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Mathematics on News: How do Students Interpret Percentages in Daily Life Situations?*

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Abstract

Contexts with real-life situations can be more motivating for students, increase students' attitudes and interest, and strengthen the connection between mathematics and daily life. This study examined student interpretations of News texts consisting entirely of real-life situations and including percentage representations. In this qualitative case study, data were obtained from 30 8th grade students. Students were asked 6 News texts containing various percentage values and were expected to explain what they understood from these percentage values. The data obtained from the study were subjected to content analysis and interpreted by authors. The results indicate that students have difficulty in interpreting real-life situations involving percentage representation, and very few students make clear and understandable comments about real-life situations. It suggests that most students focused solely on the numerical growth of the percentage expression. Some students struggled with the News text, while others provided irrelevant, unclear, or meaningless responses. According to these findings, it is recommended that students' interpretations of real-world context in mathematics lessons be discussed more frequently in the classroom settings.

Key Words

Contexts • Mathematics • Middle school students• Percentages • Real life situations

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Introduction

One of the most important goals of school mathematics is to enable students to connect mathematics with daily life. In this context, the Program for International Student Assessment (PISA), which is conducted by the Organization for Economic Cooperation and Development (OECD) every three years, measures the extent to which 15-year-old students can use the knowledge and skills they learn at school in daily life (MoNE, 2020; OECD, 2012). The concept expressed as mathematical literacy in PISA refers to a person's ability to reason, analyze, formulate and solve tasks in a real-world situation (Hope, 2007). The tasks in PISA are categorized according to various proficiency levels and each task includes a daily life context. All tasks in PISA fall into scientific, social, personal or occupational categories, and it is ensured that the tasks include realistic situations as much as possible (Kabael & Barak, 2016). In this regard, PISA reports offer a second classification framework that categorizes tasks based on how realistic the contexts are presented (OECD, 2009). This framework classifies tasks into three categories: level 0, level 1, and level 2. Zero-level contexts are defined as unrealistic, camouflage or dressed-up contexts in which the student does not need the context to solve the task, while first-order contexts are more realistic and require the student to understand the context in order to solve the task. Second level contexts are defined as real-life situations in which requires mathematization process. Although PISA reports mention the difficulty of preparing second level tasks, it is stated that students should encounter such contexts as often as possible. Studies have shown that real-life situations are more motivating for students, increase students' attitudes and interest (Stylianies & Stylianides, 2008), and strengthen the connection between mathematics and daily life (Singletary, 2012; Özgeldi & Osmanoğlu, 2017). Therefore, in this study, context examples taken entirely from real-life situations were included. Within the scope of the study, student interpretations on News texts containing percentage representation were analyzed.

Percentage notation is one of the most common mathematical representation that students encounter in daily life. Students frequently come across this notation on various platforms , including shopping, advertisements, newspapers, and the internet, even though percentages have been introduced in the mathematics classroom since middle school. In their everyday lives, they encounter large-scale representations of discounts, increases, decreases, and more in store windows and markets. They often notice prominent signage about sales, price hikes, reductions, and other related topics in storefronts and market displays. Percentage notation provides the opportunity to visually understand how different numerical data contribute to a hundred-unit scale. Employing percentage notation can help individuals better grasp the facts and discern their differences. Despite the apparent and widespread nature of the concept of percentages, numerous studies have found that students often struggle with it (Özçelik & Tutak, 2017; Lestiana, 2021; Parker & Leinhardt, 1995).

Percentage expressions are a means of representing values, including rational numbers, fractions, and decimals. How many objects would be represented, for instance, if 10 items in 20 items were included in 100 items? Actually, it is clear from this perspective that percentage statements are based on proportion. Indeed, Piaget and Inhedler (1973) also argue that percentage expressions are based on proportional reasoning. Here, the student can reach the result by expanding the denominator of the fraction 10/20 by 5 and making the denominator one hundred. Perhaps many percentage tasks can be solved with this method. However, the student may be making the denominator one

hundred without understanding the concept of percent conceptually. The findings in Koay's (1998) study show that being able to read percent expressions and to make calculations correctly does not lead to the ability to interpret and apply the concept of percent in context. This underlines the importance of conceptual understanding of the percent expression in context.

Numerous studies have been conducted on a variety of topics, including students' difficulties with percent expressions (Lestiana, 2021; Özçelik & Tutak, 2017), the impact of realistic mathematics education on percent achievement (Özçelik & Tutak, 2017), problem-posing skills for percentages (Doğuz-Karahan, & Genç, 2022), and supporting students' percent representation skills (Rianasari, Budaya, & Patahudin, 2012). However, there is no prior research that specifically examines the interpretation of percentage expressions in the context of real-life situations presented in News texts. Considering that percentage expressions are a concept that is very intertwined with life, the meaning that students attribute to the expressions in News texts gains importance. Therefore, the following research question is being addressed within the purpose of the study:

In the context of mathematical literacy, what are the 8th grade students' interpretations of the percentages in the News texts?

Method

This study utilized a qualitative research approach to investigate how students comprehend percentages in News texts in the context of mathematical literacy. It employed the case study design, one of the qualitative research techniques. Case studies are a type of research method that can be used to provide explanations for how and why questions happen in real-life situations where the researcher has no control over the variables (Yin, 2009; Ozan-Leylum, 2017). According to Yıldırım and Şimşek (2011), case studies are a research approach that enables the researcher to thoroughly explore a phenomenon or event without being able to influence it, using 'how' and 'why' questions.

Participants and Data Collection

In this study, it was aimed to determine the competencies of 14-15 year old students, who also constitute the sample level of PISA, regarding daily life situations by examining their interpretations of daily life contexts.Therefore, 30 8th grade students were asked to read 6 News texts containing contexts with various percentage values and were expected to explain what they understood from these percentage values. The News texts were presented to the students on a paper together with their visuals in order for them to be able to interpret on the situations involving percentage values. The percentage contexts were classified into three different groups. For example, "House prices in the EU increased by 42 percent in the last ten years" or "Grain exports increased by 28 percent" were examples of statements in the first group that had percentage values between 1 and 100. The second set had statements like "Reading rate increased by 1,000 percent" and "Turkey's tourism income increased by 1,000 percent," which were expressed in terms of percentage values greater than 100. The third group includes statements such as "Exports decreased by 0.6 percent in Çankırı" and "The amount of cow's milk increased by 0.6 percent" which had percentage values ranging from 0 to 1 (Table 1).

Table 1

Real Life Contexts on News Texts

Contexts with a percentage value between 1 and 100	Contexts with percentage value more than 100	Contexts with percentage value between 0 and 1
 https://www.maltahaber.com/abde-son-10-yilda-konut-fiyatlari-yuzde-42-artti/	 https://www.yerelguc.com/gundem/okuma-oraninda-yuzde-bin-artis-h8599.html	 https://www.bursatv.com.tr/amp/ekonomi/inek-sutu-miktari-yuzde-06-artti-h995099.html
Translation: House prices in the EU increased by %42 in the last ten years	Translation: Thousand percent increase in reading rate	Translation: The amount of cow's milk increased by %0.6
 https://www.sabah.com.tr/ekonomi/hububat-ihracati-yuzde-28-artti-6163736	 http://m.gunhaber.com.tr/default.asp?page=haber&haberid=505112	 https://www.trthaber.com/haber/guncel/cankirida-haziran-ayinda-ihracat-azaldi-699107.html
Translation: Grain exports increased by %28	Translation: Turkey's tourism revenue up 190 percent	Translation: Exports decreased by %0.6 in Çankırı

A pilot study was conducted before the main study. According to the results of the pilot study, the data collection tool was revised stylistically and made more understandable by the students. Additionally, the pilot study revealed that students in 6th and 7th grade had trouble comprehending how to analyze News texts, so it was decided to extend the study to 8th graders. After the data collection tool was finalized, the researcher distributed data collection papers to students, provided 40 minutes in the classroom setting and students were expected to write their interpretations about the News texts. Since the results of the pilot study showed that there were too many personal comments on the News texts, the researcher made the necessary explanations before distributing the data collection papers to the students.

Data Analysis

One of the qualitative data analysis techniques, content analysis, was used to classify the data obtained from student responses. The aim of content analysis is to bring together similar data within the framework of certain concepts and themes and to interpret them by organizing them in a way that the reader can understand (Yıldırım & Şimşek, 2011). For this reason, firstly, the students were coded as S1, S2, S3.....,S30 and the student responses were interpreted by two field experts. Then, categories were created in the light of the data obtained and student responses were placed in these categories by reaching a consensus of expert opinion. The student responses were assessed in

four categories: “Correct response, partially correct response, incorrect response, and blank response” resulting from the data collected from the student responses. Correct responses were divided into two categories as "giving daily life examples" and "procedural responses". Partially correct responses were divided into two categories as "Approximate value" and "Giving an example from daily life". Incorrect responses were divided into "Focusing on numerical increase/decrease" and "Irrelevant response". The meanings of these categories in the analysis framework are explained in Table 2.

Table 2

Explanation of Analysis Framework

Correct response	Giving daily life examples	The correct response that includes a daily life example related to the percentage expression in the News text.
	Procedural	The correct response that deals with the percentage expression in the News text procedurally.
Partially correct response	Approximate value	The response expressing the approximate value of the percentage expression in the News text.
	Giving daily life examples	The response that gives a daily life example about the percentage expression in the News text and partially reaches the correct response.
Incorrect response	Focusing on numerical increase/decrease	An incorrect response that includes a comment about the numerical increase or decrease in the percentage expression in the News text.
	Irrelevant response	An incorrect response that includes comments about the percentage expression in the News text that are not correct and not related to the given situation.
Blank response		No comment or statement in the explanation section

The validity and reliability of the research were ensured by the analysis and discussion of the data with two researchers until a consensus was reached during the coding phase.

Results

This section presents the results obtained from student responses. The main findings demonstrate that in the tasks asked in all three contexts, there were very few students who correctly interpreted the percentage expression in the News texts mathematically (Table 3). Contrary to expectations, students encountered a similar level of difficulty across all three context types.

Table 3

Findings Related to Students' Responses to the Tasks

Results of the responses to tasks with a percentage value between 1 and 100							
Tasks	Correct response		Partially correct response		Incorrect response		Blank response
	Giving daily life examples	Procedural	Approximate value	Giving daily life examples	Focusing on numerical increase/decrease	Incorrect response	Blank anwer
1	S2, S15	-	S7	-	S6, S4, S9, S10, S11, S13, S14, S16, S18, S19, S20, S22, S25, S28, S29	S3, S17, S27, S30	S1, S5, S8, S12, S21, S23, S24, S26
Total	2	-	1	-	15	4	8
2	S2	S30	-	-	S1, S4, S6, S7, S9, S11, S12, S13, S14, S16, S17, S18, S19, S20, S23, S28, S29	S3, S8, S22, S26, S27	S5, S10, S15, S21, S24, S25
Total	1	1	-	-	17	5	6
Results for the responses to the tasks with more than 100 percentages value							
Total	S2, S3, S4, S7	-	S18	-	S6, S8, S9, S10, S11, S12, S13, S14, S15, S16, S17, S19, S20, S21, S22, S23, S24, S25, S27, S28, S29	S5, S30	S1, S26,
Total	4	-	1	-	21	2	2
4	S3	-	-	S2, S7, S15	S4, S6, S9, S10, S11, S12, S13, S14, S16, S19, S20, S21, S22, S24, S25, S26, S27	S5, S8, S17, S18, S29, S30	S1, S23, S28
Total	1	-	-	3	17	6	3
Results for the responses to tasks with a percentage value between 0 and 1							
5	S3, S6	S4	-	-	S1, S5, S12, S30	S2, S7, S9, S11, S13, S14, S15, S17, S18, S19, S20, S21, S22, S24, S25, S27, S28, S29	S8, S10, S16, S23, S26
Total	2	1	-	-	4	18	5
6	-	S4	-	-	S1, S2, S3, S23, S30	S5, S6, S7, S8, S9, S11, S12, S13, S14, S15, S16, S17, S18, S19, S20, S22, S29	S10, S21, S24, S25, S26, S27, S28
Total	-	1	-	-	5	17	7

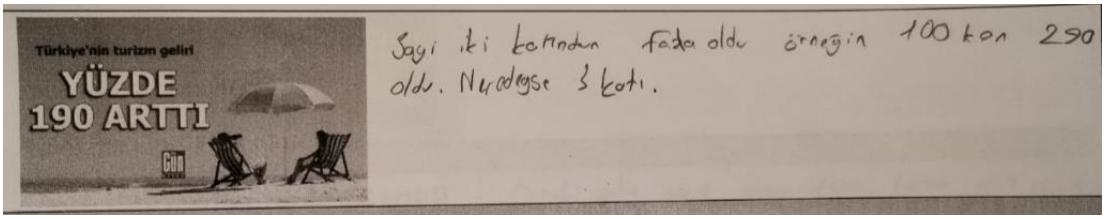
The results obtained from the tasks containing percentage expressions between 1 and 100 show that, in the first task, 2 students provided the correct response with a daily life example and 1 student provided a partially correct response by reaching an approximate response; in the second task, 1 student provided a daily life example and 1 student provided a procedural example. It is seen that the majority of the students focused only on the numerical increase or numerical decrease in the percentage expression in the News text or provided irrelevant, incomplete or blank responses. The results obtained from the tasks with a percentage value greater than 100 shows that, in the third task, 4 students provided a correct response with a daily life example, 1 student provided a partially correct response by reaching an approximate response, and in the fourth task, only 1 student reached the correct response by giving a daily life example. Similarly, the rest of the students focused only on the numerical increase or numerical decrease in the percentage expression in the News text, or provided irrelevant, incomplete or blank responses. In cases involving

percentages less than 1, it is seen that in the fifth task, 2 students provided the correct response with a daily life example and 1 student reached the correct response by giving a procedural example; in the sixth task, only 1 student reached the correct response by giving a procedural example. The remaining students, who were unable to concentrate on the numerical increase or decrease as in the other tasks, typically provided irrelevant or blank responses.

As an example, the sample student response in Figure 1 provided a number exceeding 100 and stated that it increased to 290. In actuality, he provided the correct response by elaborating on his initial remark and stating that it was nearly three times greater.

Figure 1.

First Sample Student Response to the Task with more than 100 Percentages Value

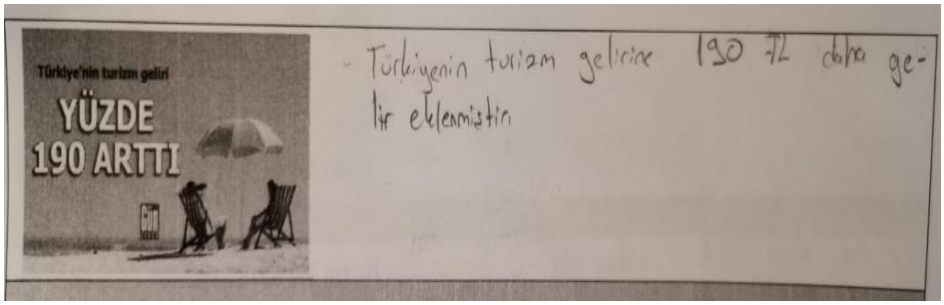


Translation: The number more than doubled, for example, from 100 to 290

Some of the students provided examples from daily life. For example, for the context "Turkey's tourism income increased by 190 percent", a student wrote a comment as "I understand that if 100 thousand people come to a country for tourism, 190 thousand more people come". And several students arrived at the correct response solely through numerical calculations without using examples from daily life. Some of the students appeared to be treating the percentage value in the situations as a number. For example, in the context of "Turkey's tourism income increased by 190 percent", comments such as "190 Turkish Liras more income was added to Turkey's tourism income" were found (Figure 2). Additionally, it was found that most students commented on an increase or decrease, as in the phrases "There has been an increase in reading level," "There has been an increase in house sales," or "There has been a raise."

Figure 2.

Second Sample Student Response to the Task with more than 100 Percentages Value

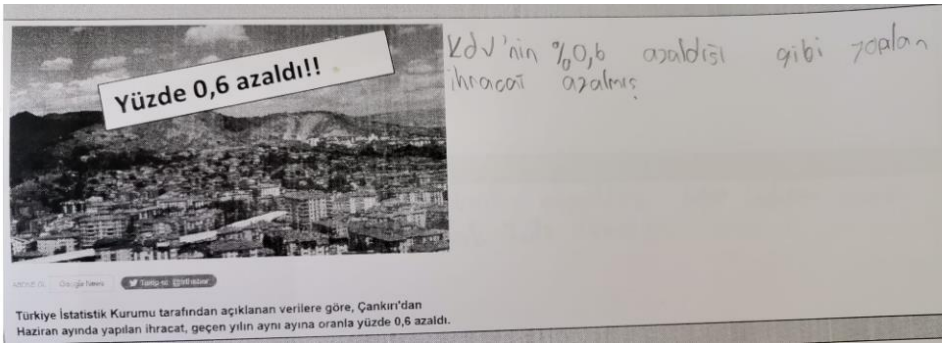


Translation: Another 190 Turkish liras were added to Turkey's tourism income.

As seen in Figure 3, S13 did not address the task mathematically at all (%0.6) and focused solely on the word 'decrease' providing an example of the decrease in exports.

Figure 3.

A Sample Student Response to Task with a Percentage Value between 0 and 1

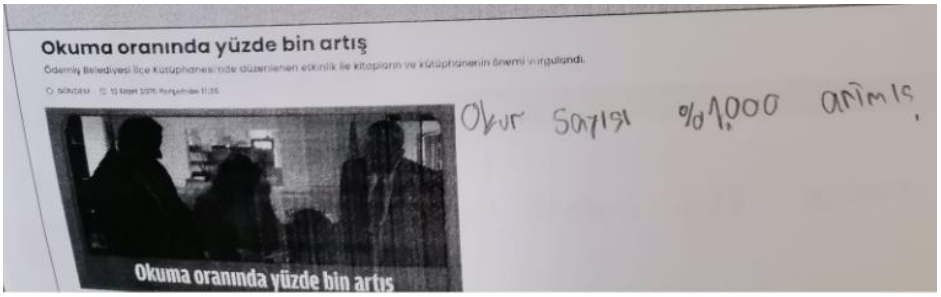


Translation: Exports decreased by 0.6%

In Figure 4, the student interpreted the increase in the reading rate as 'the number of readers has increased' instead of mathematically understanding what a 1000 percent increase entails.

Figure 4.

Third Sample Student Response to the Task with more than 100 Percentages Value



Translation: The number of readers increased by a thousand percent

In addition, irrelevant comments such as "I think it should have increased a little more", "It has increased too much", "They should decrease" as well as blank answers, are noteworthy results obtained from the study.

Discussion, Conclusion & Suggestions

Problems with daily life contexts have an important potential for students to make sense of mathematics by associating it with daily life. Based on this potential, context examples of actual real life situations were used in this study. Within the scope of the study, student comments on News texts containing percentage representation were analyzed. According to the results, students had difficulty in understanding the daily life contexts containing percentage representation and interpreting the context clearly and comprehensibly. Very few students were able to interpret the contexts by connecting them with daily life. For example, for the context "Turkey's tourism revenue

increased by 190 percent", a student wrote a comment such as "I understand that if 100 thousand people come to a country for tourism, 190 thousand more people come". Mathematics is more than a mechanical structure in which students are taught a set of rules and procedures, it requires the integrity of meaning in which students make sense of what they learn and build on previous learnings. Associating mathematics with daily life allows this structure to be built on more steady foundations (MoNE, 2013; National Council of Teachers of Mathematics [NCTM], 2000; OECD, 2012; Singletary, 2012). As a matter of fact, the international exam organization PISA measures the extent to which 15-year-old students can use the knowledge and skills they learn at school in daily life (Ministry of National Education [MoNE], 2020; OECD, 2012). The results obtained in this study indicate that students encounter significant challenges when attempting to relate the concept of percentage to everyday life.

Mathematical literacy has an important role when it comes to making connections with daily life. In this context, the results related to understanding the basic understanding underlying the context-based percentage expressions and thinking flexibly, which were asked in the study, gain importance. Students could not interpret real-life situations involving percentage expressions correctly. It was concluded that the majority of the students made comments focusing on increase or decrease, as in the expressions "There has been an increase in reading level", "There has been an increase in house sales", "There has been a raise", and produced blank or irrelevant solutions. This may be attributed to the students' inadequacy in explaining themselves and their lack of conceptual understanding of the percentage. As a matter of fact, students mostly tried to reach the answer by making only numerical calculations without establishing a relationship with daily life. For example, for the context of "Turkey's tourism income increased by 190%", comments such as "190 Turkish Liras more income was added to Turkey's tourism income" were found in the study. In many studies conducted in the literature, it was observed that students tended to apply procedural algorithm rather than conceptual understanding of percentage expressions (Gay, 1990; Van Den Heuvel-Panhuizen, 1994). In addition, it is understood that students mostly perceive percent representation as an integer. In line with the findings of this study, Erdem, Özçelik, and Gürbüz (2018) similarly concluded in their study on percentage expressions that students tend to hold misconceptions by perceiving the concept of percentage as a whole number.

In this study, students were expected to interpret three different types of contexts, each of which contained two tasks with percentage values ranging from 0-1, 1-100, and more than 100. Prior to the study, the researchers hypothesized that students wouldn't have much trouble in situations where the percentage value ranged from 1 to 100. However, regardless of the context type, students consistently made the same mistakes and got similar results. It demonstrates that students who understood the notion of percentage performed well in a variety of situations. This finding demonstrated that students face difficulties in understanding percentages regardless of the context type. Numerous studies in the literature have shown that students struggle in different ways with percentage (Özçelik & Tutak, 2017; Lestiana, 2021; Parker & Leinhardt, 1995).

According to the findins, we made some recommendations for teachers and researchers. Daily life examples or News texts might be often used while introducing the concept of percent in maths lessons to avoid students approaching it procedurally. In school textbooks and curricula, examples that will associate the concept of

percentage more with real life can be emphasized. Additionally, teaching percent expressions by connecting them to these concepts—beginning with rational numbers, fractions, and decimal fractions—can support in comprehending how percent expressions differ from integers. This could help dispel the myth that percent expressions exist in a whole different realm than rational numbers or fractions, dispelling misconceptions about them. Last but not least, emphasizing the part-whole relationship and the ratio relationship between two variables while discussing percent expressions in mathematics lessons can give students the impression that percent expressions are different from natural numbers and integers.

Ethic

We declare that the research was conducted in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

Author Contributions

This article was written with the joint contributions of four authors.

Conflict of Interest

The authors declare that they have no conflict of interest.

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