyzed first, followed by the collection of qualitative data to understand the underlying reasons for the quantitative findings, which were then examined using content analysis. Furthermore, the research adopted a general survey model, which refers to survey arrangements conducted on an entire population or a sample drawn from it to make general judgments about that population, and thus the study had a descriptive nature (Şimşek & Yıldırım, 2011). This methodological approach contributed to an in-depth and multidimensional examination of misconceptions.

Since the concept of percentage is addressed at the fifth- and seventh-grade levels in the Mathematics Curriculum of the Ministry of National Education, a 22-item diagnostic test was developed by taking the related learning outcomes in this curriculum into account. During the test development process, the opinions of a mathematics teacher and a faculty member who specialized in mathematics education were sought, and the necessary revisions were made to the test items based on expert feedback. Thus, the content validity of the diagnostic test was ensured. In the reliability analysis, the KR-20 coefficient was found to be 0.85, indicating high internal

consistency. In addition, the average item difficulty index was calculated as 0.49, and the average item discrimination index as 0.54, showing that the test items were balanced and discriminative in nature.

The research was conducted in schools after obtaining the necessary permissions. Before implementation, students were informed about the purpose of the study and were asked to answer the questions sincerely. In the explanation sections of the questions, students were asked to write how they solved the questions and what they thought during the solution process if they were able to solve them, or the reasons why they could not solve them if they failed. After the test administration, 10 students selected through maximum variation sampling—based on their school achievement levels—were interviewed using semi-structured interview forms. The interviews were audio-recorded and transcribed, and students' identities were kept confidential. The interview questions were designed to reveal the students' problem-solving approaches, thought processes, and solution strategies.

For each question in the diagnostic test, the ratios of correct, incorrect, and blank responses were presented in tables. Correct answers refer to responses that reached the correct result; incorrect answers refer to responses in which a procedure was performed but the correct result was not reached; and blank answers refer to questions left unanswered. The data obtained were analyzed using the content analysis method; general categories that caused students' misconceptions were identified, and misconceptions were analyzed in detail under each category. These categories are as follows:

1. Conceptual misconceptions arising from the topic of percentages
2. Conceptual misconceptions arising from incomplete learning or misconceptions in decimal representations.
3. Conceptual misconceptions arising from incomplete learning or misconceptions in fractions.
4. Conceptual misconceptions arising from algebraic expressions and equations
5. Conceptual misconceptions arising from the inability to make sense of the given information
6. Conceptual misconceptions arising from incomplete learning or misconceptions in the topic of ratio and proportion.
7. Conceptual misconceptions arising from procedural causes
8. Conceptual misconceptions arising from prejudices

Findings

The students' incorrect responses on the diagnostic test were grouped according to the identified categories of misconceptions; the explanations obtained from the interviews were analyzed, and the findings of the study were presented in tables, with the results interpreted accordingly. In addition, students were asked to present their solutions in detail and to explain these solutions.

Figure 1

Example of a student response containing a misconception

6. Enes kardeşi Bilgehan'a doğum günü hediyesi alacaktır. Gittiği mağazada alacağı hediye için 150 TL etiket fiyatı üzerinden % 20 + % 10 indirim yapılacağı yazmaktadır. Buna göre Enes hediye için kaç TL para vermelidir? Çözümünüzü açıklayınız.

A) 100 B) 103 C) 105 D) 108

Çözüm ve Açıklama:

$\frac{20}{100} + \frac{10}{100} = \frac{30}{100}$ → Toplam indirim

$150 - 45 = 105 \text{ TL}$

$\frac{150}{1} - \frac{30}{100} = \frac{45}{1} = 45 \text{ TL}$ indirim

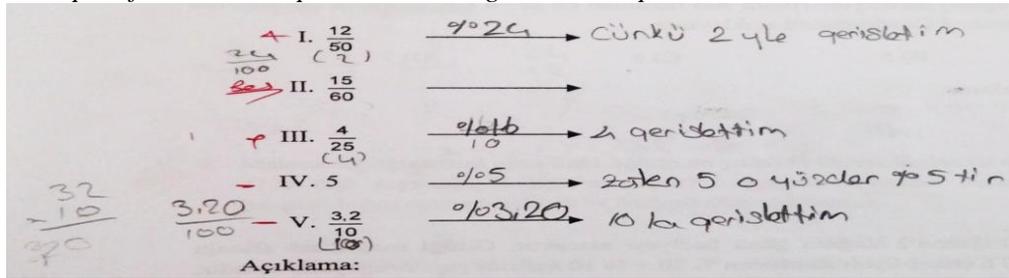
Öncelikle toplam indirim buldum. Sonra 150 TL paranın indirim kadarını yani % 30 unu buldum. Daha sonra 150 TL den bulduğum indirim fiyatını çıkardım. 105 TL ye düşmesi gerekir.

Bir A sayısının 4 katı kendisinin yüzde kaç fazlasıdır? Çözümünüzü açıklayınız.

A) 200 B) 250

Figure 2

Example of a student response containing a misconception



In the sample response shown in Figure 1, a student's misconception regarding the expression "20% + 10% discount" is observed, whereas in the sample response shown in Figure 2, another student's misconception is seen, in which the student assumed that a number given as a natural number is already a percentage. As in the sample responses presented in Figures 1 and 2, students' solutions and explanations were evaluated in terms of their conceptual misconceptions.

Question 1

In this question, students were asked to express the given fractional forms using the percent symbol and to explain how they performed this conversion.

1. Express the following statements using the percent symbol, and explain how you did it.

- I. $\frac{12}{50}$ _____
- II. $\frac{15}{60}$ _____
- III. $\frac{4}{25}$ _____
- IV. 5 _____
- V. $\frac{3,2}{10}$ _____

The percentages of students' responses to Question 1 are presented in Table 1.

Table 1

Analysis of students' responses to Question 1 in the study

Question Number	Percentage of Correct Responses	Percentage of Incorrect Responses	Percentage of Blank Responses	Percentage of Students Who Responded to the Question
1. I	64.31%	27.84%	7.85%	92.15%
1. II	33.72%	36.47%	29.81%	70.19%
1. III	58.82%	29.01%	12.17%	87.83%
1. IV	30.58%	50.58%	18.84%	81.16%
1. V	46.66%	35.29%	18.05%	81.95%

As shown in Table 1, the percentages of correct responses given by the students were 64.31% for item I, 33.72% for item II, 58.82% for item III, 30.58% for item IV, and 46.66% for item V. It was observed that the students experienced difficulties in items II, IV, and V. When the reasons for these difficulties are grouped as misconceptions, the corresponding percentages are presented in Table 2.

Table 2

Analysis of the misconceptions experienced by students in Question 1 of the study

Causes of Misconceptions in the First Question	Frequency	Percentage
1. Conceptual misconceptions arising from incomplete learning or misconceptions in fractions.	136	41.34%
2. Conceptual misconceptions arising from the topic of percentages	113	34.35%
3. Conceptual misconceptions arising from incomplete learning or misconceptions in decimal representations.	65	19.76%
4. Conceptual misconceptions arising from prejudices	15	4.55%
Total	329	100%

As shown in Table 2, the most common cause of misconceptions in this question, with a rate of 41.34%, is incomplete learning or misconceptions that have developed in fractions.

In the misconceptions observed in the first question, it was found that students attempted to make the denominator 100 in order to express a given fraction using the percent symbol. However, they associated making the denominator 100 only with the operation of expansion. Therefore, while answering the second item of the first question, most students stated that they were unable to make the denominator 100. In the question in the fourth item, many students failed to consider the implicit “one” under the five, and some indicated that this expression itself represented a percentage. In the question in the fifth item, when a decimal expression was involved, students either could not decide what to do or experienced difficulties in performing operations with decimal numbers. The conversion of decimal representations written up to the hundredths place into percentage form during lessons caused students, in this question as well, to try to convert the given fractions into decimal representations instead of expressing them with the percent symbol.

Question 2

In this question, it was aimed to investigate what students understood from an expression whose denominator was given as one hundred.

2. $\frac{a}{100}$ what does the expression mean? Explain.

The percentages of students’ responses to Question 2 are presented in Table 3.

Table 3*Analysis of students’ responses to Question 2 in the study*

Question Number	Percentage of Correct Responses	Percentage of Incorrect Responses	Percentage of Blank Responses	Percentage of Students Who Responded to the Question
2.	46.27%	16.07%	37.66%	62.34%

As shown in Table 3, the percentage of correct responses given by the students to the second question is 46.27%, while 37.66% of the students left the question unanswered. When the reasons for these results are grouped as misconceptions, the corresponding percentages are presented in Table 4.

Table 4*Analysis of the misconceptions experienced by students in Question 2 of the study*

Causes of Misconceptions in the Second Question	Frequency	Percentage
1. Conceptual misconceptions arising from the topic of percentages	8	27.59%

An investigation of seventh grade students' misconceptions and their causes regarding the concept of percentages

2. Conceptual misconceptions arising from incomplete learning or misconceptions in decimal representations.	2	6.91%
3. Conceptual misconceptions arising from incomplete learning or misconceptions in fractions.	6	20.68%
4. Conceptual misconceptions arising from algebraic expressions and equations	9	31.03%
5. Conceptual misconceptions arising from the inability to accurately make sense of the given information	4	13.79%
Total	29	100%

As shown in Table 4, the most common cause of misconceptions in this question, with a rate of 31.03%, is the conceptual misconceptions arising from algebraic expressions and equations.

The students stated that “a” was an unknown and that the question was asking about this. It was observed that, in questions involving an unknown, students focused on finding the value of the unknown and only thought about what “a” represented in the question. In this context, students provided responses such as “many numbers can be substituted for a” and “the expression is an equation.” However, the question was actually asking what the expression $\frac{a}{100}$ means. It was observed that the fact that the denominator was one hundred did not attract the students’ attention, and that most of them could not derive any meaning related to the concept of percentage. The reason for the misconception observed in this question is that students were unable to associate fractions with a denominator of one hundred with the concept of percentage, and that the concept of the unknown took precedence over the concept of percentage.

Question 3

In this question, it was intended to investigate how students wrote expressions represented by the percent symbol in fractional form.

3. Write the following expressions shown with the percent symbol as fractions.

- I. %13 _____→
- II. %2,5 _____→
- III. %4 _____→
- IV. %50 _____→

The percentages of students’ responses to Question 3 are presented in Table 5.

Table 5

Analysis of students’ responses to Question 3 in the study

Question Number	Percentage of Correct Responses	Percentage of Incorrect Responses	Percentage of Blank Responses	Percentage of Students Who Responded to the Question
3. I.	80.39%	9.41%	10.2%	89.8%
3. II.	50.19%	35.68%	14.13%	85.87%
3. III.	72.15%	18.43%	9.42%	90.58%

3.	IV.	80%	10.58%	9.42%	90.58%
----	-----	-----	--------	-------	--------

The findings related to the misconceptions encountered in the third question are presented in Table 6 in terms of percentages and frequencies.

Table 6

Analysis of the misconceptions experienced by students in Question 3 of the study

Causes of Misconceptions in the Third Question		Frequency	Percentage
1.	Conceptual misconceptions arising from incomplete learning or misconceptions in fractions.	35	32.71%
2.	Conceptual misconceptions arising from the topic of percentages	23	21.50%
3.	Conceptual misconceptions arising from incomplete learning or misconceptions in decimal representations.	49	45.79%
Total		107	100%

As shown in Table 6, the most common cause of misconceptions in this question, with a rate of 45.79%, is the conceptual misconceptions arising from incomplete learning or misconceptions in decimal representations.

The research findings reveal that students have largely acquired the learning outcome of expressing statements given with the percent symbol in fractional form. Approximately 80% of the students answered correctly in the first and fourth items of the question, and 72% answered correctly in the third item. However, the rate of correct responses to the second item decreased to 50%. The misconception observed in this item primarily stems from the fact that the number next to the percent symbol was given in decimal form. This situation led the majority of students to display behaviors such as being unable to decide what to do, applying the same solution strategies they used in the previous items, and attempting to “eliminate” the decimal representation. Incomplete or incorrect learning related to the topic of decimal representations also continued to affect students in the process of converting from percentages to fractions. Therefore, procedural errors such as shifting the decimal point, adding zeros, or omitting zeros were frequently observed among students. In addition, the fact that the concept of fractions had not been fully constructed in students caused incorrect representations to emerge in percentage–fraction conversions. Even in the correct representations, it was determined that students hesitated and were not confident in their responses. This situation was reflected in students’ behaviors such as writing the number next to the percent symbol in the denominator instead of the numerator, or dividing one hundred by the number next to the percent symbol to find the percentile value.

Question 4

In this question, it was intended to investigate how students made use of proportion when converting from fractional representation to percentage representation and to what extent misconceptions about proportion affected their learning of percentages.

4. $\frac{x}{100} = \frac{4}{5}$ what is the value of x in the equation? Explain your solution.

A) 70 B) 80 C) 90 D) 100

The percentages of students’ responses to Question 4 are presented in Table 7.

The percentages of students' responses to Question 5 are presented in Table 9.

Table 9

Analysis of students' responses to Question 5 in the study

Question Number	Percentage of Correct Responses	Percentage of Incorrect Responses	Percentage of Blank Responses	Percentage of Students Who Responded to the Question
5.	22.35%	62.74%	14.91%	85.09%

The findings related to the misconceptions encountered in the fifth question are presented in Table 10 in terms of percentages and frequencies.

Table 10

Analysis of the misconceptions experienced by students in Question 5 of the study

Causes of Misconceptions in the Fifth Question	Frequency	Percentage
1. Conceptual misconceptions arising from the inability to accurately make sense of the given information	39	44.32%
2. Conceptual misconceptions arising from procedural causes	28	31.82%
3. Conceptual misconceptions arising from prejudices	21	23.86%
Total	88	100%

As shown in Table 10, the most common cause of misconceptions in this question, with a rate of 44.32%, is the conceptual misconceptions arising from the inability to accurately make sense of the given information.

In the misconceptions observed in the fifth question, it was found that students followed the correct procedural steps at the beginning of the solution but failed to fully grasp the meaning dimension of the problem. Incomplete learning related to the concept of percentage led students to interpret each intermediate result they reached, without considering the whole, as a percentage expression. In the process of mathematical problem solving, the ability to understand the problem is one of the fundamental determinants of reaching the correct solution. In this context, the most common difficulty encountered among students stems from their inability to adequately analyze the information given and required in the problem.

Question 6

In this question, a problem commonly encountered in everyday shopping situations was presented. An attempt was made to observe what the students thought in such a situation and the types of misconceptions they exhibited.

6. Enes is going to buy a birthday gift for his brother Bilgehan. In the store he visits, it is written that a discount of 20% + 10% will be applied to the gift's price of 150 TL. Accordingly, how much should Enes pay for the gift? Explain your solution.
- A) 100 B) 103 C) 105 D) 108

The percentages of students' responses to Question 6 are presented in Table 11.

Table 14*Analysis of the misconceptions experienced by students in Question 7 of the study*

Causes of Misconceptions in the Seventh Question		Frequency	Percentage
1.	Conceptual misconceptions arising from the inability to accurately make sense of the given information	56	57.73%
2.	Conceptual misconceptions arising from procedural causes	32	32.99%
3.	Conceptual misconceptions arising from prejudices	9	9.28%
Total		97	100%

As shown in Table 14, the most common cause of misconceptions in this question, with a rate of 57.73%, is the conceptual misconceptions arising from the inability to accurately make sense of the given information.

It was observed that the students were unable to comprehend the problem in a holistic manner and focused only on certain parts of it. As a result of this, some students stated that the result was 400 by taking four times 100. The findings indicate that misconceptions arise when the stages of problem solving are not applied systematically and consciously. Therefore, it is necessary to carefully analyze the given and required information during the problem-solving process and to ensure that students carry out these stages within a meaningful and coherent framework.

Question 8

In this question, students were asked to find what percentage profit was made from a sale. An attempt was made to observe what the students thought in such a question and the types of misconceptions they exhibited.

8. Uncle Musa, who owns a store, sells the products in his shop at a 20% profit based on their cost price. The cost prices of the products in the store are given below.

Product	Cost Price
Shirt	20 TL
Trouser	30 TL
Sweater	40 TL
Jacket	60 TL

Accordingly, if Uncle Musa sells 3 shirts, 2 pairs of trousers, 3 sweaters, and 1 jacket, what percentage of profit does he make? Explain your solution.

- A) 15 B) 20 C) 25 D) 40

The percentages of students' responses to Question 8 are presented in Table 15.

Table 15*Analysis of students' responses to Question 8 in the study*

Question Number	Percentage of Correct Responses	Percentage of Incorrect Responses	Percentage of Blank Responses	Percentage of Students Who Responded to the Question
8.	28.23%	48.62%	23.15%	76.85%

The findings related to the misconceptions encountered in the eighth question are presented in Table 16 in terms of percentages and frequencies.

Table 16

Analysis of the misconceptions experienced by students in Question 8 of the study

Causes of Misconceptions in the Eighth Question		Frequency	Percentage
1.	Conceptual misconceptions arising from the topic of percentages	53	77.95%
2.	Conceptual misconceptions arising from incomplete learning or misconceptions in the topic of ratio and proportion	15	22.05%
Total		68	100%

As shown in Table 16, the most common cause of misconceptions in this question, with a rate of 77.95%, is the conceptual misconceptions arising from the topic of percentages.

It was observed that students were able to calculate a certain percentage of a whole, and that a considerable number of them could correctly determine the profit rate. However, students had difficulty identifying which value a specific portion of the whole corresponded to as a percentage. This finding indicates that the concept was only partially learned by students and that learning deficiencies persisted. This lack of understanding regarding percentages made it difficult for students to comprehend the problem as a whole and led them to develop their own solution methods when they failed to reach the correct result. Although the question clearly stated that the products were sold with a 20% profit, the variety and quantity of products mentioned in the problem prompted students to perform individual calculations for each item. Nevertheless, some students were able to recognize the 20% profit condition correctly and explicitly expressed it in their answers. Overall, the findings reveal that while students were generally able to complete the procedural steps, they reached incorrect results due to deficiencies in conceptual understanding. To reduce such misconceptions, it is necessary to emphasize the meaningful acquisition of related learning outcomes and to reinforce conceptual learning throughout the teaching process.

Question 9

In this question, students were asked to find a certain percentage of a whole in a problem that involved both large numbers and decimal values. An attempt was made to observe what the students thought in such a question and the types of misconceptions they exhibited.

9. Baki, a mathematics teacher, asked his students the following question in a written exam: "What is 0.06% of 720,000?" Which of the students whose answers are given below provided the correct answer? Explain your solution.
- A) AYŞE (426) B) YUNUS (428)
 C) MEDİNE (430) D) OSMAN (432)

The percentages of students' responses to Question 9 are presented in Table 17.

Table 17

Analysis of students' responses to Question 9 in the study

Question Number	Percentage of Correct Responses	Percentage of Incorrect Responses	Percentage of Blank Responses	Percentage of Students Who Responded to the Question
9.	48.23%	31.37%	20.4%	79.6%

The findings related to the misconceptions encountered in the ninth question are presented in Table 18 in terms of percentages and frequencies.

Table 18*Analysis of the misconceptions experienced by students in Question 9 of the study*

Causes of Misconceptions in the Ninth Question		Frequency	Percentage
1.	Conceptual misconceptions arising from incomplete learning or misconceptions in decimal representations	32	74.42%
2.	Conceptual misconceptions arising from incomplete learning or misconceptions in the topic of ratio and proportion	9	20.93%
3.	Conceptual misconceptions arising from procedural causes	2	4.65%
Total		43	100%

As shown in Table 18, the most common cause of misconceptions in this question, with a rate of 74.42%, is the conceptual misconceptions arising from incomplete learning or misconceptions related to decimal representations.

In the misconceptions observed in the ninth question, it was determined that students' incorrect and blank responses were primarily due to conceptual deficiencies related to decimal representation. The findings indicate that students grasped the principle of calculating a certain percentage of a whole; however, they failed to reach the correct result because they were unable to perform the operations involving decimal representations accurately. This situation reveals that mathematics has a cumulative structure and that deficiencies in prior learning are directly reflected in subsequent topics.

Question 10

In this question, students were asked to find the number whose certain percentage was given. An attempt was made to observe what the students thought regarding the intended learning outcome when a decimal representation was involved in the question and the types of misconceptions they exhibited.

10. What is the number whose 0.7% equals 1.4? Explain your solution.
 A) 100 B) 150 C) 200 D) 250

The percentages of students' responses to Question 10 are presented in Table 19.

Table 19*Analysis of students' responses to Question 10 in the study*

Question Number	Percentage of Correct Responses	Percentage of Incorrect Responses	Percentage of Blank Responses	Percentage of Students Who Responded to the Question
10.	41.96%	31.76%	26.28%	73.72%

The findings related to the misconceptions encountered in the tenth question are presented in Table 20 in terms of percentages and frequencies.

Table 20*Analysis of the misconceptions experienced by students in Question 10 of the study*

Causes of Misconceptions in the Tenth Question		Frequency	Percentage
1.	Conceptual misconceptions arising from the topic of percentages	31	56.36%
2.	Conceptual misconceptions arising from incomplete learning or misconceptions in decimal representations	24	43.64%

Total	55	100%
--------------	----	------

As shown in Table 20, the most common cause of misconceptions in this question, with a rate of 56.36%, is the conceptual misconceptions arising from the topic of percentages. Following this, with a rate of 43.64%, are the conceptual misconceptions resulting from incomplete learning or misconceptions related to decimal representations.

In the misconceptions observed in the tenth question, it was determined that students experienced difficulties in performing operations involving decimal representations. It was also observed that some students were unable to correctly identify the relationship between the whole and its parts in the problem. These findings indicate that students' prior incomplete learning continued to affect subsequent learning processes and reinforced their misconceptions. Therefore, it is necessary to systematically maintain instructional support aimed at addressing students' learning deficiencies.

Question 11

In this question, students were asked to find the value of a certain percentage of a specific percentage of a whole. It was attempted to observe what the students thought in this question and the types of misconceptions they exhibited.

11. What is 20% of 25% of 80? Explain your solution.

- A) 4 B) 8 C) 16 D) 20

The percentages of students' responses to Question 11 are presented in Table 21.

Table 21

Analysis of students' responses to Question 11 in the study

Question Number	Percentage of Correct Responses	Percentage of Incorrect Responses	Percentage of Blank Responses	Percentage of Students Who Responded to the Question
11.	54.50%	38.43%	7.07%	92.93%

The findings related to the misconceptions encountered in the eleventh question are presented in Table 22 in terms of percentages and frequencies.

Table 22

Analysis of the misconceptions experienced by students in Question 11 of the study

Causes of Misconceptions in the Eleventh Question		Frequency	Percentage
1.	Conceptual misconceptions arising from the topic of percentages	33	56.90%
2.	Conceptual misconceptions arising from the inability to accurately make sense of the given information	20	34.48%
3.	Conceptual misconceptions arising from prejudices	5	8.62%
Total		58	100%

As shown in Table 22, the most common cause of misconceptions in this question, with a rate of 56.90%, is the conceptual misconceptions arising from the topic of percentages.

It was observed that students were unable to learn new or different types of information because they could not move beyond their fixed or formulaic knowledge. The strategic approaches they developed to simplify operations eventually led to the formation of

misconceptions over time. Students generalized these approaches and adopted them as problem-solving methods in similar questions.

Question 12

In this question, students were asked to demonstrate how multiplying a number by a decimal number extending to the hundredths place affects the number in terms of percentage change. An attempt was made to observe what the students thought in this question and the types of misconceptions they exhibited.

12. When a number is multiplied by 1.15, by what percentage (%) is the number increased? Explain your solution.

A) 1,15 B) 11,5 C) 115 D) 15

The percentages of students' responses to Question 12 are presented in Table 23.

Table 23

Analysis of students' responses to Question 12 in the study

Question Number	Percentage of Correct Responses	Percentage of Incorrect Responses	Percentage of Blank Responses	Percentage of Students Who Responded to the Question
12.	20.78%	67.45%	11.77%	88.23%

The findings related to the misconceptions identified in Question twelve are presented in Table 24 in terms of percentages and frequencies.

Table 24

Analysis of the misconceptions experienced by students in Question 12 of the study

Causes of the misconceptions in the twelfth question	Frequency	Percentage
1. Conceptual misconceptions arising from the topic of percentages	76	69.72%
2. Conceptual misconceptions arising from incomplete learning or misconceptions in decimal representations	6	5.50%
3. Conceptual misconceptions arising from procedural causes	27	24.78%
Total	109	100%

As shown in Table 24, the misconceptions that most frequently led to errors in this question, with a rate of 69.72%, were those arising from the topic of percentages.

It was observed that the majority of students gave either 1.15 or 115 as their answers to the question. The formation of these responses was influenced by thoughts such as "multiplying by 1.15 means increasing the number by that percentage" or "we should multiply 1.15 by 100 and remove the decimal point; when the decimals are removed, it becomes 115, which represents a percentage increase." All these show that the students had created their own rules. They generalized and applied the incorrect rules they had formed, such as "once the decimal is removed, the answer appears" or "multiplying means the answer is already found," to the questions. These types of misconceptions can be resolved through immediate feedback generated by monitoring the students' responses to similar questions presented during lessons.

Question 13

In this question, as in the previous one, students were asked to demonstrate how multiplying a number by a decimal value rounded to the hundredths place affects the number in terms of percentage change. An attempt was made to observe what the students thought in this question and the types of misconceptions they exhibited.

Table 30

Analysis of the misconceptions experienced by students in Question 15 of the study

Causes of the misconceptions in the fifteenth question		Frequency	Percentage
1.	Conceptual misconceptions arising from the topic of percentages	38	73.08%
2.	Conceptual misconceptions arising from the inability to accurately make sense of the given information	14	26.92%
Total		52	100%

As shown in Table 30, the misconceptions most frequently observed in this question, at a rate of 73.08%, were conceptual misconceptions arising from the topic of percentages.

As in the previous questions, the students performed calculations without fully understanding what the problem was asking. This led to confusion within their existing knowledge of percentages and the formation of new misconceptions. Since the learning outcomes related to percentages are prone to being confused with one another, the students developed additional misconceptions.

Question 16

In this question, students were asked to express the percentages of the substances mixed in a mixture problem that they might encounter in daily life. An attempt was made to observe what the students thought in this question and the types of misconceptions they exhibited.

16. A saltwater mixture is prepared by mixing 24 kilograms of water with 8 kilograms of salt. What is the ratio of water in the mixture expressed as a percentage? Explain your solution.
 A) 25 B) 50 C) 75 D) 85

The percentages of the students' responses to Question 16 are presented in Table 31.

Table 31

Analysis of students' responses to Question 16 in the study.

Question Number	Percentage of Correct Responses	Percentage of Incorrect Responses	Percentage of Blank Responses	Percentage of Students Who Responded to the Question
16.	32.54%	39.60%	27.86%	72.14%

The findings related to the misconceptions identified in Question sixteen are presented in Table 32 in terms of percentages and frequencies.

Table 32

Analysis of the misconceptions experienced by students in Question 16 of the study

Causes of the misconceptions in the sixteenth question		Frequency	Percentage
1.	Conceptual misconceptions arising from incomplete learning or misconceptions in fractions	21	45.65%
2.	Conceptual misconceptions arising from incomplete learning or misconceptions in the topic of ratio and proportion	16	34.78%
3.	Conceptual misconceptions arising from the inability to accurately make sense of the given information	9	19.57%
Total		46	100%

As shown in Table 32, the most common misconception in this question, with a rate of 45.65%, resulted from incomplete learning in fractions or misconceptions formed in fractions.

It was determined that the misconceptions observed in the sixteenth question stemmed from students' inability to fully comprehend the question and from their incomplete learning of fundamental topics. This situation indicates that students need to accurately analyze the relationship between the given and required information in the questions and perform meaningful and consistent operations. During the instructional process, conducting regular review activities focusing on fundamental mathematical concepts may contribute to addressing students' conceptual deficiencies. In this way, it is anticipated that misconceptions and errors can be minimized.

Question 17

In this question, students were asked to find the original price of a product sold at a certain discounted price with a given percentage discount, similar to situations they might encounter in daily life. An attempt was made to observe what the students thought in this question and the types of misconceptions they exhibited.

17. Mr. Mehmet bought a printer from a technology store for 210 TL after a 30% discount. Accordingly, what was the original price of the printer before the discount? Explain your solution.
- A) 147 B) 210 C) 300 D) 320

The percentages of the students' responses to Question 17 are presented in Table 33.

Table 33

Analysis of students' responses to Question 17 in the study

Question Number	Percentage of Correct Responses	Percentage of Incorrect Responses	Percentage of Blank Responses	Percentage of Students Who Responded to the Question
17.	44,70%	40,00%	15,30%	84,70%

The findings related to the misconceptions identified in Question seventeen are presented in Table 34 in terms of percentages and frequencies.

Table 34

Analysis of the misconceptions experienced by students in Question 17 of the study

Causes of the misconceptions in Question Seventeen	Frequency	Percentage
1. Conceptual misconceptions arising from the inability to accurately make sense of the given information	35	71.43%
2. Conceptual misconceptions arising from procedural causes	14	28.57%
Total	49	100%

As shown in Table 34, the most common misconceptions in this question, accounting for 71.43%, were conceptual misconceptions arising from the inability to correctly interpret the given information.

It was determined that the misconceptions observed in Question Seventeen stemmed from the students' inability to accurately comprehend the information given and requested in the problem statement. The findings revealed that students, relying on previously acquired

stereotyped knowledge, focused solely on the concept of discount and, as a result, performed incorrect operations that led to conceptual misconceptions. Although the problem explicitly provided the post-discount price, many students erroneously applied an additional 30% discount to the already discounted price of 210 TL, effectively performing a second discount operation.

Question 18

In this question, students were asked to analyze a situation they encounter in daily life by determining the percentage part based on the whole and then finding the whole itself. An attempt was made to observe what the students thought in this question and the types of misconceptions they exhibited.

18. In a class, **36%** of the students are boys. If the number of girls in the class is **32**, how many students are there in total? Explain your solution.

A) 42

B) 45

C) 48

D) 50

The percentages of the students' responses to Question 18 are presented in Table 35.

Table 35

Analysis of students' responses to Question 18 in the study

Question Number	Percentage of Correct Responses	Percentage of Incorrect Responses	Percentage of Blank Responses	Percentage of Students Who Responded to the Question
18.	34.11%	35.29%	30.60%	69.40%

The findings related to the misconceptions identified in Question eighteen are presented in Table 36 in terms of percentages and frequencies.

Table 36

Analysis of the misconceptions experienced by students in Question 18 of the study

Causes of the misconceptions in Question Eighteen	Frequency	Percentage
1. Conceptual misconceptions arising from procedural causes	26	70.27%
2. Conceptual misconceptions arising from the inability to accurately make sense of the given information	11	29.73%
Total	37	100%

As shown in Table 36. the most common misconceptions in this question. accounting for 70.27%. were conceptual misconceptions arising from procedural causes.

In the misconceptions observed in the eighteenth question. it was determined that students attempted to reach the solution by establishing proportional relationships. However. due to their incomplete learning of fractions. they made errors in the procedural steps. As a result. some students provided incorrect answers. while others left the question unanswered. stating in their explanations that they did not fully understand the problem and were uncertain about how to approach the solution.

Question 19

In this question. students were asked to find the whole by using numbers with given percentages that they encounter in everyday life. An attempt was made to observe what the students thought in this question and the types of misconceptions they exhibited.

19. After spending 25% of his monthly income on rent, 5% on kitchen expenses, and 10% on bills, Mr. Vefa has 1.260 TL left. Accordingly, what is Mr. Vefa's monthly income? Explain your solution.

A) 2100 B) 2150 C) 2050 D) 2250

The percentages of the students' responses to Question 19 are presented in Table 37.

Table 37

Analysis of students' responses to Question 19 in the study

Question Number	Percentage of Correct Responses	Percentage of Incorrect Responses	Percentage of Blank Responses	Percentage of Students Who Responded to the Question
19.	37.64%	39.60%	22.76%	77.24%

The findings related to the misconceptions identified in Question nineteen are presented in Table 38 in terms of percentages and frequencies.

Table 38

Analysis of the misconceptions experienced by students in Question 19 of the study

Causes of the misconceptions in Question Nineteen	Frequency	Percentage
1. Conceptual misconceptions arising from incomplete learning or misconceptions in decimal representations	8	16%
2. Conceptual misconceptions arising from prejudices	13	26%
3. Conceptual misconceptions arising from the inability to accurately make sense of the given information	29	58%
Total	50	100%

As shown in Table 38, the most common misconceptions in this question, accounting for 58%, were conceptual misconceptions arising from the inability to correctly interpret the given information.

In Question nineteen, it was observed that students tended to calculate each percentage separately when solving problems involving multiple percentage expressions. However, although the question asked for the whole, some students treated the given part as the whole and performed percentage calculations based on this incorrect assumption, leading to erroneous results. Others stated that they were unable to solve problems containing multiple percentage expressions and left the question unanswered. The main cause of this misconception lies in the students' inability to understand what the percentage expressions in the question represented. The findings indicate that although students possessed basic knowledge of the concept of percentage, similar to situations encountered in daily life, they were unable to apply this knowledge correctly during the problem-solving process.

Question 20

In this question, students were asked to find the price of a product excluding VAT (Value Added Tax) based on its VAT-included price, as encountered in daily life. An attempt was made to observe what the students thought in this question and the types of misconceptions they exhibited.

20. What is the price of a suit excluding VAT (Value Added Tax) if its price including 14% VAT is 342 TL? Explain your solution.

A) 250 B) 280 C) 300 D) 320

The percentages of the students' responses to Question 20 are presented in Table 39.

Table 39

Analysis of students' responses to Question 20 in the study

Question Number	Percentage of Correct Responses	Percentage of Incorrect Responses	Percentage of Blank Responses	Percentage of Students Who Responded to the Question
20.	36.47%	36.86%	26.67%	73.33%

The findings related to the misconceptions identified in Question twenty are presented in Table 40 in terms of percentages and frequencies.

Table 40

Analysis of the misconceptions experienced by students in Question 20 of the study

Causes of the misconceptions in Question twenty	Frequency	Percentage
1. Conceptual misconceptions arising from the inability to accurately make sense of the given information	41	100%
Total	41	100%

As shown in Table 40. in this question. 100% of the misconceptions were caused by conceptual misunderstandings arising from the inability to correctly interpret the given information.

In Question twenty. it was determined that students experienced difficulties in making sense of the concept of Value Added Tax (VAT). The findings indicated that students did not fully comprehend that VAT is an additional value added to the cost price. Some students confused VAT with the concept of discount. leading to incorrect calculations. while others assumed that since a percentage was mentioned in the question. they needed to find the given percentage of the number. which resulted in incorrect solution strategies. This situation revealed that students focused on the superficial procedural aspects of the problem rather than analyzing it holistically and that they lacked a complete understanding of fundamental concepts. Therefore. during the teaching process. instead of having students memorize specific problem patterns. instructional approaches should be adopted that help them understand what the questions represent and develop their conceptual thinking skills.

Question 21

In the context of daily life. students were asked to determine how much interest a certain amount of money deposited in a bank would earn at a given interest rate. An attempt was made to observe what the students thought in this question and the types of misconceptions they exhibited.

21. Mine deposits 15.000 TL in a bank for two years at an annual interest rate of 18%. How much interest will Mine receive from the bank at the end of this period? Explain your solution.
- A) 5000 B) 5250 C) 5300 D) 5400

The percentages of the students' responses to Question 21 are presented in Table 41.

Table 41*Analysis of students' responses to Question 21 in the study*

Question Number	Percentage of Correct Responses	Percentage of Incorrect Responses	Percentage of Blank Responses	Percentage of Students Who Responded to the Question
21.	42.35%	33.33%	24.32%	75.68%

The findings related to the misconceptions identified in Question twenty-one are presented in Table 42 in terms of percentage and frequency.

Table 42*Analysis of the misconceptions experienced by students in Question 21 of the study*

Causes of the misconceptions in Question twenty-one	Frequency	Percentage
1. Conceptual misconceptions arising from the topic of percentages	29	65.91%
2. Conceptual misconceptions arising from procedural causes	6	13.64%
3. Conceptual misconceptions arising from prejudices	9	20.45%
Total	44	100%

As shown in Table 42. the most common misconceptions in this question. accounting for 65.91%. were conceptual misconceptions arising from the topic of percentages.

Students experienced difficulties in their computational skills due to the large numerical values presented in the question. This situation led to the emergence of conceptual misconceptions related to the topic of percentages. The concept of interest had not been fully formed as a mathematical idea among the students. Similar to the value-added tax (VAT) concept in Question twenty. it was observed that students were unable to fully comprehend the concept of interest or determine an appropriate method for solving such problems. Consequently. they made errors in applying the percentage-based interest expression during their solutions.

Question 22

In this question. which was based on an example from daily life. students were asked to determine the value-added tax (VAT) percentage of a product whose VAT-included price and VAT amount were provided. An attempt was made to observe what the students thought in this question and the types of misconceptions they exhibited.

22. Nevin purchased a product from a store for 327 TL. including VAT. and paid 27 TL as VAT. Accordingly. what is the percentage of VAT for the product Nevin purchased? Explain your solution.
- A) 7 B) 8 C) 9 D) 10

The percentages of the students' responses to Question 22 are presented in Table 43.

Table 43*Analysis of students' responses to Question 22 in the study*

Question Number	Percentage of Correct Responses	Percentage of Incorrect Responses	Percentage of Blank Responses	Percentage of Students Who Responded to the Question
22.	34.90%	36.07%	29.03%	70.97%

The findings related to the misconceptions identified in Question twenty-two are presented in Table 44 in terms of percentage and frequency.

Table 44

Analysis of the misconceptions experienced by students in Question 22 of the study

Causes of the misconceptions in Question twenty-two	Frequency	Percentage
1. Conceptual misconceptions arising from procedural causes	28	51.85%
2. Conceptual misconceptions arising from the inability to accurately make sense of the given information	15	27.78%
3. Conceptual misconceptions arising from prejudices	11	20.37%
Total	54	100%

As seen in Table 44. the misconceptions caused by procedural reasons are the most common in this question. accounting for 51.85% of the total misconceptions.

In the misconceptions observed in Question twenty-two. it was seen that students' perspectives on the question changed when they saw the term VAT. Some students found the price without VAT but could not figure out how to proceed. Others thought they could determine the VAT percentage by trying the options. They also performed operations based on the VAT-included price given in the question. Difficulties in their procedural skills led them to form new misconceptions. Since the given information was not fully understood. many incorrect and misconception-based answers emerged.

According to the findings obtained from the diagnostic test. the grouping that indicates the frequencies and percentages of all categories of misconceptions is presented in Table 45.

Table 45

Frequencies and percentages of the misconceptions experienced by students in the study

Causes of misconceptions	Frequency	Percentage
1. Conceptual misconceptions arising from the topic of percentages	499	31.91%
2. Conceptual misconceptions arising from incomplete learning or misconceptions in decimal representations	233	14.89%
3. Conceptual misconceptions arising from incomplete learning or misconceptions in fractions	198	12.66%
4. Conceptual misconceptions arising from algebraic expressions and equations	9	0.58%
5. Conceptual misconceptions arising from the inability to accurately make sense of the given information	300	19.18%
6. Conceptual misconceptions arising from incomplete learning or misconceptions in the topic of ratio and proportion	54	3.45%
7. Conceptual misconceptions arising from procedural causes	188	12.02%
8. Conceptual misconceptions arising from prejudices	83	5.31%
Total	1564	100%

According to the data in Table 45. the misconceptions that originated from the concept of percentages ranked first. accounting for 31.91% of the incorrect responses given to our diagnostic test on the topic of percentages. The second most common misconceptions. with a rate of 19.18%. resulted from the inability to correctly interpret the given information. In third place.

misconceptions caused by incomplete learning or misunderstandings related to decimal representations accounted for 14.89%.

Discussion and Conclusion

In this study, the misconceptions of 7th-grade students regarding the concept of percentages were examined in a multidimensional manner. The findings indicate that a considerable proportion of students have not fully comprehended the fundamental concepts related to percentages; in particular, they experience notable difficulties in fraction–decimal–percent conversions, in understanding the logic of ratio and proportion, in interpreting the meaning of the percent symbol, and in applying percentages within real-life contexts. According to the research results, 31.58% of students' misconceptions about percentages originate from deficiencies in their prior learning, and this rate reflects the combined total of deficiencies in fractions (12.66%), decimal representations (14.89%), ratio–proportion (3.45%), and algebraic expressions and equations (0.58%). The misconceptions are generally rooted in previous learning deficiencies, and this situation leads students to develop rote-based, superficial, and incorrect solution strategies when solving problems related to percentages.

The percent expression represents a fraction with a denominator of one hundred. Therefore, it is observed that deficiencies in simplifying and expanding fractions lead to misconceptions about percentages. Indeed, in the study conducted by Yılmaz and Yenilmez (2008), it was stated that the misconceptions of 7th- and 8th-grade students regarding decimal numbers stemmed from their inadequacies in expanding a given fraction so that its denominator becomes one hundred. These findings are consistent with the data obtained in our study.

The findings obtained reveal that students have not fully internalized the learning outcomes related to the concept of percentages. The failure to sufficiently internalize these outcomes leads to confusion between concepts in practice and to the inability to make sense of percentage expressions correctly. At the root of this problem lie the challenges students face in mentally concretizing abstract concepts. Similarly, in the study conducted by Yıldız and Sayan (2010), titled *Teachers' Views on the Representation of Decimal Numbers*, it was stated based on teachers' opinions that students were unable to concretize these abstract concepts in their minds and failed to make sense of them, which consequently led to the formation of misconceptions.

The study reveals that even students who have learned the learning outcomes related to percentages have difficulty determining which outcome they should focus on in the questions and make mistakes in practice. Bell and Baki (1997) also emphasized that students were unable to establish the relationship between fractions and decimal representations and therefore developed misconceptions (Bell & Baki, 1997, as cited in Altıparmak & Palabıyık, 2017). Clearly conveying to students that the concept of percentage is a special form of fraction will help information to be retained in the mind in a more permanent and solid way, thereby reducing the formation of misconceptions. Allinger and Payne (1986) also demonstrated that students generally developed rule-based and rote solution strategies when solving percentage problems (Allinger & Payne, 1986, as cited in Yapıcı, 2013).

In the study, it was determined that 19.18% of the misconceptions stemmed from students' failure to correctly make sense of the given information. Meaning lies at the core of conceptual knowledge. The association and internalization of information contribute to the development of conceptual understanding (Ersoy, 2003). Students often perform arithmetic operations that they find appropriate for the given numbers in the questions, yet they are unable to explain why they use those operations and mostly aim to reach one of the options provided. Gay (1990) states that for some students, the percent symbol does not carry any particular meaning. This superficial approach observed in students' problem-solving processes is one of the

main reasons not only for misconceptions related to the concept of percentage but also for conceptual deficiencies in general. Similarly, in the study conducted by Kaplan, İşleyen, and Öztürk (2011), it was observed that misconceptions occurred as a result of the inability to adequately make sense of the concept of ratio and the tendency toward overgeneralization. To minimize misconceptions, instructional processes should be designed to focus on meaningful learning, students' progress should be closely monitored, and regular studies should be carried out under the guidance of teachers.

The results of this study indicate that students experienced significant difficulties, particularly in the topic of decimal representation. In decimal numbers containing a comma, students have difficulty performing operations and mostly fail to comprehend the function of the comma. In the study conducted by Yıldız and Sayan (2010), titled *Teachers' Views on the Representation of Decimal Numbers*, it was stated that the concept of the comma was not understood by students, and that they either ignored the comma and considered the number as a whole number or perceived it merely as a separator between two integers. Similarly, in the study conducted by Gür and Seyhan (2004), it was observed—consistent with the findings of our research—that students were unable to make sense of the concept of the comma in decimal representations. In addition, errors in understanding how the comma moves during operations with decimal numbers also led to misconceptions (Gür & Seyhan, 2004, as cited in Alkan, 2009, pp. 18–19), and in our study as well, it was observed that students experienced similar misconceptions in the questions involving decimal representations.

Kayhan (2005) emphasizes that the topic of ratio and proportion is a fundamental and important area in mathematics for many other topics. Indeed, in the present study, it was determined that one of the major causes of misconceptions regarding percentages was the incomplete learning of the topic of ratio and proportion. Çetin (2009) also states that the main reason students at different grade levels have difficulties with ratio–proportion and fractions lies in the complex relationships among these concepts. The interactions of these concepts, both among themselves and with other mathematical concepts, provide a basis for the formation of misconceptions. Percentage is also a fraction and a ratio (Baykul, 2019), which indicates that misconceptions about percentages are closely related to deficiencies in students' knowledge of ratio, proportion, and fractions. The findings of our study also reveal that these misconceptions stem from the inability to adequately establish connections and transitions between mathematical concepts.

Yıldız ve Sayan (2010) state that the deficiencies in students' previously learned topics lead to misconceptions. The main source of these misconceptions mostly stems from the gaps formed in students' prior learning. In particular, the failure to construct concepts in sufficient depth in topics such as fractions, decimals, and ratio–proportion directly reflects on the topic of percentages and paves the way for the formation of new misconceptions. Students are often able to perform operations mechanically; however, since they fail to grasp the conceptual basis underlying these procedural steps, they develop rote-based, superficial, and incorrect solution strategies in problems related to percentages. This situation weakens the meaning dimension of mathematical thinking and poses a serious obstacle to permanent learning.

The present study revealed that 12.02% of the students developed misconceptions about percentages due to their insufficient procedural knowledge. In particular, their inability to correctly determine which operations should be applied to concepts such as raise, discount, profit, VAT, and interest provides a basis for the emergence of these misconceptions. In addition, it was observed that incomplete learning of division and multiplication also contributed to the development of new misconceptions. The test results and interview data indicate that when solving problems involving real-life contexts, students generally give answers based on guessing

or intuition rather than reasoning, and they often cannot explain why they perform certain operations.

According to the findings obtained in the study, 5.31% of the misconceptions were found to stem from the students' existing prejudices. Tekkaya, Çapa, and Yılmaz emphasize that the lack of prior knowledge, the presence of unscientific preconceptions, and the difference between the language used in textbooks and daily life and that of scientific discourse lead to the formation of misconceptions (Tekkaya, Çapa, & Yılmaz, 2000). In our study as well, it was observed that students held prejudiced thoughts such as "I can't do questions with commas," "I have difficulty solving percentage questions," or "I can't solve when there is more than one percentage." These prejudices not only hinder the understanding of the topic but also pave the way for the formation of new misconceptions. It is considered important that students' readiness levels be evaluated not only in cognitive but also in psychological dimensions, and that this psychological foundation be strengthened before the introduction of new topics.

In conclusion, in order to prevent misconceptions, instructional processes need to be restructured in a way that supports students' meaningful learning. Students' development should be closely monitored, they should be encouraged to develop regular reading habits, and the teaching of concepts should be ensured by relating them to daily life. In this way, it will be possible both to achieve permanent learning of mathematical concepts and to enable students to acquire a stronger conceptual foundation in topics such as percentages, which are frequently encountered in everyday life.

Limitations

The study was conducted only in three schools located in the Aegean Region of Türkiye, and therefore, the generalizability of the findings is limited for other regions that differ in geographical, cultural, and socio-economic characteristics. The inter-coder reliability was not measured during the analysis of the interview data. In addition, the number of interviews was limited to only 10 students.

Recommendations

This study revealed that the concept of percentage holds critical importance for students not only in terms of academic achievement but also in relation to daily life skills. In line with the findings obtained, several recommendations have been presented to minimize misconceptions about percentages and to support students' conceptual development.

Students should be ensured to have a solid conceptual foundation in topics such as fractions, decimal representations, and ratio–proportion before moving on to the concept of percentages. In this context, preparatory activities, diagnostic tests, and topic reviews should be included to identify and address learning deficiencies.

Students should be encouraged to grasp not only the procedural aspect of the percent symbol but also the meaning it represents (for example, how many units it indicates out of every 100 units). In this context, at the beginning of the topic, concrete materials, physical models (such as visuals showing 25% painted areas), and concept maps should be used to help students mentally construct the concept and to ensure that their conceptual development is effectively supported.

Addressing the topic of percentages within real-life contexts such as discount, interest, tax, profit–loss, and mixture problems facilitates students' concretization and internalization of the concept. It is therefore recommended that such contexts be incorporated more extensively into instructional materials.

It is important to use assessment tools that include open-ended and justification-based questions in order to identify students' misconceptions. In this way, errors can be detected and corrected immediately. In addition, previous studies on misconceptions should be examined, and preventive measures should be taken against the possibility of similar problems arising.

In the teaching process, emphasis should be placed not on how operations are performed but on why they are performed, and students should be encouraged to justify their solution processes. For this purpose, after each question, students should be guided to reflect on what they did, why they did it that way, and what alternative approaches could be applied. Active participation in the lesson should be supported; concepts should be presented through multiple solution methods and case analyses, and students' opinions on the topic should be taken to identify and correct possible misconceptions at an early stage. Teachers should contribute to strengthening conceptual understanding by conducting in-class problem-solving and discussions based on examples that include common student errors. In addition, at the end of each topic, reflective sessions should be held with questions such as "What did we learn today?", "Where did we have difficulties?", and "Why did we have difficulties?".

Student prejudices regarding the concept of percentage can be identified through the use of simple attitude scales, and based on the data obtained, the causes of these prejudices should be explained and addressed. Students' psychological readiness levels should be taken into consideration during this process.

Nguyen and Nguyen (2023) stated that when calculators are used consciously and for pedagogical purposes in mathematics instruction, they support students' conceptual learning. According to the researchers, a calculator should not be regarded merely as a tool that accelerates computational processes but also as a learning environment that facilitates students' exploration of relationships among mathematical concepts. The study emphasized that with the aid of calculators, students were able to compare different solution strategies, experienced reduced anxiety about making mistakes, and participated more actively in the problem-solving process. However, Nguyen and Nguyen (2023) suggested that teachers should explain to students the underlying logic of how these tools operate and integrate calculator use with conceptual discussions. These findings indicate that calculators can be used in teaching the concept of percentage not merely as mechanical tools but as cognitive instruments that promote meaningful learning. Therefore, calculators and digital tools should be incorporated into the instructional process in ways that support students' ability to solve percentage-related problems using different strategies. In addition, to reinforce conceptual coherence, the operational logic of these tools should be explicitly presented to students, and the technology-supported learning process should be structured in alignment with pedagogical objectives.

Preservice and current teachers should be included in in-service training programs on the nature, identification, and elimination of misconceptions. Teachers' professional competencies should be supported through case analyses and classroom practice examples specific to the topic of percentages.

Finally, sufficient time should be allocated in the instructional process to allow for the in-depth discussion of concepts, the development of different perspectives, and the cultivation of holistic thinking skills. Students should be supported in learning concepts in a meaningful way.

References

- Alkan. R. (2009). *İlköğretim 7. sınıf öğrencilerinin matematik dersi rasyonel sayılar konusu ile ilgili hata ve kavram yanlışlarının analizi* [Yüksek lisans tezi. Gazi Üniversitesi]. YÖK Tez Merkezi.
- Altıparmak. K.. & Palabıyık. E. (2017). 4. ve 5. sınıf öğrencilerinin ondalık gösterim konusundaki kavram yanlışlarının ve hatalarının tespiti ve analizi. *Muş Alparslan Üniversitesi Sosyal Bilimler Dergisi*, 5(2). 447–470.
- Baykul. Y. (2019). *Ortaokulda matematik öğretimi* (3. bs.). Pegem Akademi.
- Bingölbali. E.. & Özmantar. M. F. (2012). *İlköğretimde karşılaşılan matematiksel zorluklar ve çözüm önerileri*. Pegem Akademi.
- Cole. B.. & Weissenfluh. H. (1974). An analysis of teaching percentages. *Arithmetic Teacher*, 21. 226–228.
- Çetin. İ. (2009). *7. ve 9. sınıf öğrencilerinin oran ve orantı konusundaki kavram yanlışları* [Yüksek lisans tezi. Selçuk Üniversitesi]. YÖK Tez Merkezi.
- Danan. J. A. J.. & Gelman. R. (2018). The problem with percentages. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 373(1740). 20160519. <https://doi.org/10.1098/rstb.2016.0519>
- English. L. D.. & Halford. S. (1995). *Mathematics education models and processes*. Lawrence Erlbaum Associates Publishers.
- Erdem. A. R.. & Genç. G. (2014). Ortaokul beşinci sınıfta seçmeli “Matematik Uygulamaları” dersini seçen öğrencilerin derse ilişkin görüşleri. *Eğitimde Nitel Araştırmalar Dergisi*, 2(2). 9–26.
- Ersoy. Y. (2003). *Matematik okur-yazarlığı II: Hedefler, geliştirilecek yetiler ve beceriler*. <http://www.matder.org.tr/matematik-okur-yazarligi-iihedefler-gelistirilecek-yetiler-ve-beceriler>
- Gay. A. S. (1990). *A study of middle school students' understanding of number sense related to percent* (Doctoral dissertation. Oklahoma State University). *Dissertation Abstracts International*, 51(6). 1823. UMI No. 9119873. <https://openresearch.okstate.edu/server/api/core/bitstreams/cadbb25a-e047-4829-88cc-beacf50dc649/content>
- Kaplan. A.. İşleyen. T.. & Öztürk. M. (2011). 6. sınıf oran orantı konusundaki kavram yanlışları. *Kastamonu Eğitim Dergisi*, 19(3). 953–968.
- Kayhan. M. (2005). *6. ve 7. sınıf öğrencilerinin oran-orantı konusuna yönelik çözüm stratejilerinin; sınıf düzeyine, cinsiyete ve soru tipine göre değişiminin incelenmesi* [Yüksek lisans tezi. Hacettepe Üniversitesi]. YÖK Tez Merkezi.
- Millî Eğitim Bakanlığı. (2018). *Matematik dersi (1.-8. sınıflar) öğretim programı*.
- National Research Council. (1997). *Science teaching reconsidered: A handbook* [Chapter 4: Misconceptions as barriers to understanding science]. National Academies Press. <https://nap.nationalacademies.org/read/5287/chapter/5>
- Nguyen. N. D.. & Nguyen. H. V. (2023). The use of calculators in teaching mathematics: A survey in Vietnam. *European Journal of Educational Research*, 12(3). 1475–1491. <https://files.eric.ed.gov/fulltext/EJ1409268.pdf>
- Şimşek. H.. & Yıldırım. A. (2011). *Sosyal bilimlerde nitel araştırma yöntemleri*. Seçkin Yayıncılık.
- Tekkaya. C.. Çapa. Y.. & Yılmaz. Ö. (2000). Biyoloji öğretmen adaylarının genel biyoloji konularındaki kavram yanlışları. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, 18. 140–147.
- Yapıcı. A. (2013). *5. 6 ve 7. sınıf öğrencilerinin yüzdeler konusunda sayı duyularının incelenmesi* [Yüksek lisans tezi. Hacettepe Üniversitesi]. YÖK Tez Merkezi.

- Yapıcı. A.. & Kayhan Altay. M. (2017). An investigation of middle school students' number sense regarding percent. *Abant İzzet Baysal Üniversitesi Eğitim Fakültesi Dergisi*, 17(4). 2221–2243.
- Yaşa. E.. & Yenilmez. K. (2008). İlköğretim öğrencilerinin geometrideki kavram yanlışları. *Uludağ Üniversitesi Eğitim Fakültesi Dergisi*, 21(2). 461–483.
- Yenilmez. K.. & Duman. A. (2008). İlköğretimde matematik başarısını etkileyen faktörlere ilişkin öğrenci görüşleri. *Manas Üniversitesi Sosyal Bilimler Dergisi*, 10(19). 251–268.
- Yıldız. C.. & Sayan. E. (2010. Eylül). Ondalık sayıların öğretimiyle ilgili öğretmen görüşleri. 9. *Ulusal Fen Bilimleri ve Matematik Eğitimi Kongresi*. Dokuz Eylül Üniversitesi. İzmir. Türkiye.
- Yılmaz. Z.. & Yenilmez. K. (2008). İlköğretim 7. ve 8. sınıf öğrencilerinin ondalık sayılar konusundaki kavram yanlışları. *Afyon Kocatepe Üniversitesi Fen Bilimleri Dergisi*, 8(1). 291–312.