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The Effect of Writing Operation Scenarios on Higher-Order Thinking Skills

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Abstract

The purpose of this study is to reveal the effect of writing scenarios for solved mathematical operations on students' higher-order thinking skills in mathematics lessons. Explanatory mixed-methods design was employed throughout the research process, collecting first the quantitative data and then the qualitative data set. The study group consisted of 90 third-grade students and 9 teachers teaching at the third grade of the research context. In the study, the teachers and 18 students who took part in the activity expressed their opinions regarding the activity itself. According to the quantitative results, it was found that students' script writing had an effect on their high-level skills. According to the opinions of both teachers and students, the activity influenced the students' higher-order thinking skills in a positive way. In addition, it was observed that the study contributed to students' love of mathematics, writing skills, and higher-order thinking skills.

Keywords:

Operation Scenario, Mathematics Lesson, Writing Skills, Higher-Order Thinking Skills

Introduction

One of the characteristics that distinguishes humans from other living beings is the ability to think. Thinking encompasses a rather complex process. An individual's developmental level and age can give them a way and depth of thinking. This way of thinking can be basic in some children, intermediate in some, and advanced in others (Applegate, Quinn & Applegate, 2002; Davidson, 1969; Sarar Kuzu, 2013).

In many studies, these levels have been divided into different stages such as remembering, understanding, applying, analyzing, synthesizing, and evaluating. Therefore, many studies have been conducted to develop or identify these levels (Abu, Abidin & Aris, 2013; Çakmak Güleç, 2010; Kılıç, Köse, Tanışlı & Özdaş, 2007; Kırbağlar, Özsoy Güneş & Derelioğlu, 2010). However, different variables such as family, school, environment, and friends can affect the development and formation of these stages. Some studies have revealed that family is one of the most effective factors in developing thinking among these variables, and another factor that supports this element is the school (Çiçek, 2002; Keskin, 2020;

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Kol, 2011). In addition, this differentiation contributes to students' creative and critical thinking skills. According to Güneş (2012), the inability to develop students' thinking skills is a problem of many countries. However, especially if the basic skills that should be acquired at school are not acquired on time, it can be quite difficult for the child to find a solution to this problem or to express it in writing and verbally; to solve it with a different superior thinking skill when he encounters a problem in his life after school. In the study of Sevim and Zıhar (2020), it was concluded that the reflective thinking skills of students with high report card grades were higher than those with low report card grades, and there was a positive relationship between thinking skills and self-efficacy. Özdil and Beyhan (2023) concluded that thinking skills are predictors of mathematics success. In this context, studies are being carried out to help children gain higher-order thinking skills during the school period (Şahin & Akman, 2018; Tuğrul, 2006), and various game-based activities come first. Through these activities, children can both play games and develop their thinking skills. The point emphasized here is that the developed activities should be designed in accordance with the children's level and interests. Therefore, focusing on children in the preparation of activities increases the effectiveness of the studies (Ergin, 2005).

In the activities, having the child write the formation, cause and result of an event affects the child's perspective on a subject. These practices also positively affect children's acquisition of self-expression skills both verbally and in writing. Thus, children's scenarioization of a subject (Yılmaz, Üstündağ & Güneş, 2017) helps to develop the ability to visualize and concretize that subject in the minds of children (Latifi, Noroozi & Talaee, 2020). Scenarioization of a subject, event or phenomenon contributes to the development of the child's thinking skills (Gülmez Güngörmez, Akgün & Duruk, 2016; Tok & Sevinç, 2012; Uzunoğlu & Bulut, 2022). When the literature is examined, no studies have been found on whether the scenario writing skill for the process steps has an effect on higher-order thinking skills. One of the reasons why the scenario activity is used in the study is that the student verbalizes mathematical operations and relates them to daily life while writing the scenario. Another reason is that students try to develop their decision-making, imagination, creative thinking, critical thinking and language skills during these processes. Another aspect is that since the solution of the operation is given, the student tells the story of the operation. For this reason, this study aimed to examine the effect of scenario writing activity on the higher-order thinking skills of third grade students. Based on this purpose, the following questions were sought:

1. What is the effect of students writing a mathematical scenario for solved operations on their higher-order thinking skills?
2. What are the teachers' opinions about the activity of students writing a mathematical scenario for solved operations?
3. What are the teachers' opinions about the effect of the scenario writing activity on other areas?
4. What are the students' opinions about the contribution of writing a mathematical scenario for solved operations to their higher-order thinking skills?
5. What are the students' opinions about the scenario writing activity?

Method

This study employed mixed-methods research design. Maxwell (2016) defined mixed-methods as the systematic use of quantitative and qualitative methods together within a single study. Throughout the research, quantitative data and qualitative data were collected sequentially, former being the first, thus it was thought that the study was suitable for the explanatory sequential mixed design. Creswell and Plano Clark (2018) stated that the explanatory sequential mixed design is the collection of quantitative data first, followed by interviews with the participants to reveal the why and how of the quantitative data after it is interpreted. The number of correctly written problem scenarios, incorrectly written scenarios, and scenarios by error types from students and teachers constitute the quantitative part of the research. On the other hand, data on the opinions of students and teachers about the activity constitutes the qualitative part.

Ethical approval was obtained from the Social and Humanities Sciences Scientific Research and Publication Ethics Committee of the Uşak University with the decision dated 08.02.2024 and numbered 2024-39.

Study Group

In selecting the schools, teachers, and students included in the study group, a convenience sampling method was used within the scope of the research. Accordingly, three schools representing low, medium, and high socio-economic status — where the implementation could be carried out — were selected based on accessibility and the willingness of participants to take part in the study. In total, 3 school administrators, 9 teachers, and 90 students were included. The convenience sampling method was chosen because the researchers had previously conducted activities in these schools and had ongoing communication with the school administrations.

Within each participating classroom, 10 students — five boys and five girls — were randomly selected among those willing to participate. While the activities

were carried out with all students in the class, data were only collected from these ten selected students.

The school administrators were informed about the purpose of the study. Subsequently, detailed information was provided to the participating teachers, students, and their parents, and parental consent was obtained for student participation.

Although the study group consisted of 90 students, the dataset appears to include data from 1,080 students. This is due to the fact that the analysis was conducted on the basis of individual mathematical operations. Each student wrote a scenario for 12 different math problems. Therefore, 90 students × 12 scenarios = 1,080 entries, which explains the inflated appearance of the dataset size.

Implementation

Starting the Activity

In the process of starting the activity, a two-week introduction and different game-based activities were held with the students. Gifts suitable for their levels were given to them. With these activities, a good rapport was established between the students and the researchers. During these two weeks, the main purpose was to get closer with the student group.

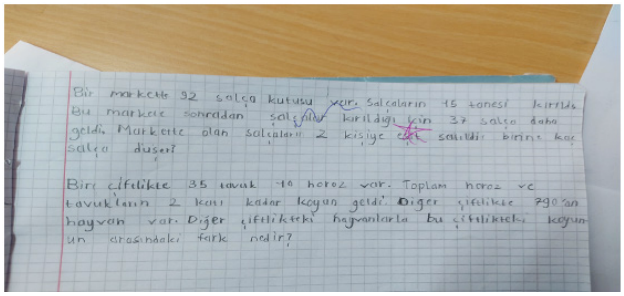
Scenario Writing Activities

In this process, students were given four tasks requiring one operation, four tasks requiring two operations, and three tasks requiring three operations. Operations are at most three-digit operations. Because in the Ministery of National Education (MoNE) (2018) mathematics curriculum, in the M 3.1.2.1. attainment, it is emphasized that "It performs addition with and without carry-over with numbers up to three digits at most". For this reason, the operations given to the students are also the operations that remain within a maximum of three digits. After the data of the pre-test application were collected, the students were informed about the purpose of the study. The following week, five examples were implemented by the researchers. In the third week, the students were given five solutions that required a pilot operation, and after explaining the necessary points, the students were asked to write a scenario related to the process as in Figure 1.

Feedback was given on the scenarios they wrote during the activity. One of the sample scenarios written by the students was written on the board. After the operations were done, the students' scenarios were collected and evaluated. In the evaluation, students' writings were evaluated with criteria such as compliance with spelling rules, expression disorder, suitability for developmental level, concretization, relating to real life, measurement and evaluation, and acquisition of higher thinking skills. As a result of this pilot activity, it was seen that the students did not have a problem with understanding the activity. For this, an evaluation rubric was developed by the researchers. The actual application started in the fourth week. The students were asked to write scenarios for mathematical operations that required one operation andwere developed by the researchers. Suitability of the operations were also confirmed by the teachers. In the fifth week, they were asked to write scenarios for the solution requiring two operations. The evaluation was done in the same way. In the sixth week, a mathematical task requiring three operations was given and they were asked to write a scenario suitable for this operation. Students' scenarios were evaluated according to the criteria in the first and second steps. The class teacher was asked to observe the students during the process and prepare an observation report for each student. The teacher expressed his/her report as an opinion in semi-structured interviews. In the seventh week, the final test was applied to the students. Due to the nature of the method, after the quantitative data of the research were evaluated, the teachers and students were asked in a semi-structured interview whether the activity had an effect on the students' higher-order thinking skills. The activities were carried out by the researchers, and the teachers were present in the class as observers. Thus, negativities such as teachers' biased behavior and memorization by students were prevented. The activity continued for a total of eight weeks, along with teacher and student interviews.

Figure 1

Example of a Student-Written Screenplay

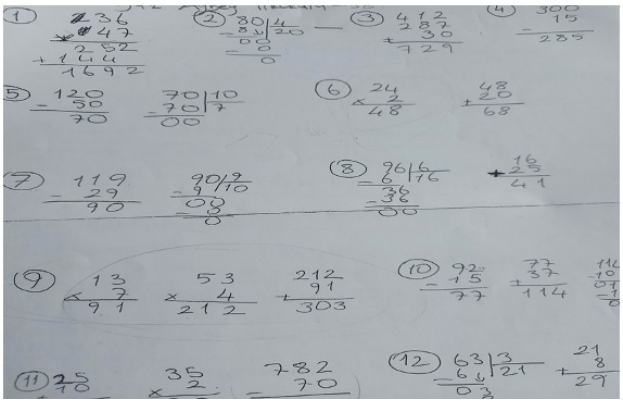


Data Collection Tool

Two different data collection tools were used in the study. The first data collection tool was created by the researchers, consisting of mathematical operations for which five teachers currently working in the third grades have completely agreed on the writing of a solved mathematical scenario. In line with the opinions of the teachers, four tasks requiring one operation, four tasks requiring two operations, and three tasks requiring three operations were used to collect quantitative data with 12 solved mathematical operations for the pre-test application. Examples are shown in Figure 2.

Figure 2

Solved Mathematical Operations Scenario Written by Students



The other data collection tool consisted of the data obtained from the semi-structured interview form conducted with the students who participated in the activity and their teachers. In the development of the form, the opinions of four experts in the fields of classroom teaching, mathematics education, Turkish education and measurement and evaluation were consulted. The questions on which the experts fully agreed on were included in the interview form.

Data Analysis

Quantitative and qualitative analysis was performed in the study. A rubric was developed for quantitative analysis. The rubric developed by the researchers was sent to five academics who are experts in five different fields. In the rubric, the sub-dimensions of originality and fluency of creative thinking skill, which are among the higher-order thinking skills, were considered by reviewing the literature. The sub-dimensions of cause and effect relationship, generalization, questioning, inference, concretizing the abstract concept in associating with current life, associating mathematical language with current language, coherence and fictionalization sub-dimensions took place for language and expression skills. The experts agreed that the study was related to the above-mentioned features of higher-order thinking skills. According to Cohen's Kappa formula, those with 90% and above consensus among academics were included in the rubric. The rubric was scored as 0, 1, 2, 3, 4 and 5 points. If the student did not write anything in the scenario writing activity, they got zero points, if they wrote very little, they got one, if they wrote a little, they got two points. If the student wrote the scenario moderately, they got three points, if they wrote it well, they got four points, and if they wrote it very well, they got five points. The evaluators were given the evaluation criteria. The experts made their evaluations according to these criteria. The quantitative data obtained from the rubric were analyzed in the statistical program. Paired-samples t-test analysis was performed in the analysis of quantitative data. On the other hand, qualitative data were analyzed by descriptive analysis. For these analyzes, themes were determined with the opinions previously received from experts. In the analysis, teachers were coded as T1, T2., and students as S1, S2. Codes and sub-codes were created according to the themes. The codes and sub-codes derived from the analysis were presented to three experts. In calculating the inter-coder agreement, 90% agreement was achieved according to Cohen's Kappa formula.

Findings and Comments

In this section, findings and comments on the sub-problems are given. The findings and comments regarding the sub-purpose of "What is the effect of students writing a mathematical scenario for solved operations on their higher-order thinking skills?" are given below:

Table 1

t-Test of the Effect of Writing a Scenario for a Mathematical Operation on Higher Order Thinking Skills

Variable	Measurement	N	M	Sd	t	df	p
Overall Total	Pre-test	1079	16.74	2.17	-121.625	1078	000
	Post-test	1079	43.46	8.66			
Creative Thinking	Pre-test	1079	2.94	.35	-131.985	1078	000
	Post-test	1079	5.77	.95			
Critical Thinking	Pre-test	1079	7.85	1.09	-140.881	1078	000
	Post-test	1079	19.04	3.45			
Mathematical Language	Pre-test	1079	2.06	.45	-150.814	1078	000
	Post-test	1079	9.54	1.69			
Language and Expression	Pre-test	1079	3.89	.54	-136.766	1078	000
	Post-test	1079	9.48	1.77			

Table 1 shows the effect of writing a scenario for a mathematical operation on higher-order thinking skills. As a result of the paired-samples t-test, a significant difference was found at the p<.001 level. The pre-test average was 16.74, and the post-test average was 43.46. It was seen that the activity of writing a scenario for a mathematical operation developed students' creative thinking, critical thinking, relating mathematical language to current language, and language and expression skills.

The contribution of writing a scenario for a mathematical operation to creative thinking skills, one of the higher-order thinking skills, is also observed. In this section, the highest score a student can get is 10. The pre-test score average of the students was 2.94, while the post-test score average was 5.77. Students' creative writing skills developed less than other skills. The dimension that lowers the average score is originality. While students' fluency skills developed, their originality skills did not develop at the same rate.

It has been observed that writing a scenario for a mathematical operation significantly contributes to critical thinking skills, a component of higher-order

thinking (p<.001). In this section, the highest total score a student can get is 20. In the post-test application, the average of the students was 19.04. It can be said that the activity contributes significantly to students' critical thinking skills.

A significant difference was found at the p<.001 level between the pre-test scores and post-test scores of the students in the skill of associating mathematical language with daily life, which is also one of the higher-order thinking skills of writing a scenario for a mathematical operation. It was found that the activity of writing a scenario for a mathematical operation contributed to the students' use of mathematical language in daily life. In the pre-test application, the pre-test score average of the students was 2.06, while the post-test application score was 9.54, meaning that was the skill students developed the most. The maximum score a student can get is 10, and the students' success was close to the maximum score.

Language and expression skills are among the skills that the activity of writing a scenario for a mathematical operation contributes to. A significant difference was found at the p<.001 level between the students' pre-test scores and post-test scores. The pre-test score average of the students is 3.89, and the post-test scores are 9.48. The activity contributed to the students' language and expression skills.

The findings and comments regarding the sub-problem of "What are the teachers' opinions about the activity of students writing a mathematical scenario for solved operations?" are given below in Table 2.

Table 2

Teachers' Opinions on the Contribution of Scenario Writing to Higher Order Thinking Skills

Theme	Code	Sub-Code	f
Effect on Higher-Order Thinking Skills	Effect on Critical Thinking Skills	Establishing cause and effect relationships	9
		Questioning	9
		Generalization	9
		Making inferences	9
	Creative Thinking Skills	Originality	3
		Fluency	7
	Relating to Daily Life	Concretizing abstract concepts	9
		Relating mathematical language to everyday language	9
	Effect on Language and Expression Skills	Consistency	7
		Structuring	5

As shown in the table, the teachers stated that writing the scenario of the operation contributed to higher-order thinking skills; they emphasized the findings obtained from quantitative data depending on the codes. This situation reveals the internal consistency of the research.

Four sub-codes were formed depending on the code of the effect on critical thinking skills. One of these is the sub-code of establishing cause and effect relationships. Teachers stated their views as follows regarding this sub-code. In this regard, T1 said, "After the activities, students want to learn the reason for a word or explanation that is said, and they can make comments accordingly. Now I have to tell them the reason for everything I say. They no longer accept anything as right or wrong from the beginning." T3 said, "Now they want to know the reason for everything that is said. Now they want this outside of math class as well. The other day, in the life science class, I gave an example from real life to concretize the subject. The students asked, 'Teacher, why did this happen?' They responded to every reason I gave by saying, 'But if that's the case, then this happens.' I was surprised. This development pleased me greatly." Teachers made explanations about establishing cause and effect relationships in their explanations. According to the teachers' opinions, the students acquired the ability to establish cause and effect relationships in terms of critical thinking skills.

According to the teachers' opinions, one of the higher-order thinking skills that students acquired with scenario writing is the questioning skill. The teachers, who expressed their opinions on the subject, revealed that the students passed through a thinking system without perceiving anything as right or wrong by thinking about the different dimensions of what they learned. In this regard, T6 said, "I asked the problem in math class, after checking the solution of the problem with the students, I had a student do the solution on the board. A few students said, 'Teacher, why do you only want one solution when there are multiple ways to solve this problem?' and I was surprised. When I said tell me, they solved the problem in five different ways. Another student also said, 'Teacher, we can also set up this problem in other ways.' That student also asked the same problem in three different ways without changing the numbers and the plot of the event. I was surprised. Here is the result." Teachers exemplified the questioning skill with those utterances.

One of the skills acquired within the scope of critical thinking skills of the activity of writing scenarios for mathematical operations is the generalization skill. The ability to make inferences is another skill that students acquire within the scope of critical thinking skills.

According to the teachers' opinions, one of the codes formed in relation to the effect of writing operation scenarios on higher-order thinking skills is creative thinking. Sub-codes of originality and fluency were formed depending on creative thinking. In the

originality sub-code, according to the quantitative findings, the least developed skills of the students in writing the scenario of the operation are originality. Teachers attribute this situation to the lack of vocabulary, the limitations of the environment in which the students live, the test-solving-oriented course, the insufficient level of parent education, the indifference of the student's parents, and the students' limited time with their peers or the environment outside of school. T7 stated his opinion by saying, "Students interact with a limited number of environments here. Because they do not go to a different place or environment outside of this environment, they think with a limited number of words. That's why they use similar words when writing operation scenarios." T9 said, "We are teaching test-oriented lessons with the students here according to the expectations of the parents. Since the test questions are in the same format and contain similar words, the student thinks in the same format and cannot think creatively." The teacher revealed the effect of test-solution-oriented teaching on creative thinking and emphasized the effect of vocabulary richness on scenario writing.

One of the skills acquired by the students in relation to creative thinking skills along with the activity of writing operation scenarios is fluency. It is an important gain in higher-order thinking skills for students to establish connections between words and concepts and to question words and concepts while writing operation scenarios. T2 emphasized fluency by saying, "With these activities, the students created a very nice integrity within the scenario they wrote. They do not use expressions that will cause expression disorder in the text. As a teacher, I am very happy for the students. I wish such an activity had been implemented." It can be said that it is important for students to organize the event by establishing a relationship between concepts and words in terms of fluency skills. T4 said, "I feel like I'm reading poetry when I read what the students wrote." The teacher approached fluency from a different angle. T6 said, "Students used to write, 'My father gave me money,' and move on. Now they make connections like why he gave the money, what I'm going to do, and create integrity, there is a good flow." The teacher stated the relationship between fluency and integration. He expressed the effect of writing operation scenarios on students' acquisition of fluent expression skills.

Another impact of writing operation scenarios on students' higher-order thinking skills is the skill of associating mathematics with daily life. Sub-codes of concretizing abstract concepts and associating mathematical language with everyday language were formed depending on this code. In the sub-code of concretizing the abstract concept, a more concrete explanation of abstract concepts such as solid, more, less, which were previously given in an abstract way, were emphasized while writing the story of the operation. In this regard, T4 said, "Me and our students used to ask the question in a short way before. For example, we were asking questions like 'What is 12 less than five times 8? Because the layer remained abstract, the students did not understand and memorized it. Instead, my father bought eight boxes of eggs for our house. We put the eggs in the refrigerator. Each box contained five eggs. My mother made menemen with 12 of the eggs. Now, how many eggs do we have in our refrigerator?' stories written that way concretize the process." The teacher exemplified the concretization of abstract concepts in mathematics.

Depending on the sub-code of associating mathematics with daily life, students associated the operation scenarios they wrote with examples from daily life. They reflected examples from their lives, such as going shopping, playing marbles, and the number of students at school, into the operation scenario. In this regard, T1 said, "We used to use only mathematical concepts in operations. We used to write like "25 plus 55 equals how much?". But with this activity, they make associations with examples from daily life. 'Because I kissed the hands of my elders on Eid, my elders gave me 550 liras of Eid pocket money. We went to the market to buy the jersey of my favorite team with the money. My father bargained with the seller. We bought the jersey of my favorite team for 300 liras. How much money is left from my Eid pocket money?' They relate mathematical language to daily life as in the example." The teacher concretized the subject with an example. Students included realistic mathematics education with the activity of writing operation scenarios.

Students' language and expression skills were also examined along with the activity of writing operation scenarios. In this context, consistency and structuring skills are also among the skills acquired by students. Depending on the consistency sub-code, the students revealed the consistency in the operation scenario writing activity, such as the harmony between the given values and the desired ones within the integrity of the scenario, and the sentences being a continuation of each other. In this regard, T2 said, "We didn't pay enough attention to the question writing activity before. We were solving the operations and problems given on the websites on the smart boards. That's why our writing skills were weak. When I asked them to write an essay in lessons other than mathematics, there created pieces of writing unrelated to the subject. For example, in the semester before the event, I had asked the students to describe their families. They had made such a narrative that it consisted of short and meaningless sentences like a telegram. While reading, I had thought what he was talking about here. After the activity, they started to

tell the story with a story structure by establishing a relationship between the concepts related to the given topic." The teacher exemplified the consistency of the activity in terms of language and expression.

Structuring is one of the higher-order thinking skills that students acquired in terms of language and expression. Teachers stated that the problems arose from the weakening of students' thinking and writing skills due to the fact that test-oriented lessons were conducted before the activity and ready-made problems were asked to the students because the lessons were conducted from the websites in the digital environment weakened the structuring skills. T9 said, "As teachers, we used to ask students structured questions from test booklets or digital environments. Students were reaching the answers to these questions in a classic way with a single method. With this activity, the students structured the questions very nicely by telling them as if they were a whole story, like an event that happened. In the following process, they started to ask a question by structuring it with different structures. This structuring skill also improved comprehension and narration skills. Moreover, the students are extremely satisfied and happy with this. When they heard you were coming, they couldn't wait for the time to pass." The teacher emphasized the development of the students and the different gains they achieved with the structuring skill.

The findings and comments regarding the sub-problem of "What are the teachers' opinions about the effect of the scenario writing activity on other areas?" are given below in Table 3:

Table 3

Teachers' Opinions on the Effect of the Scenario Writing Activity on Other Areas

Theme	Code	Sub-Code	f
Effects on Other Areas	Effects on Math	Loving math	9
		Overcoming fear of math	8
		Deciding on the solution to the problem	7
		Attracting interest	9
	Effects on Reading and Writing	Originality	5
		Structuring	5
		Loving to write	9
		Fluency	7
	Effects on Other Lessons	Questioning what is learned	9
		Researching the source of information	9
		Making interdisciplinary connections	9
		Transfer of topics	9
	Effects on Affective Traits	Self-confidence	7
		Learned helplessness	5
		Active participation in lessons	7
	Effects on Life Skills	Communication with friends	9
		Participation in activities	9
		Social learning	9
		Taking part in a group	9
	Effects on Comprehension Skills	Decision-making skills	8
		Ability to use information	7
		Transferring information to different areas	8

When Table 3 is examined, it includes the opinions of teachers about the effect of the operation scenario writing activity on other areas. It was found that writing operation scenarios had an effect on mathematics, reading and writing skills, other lessons, affective characteristics, social life skills, and comprehension skills. According to the opinions of the teachers, writing an operation scenario had an effect on life skills.

Regarding the effect on mathematics, it was determined that students had gains such as loving mathematics, overcoming the fear of mathematics, deciding on the solution to the problem, and attracting interest. As is known, mathematics has the characteristic of being a lesson that is feared and not loved enough all over the world. However, according to the opinions of the teachers, the activity of writing operation scenarios increases students' love of mathematics. T3 said, "Well, the students are looking forward to the day you will come for the activity. They want me to continue the same activity. However, due to the nature of scientific research, I cannot do such a thing in order not to harm the validity and reliability of the research. Thanks to this activity, mathematics has become the most loved lesson. I especially think this is because students' thinking skills develop and they get positive feedback from you that their thoughts are correct." He told the story of how the activity turned mathematics from a feared subject to a loved one. T9 said, "I also had a fear of math in the past. I was experiencing this fear even when I started my profession. If such activities were done to us in due time, I could have loved mathematics too." The teacher concretized the subject by giving an example from his own life. In parallel with loving mathematics, overcoming the fear of mathematics is also mentioned.

Decision-making on problem solving is another skill that students acquired in the process. While students can write and read the problem, they cannot decide what to do in the operation, or they make wrong solutions or wait without solving the problem. In this regard, T5 said, "The students write and read the problem, but they could not decide what to do. When the student is told to do multiplication here, he can multiply multi-digit numbers. With the operation scenario, students know very well what to do in problem solving," revealing the contribution of the activity to deciding on the solution to the problem. T7 said, "The decision-making skill has not only developed in mathematics lessons, but it has also affected their decision-making regarding other lessons and daily life." The teacher revealed the contribution of transferring math-related skills to other areas. The opinion that students' love of mathematics and overcoming the fear of mathematics increases their interest in mathematics was expressed by the teachers.

Regarding the effect of scenario writing on reading and writing, it was seen that it also contributed to skills such as originality, structuring, love of writing, and fluency. Depending on the originality code, the teachers expressed their satisfaction with the students writing their own scenarios for the operations. T6 said, " I was very pleased that the students started to write their own stories with the activities carried out in the mathematics lesson. I think my students have reached the creation stage. There has also been an increase in the number of words my students use. The development in vocabulary increase has improved their ability to write in different ways with their own sentences in reading, writing and speaking skills." In parallel with the originality skill, the structuring skill is also one of the skills that students develop in the field of reading and writing. It is an important contribution that students adjust the flow of the event well and use words and concepts in place. Again, loving to write is one of the characteristics that improved with writing operation scenarios. Writing skills are among the ones that developed when students wrote operation scenarios. In this regard, all of the teachers stated that the students who did not like to pick up a pen and did not like to write before, now try to write. In this regard, T4 said, "Now my students want to write something and want to share what they write with me." The teacher revealed the contribution to writing skills. One of the skills that also developed together with writing skills is fluency.

Another area affected by the activity of writing scenarios for operations in mathematics lessons is its contribution to affective characteristics. In this regard, self-confidence, learned helplessness, and active participation in lessons are among the developing skills. As students participated in the activities and received feedback, their self-confidence developed and, consequently, they got rid of the problem of learned helplessness. Students who overcame the problem of learned helplessness also participated actively in the lesson. In this regard, all of the teachers expressed their views as follows: "Students had a fear and anxiety of mathematics because they experienced learned helplessness. Students with low self-confidence could not actively participate in the lessons. Now that the problem of learned helplessness has been eliminated with this activity, their self-confidence has developed. They actively participate in the lessons by taking the floor and stating that they want to do the operation."

Life skills, which are among the 21st-century skills, are also affected by the operation scenario. Developing skills include communication with friends, participation in activities, social learning, and taking part in a group. With the lack of self-confidence created by the failure in mathematics in the students, learned helplessness occurs, and the student avoids communicating with his friends. As the self-confidence developed with the activities ensures active participation in the lessons, the student communicates with his friends to discuss the subject. T9 said, "My student, who never participated in the lessons before, now participates in the lesson, plays with his friends at recess, makes games with them, I realized that he was a hidden treasure." The teacher exemplified the acquisition of life skills through a student. According to the teachers, another skill that students gain with the scenario writing activity is the social learning skill. While a student is doing activities with his friends in the class, he learns in the group thanks to the feedback given to his friends what he is missing and cannot learn. T8 said, "What I saw during the activity was that the students who did not know were turning the feedback given to their friends into a gain for themselves. When he could not decide, he benefited from these feedbacks and shaped his own scenario while reading his friend's scenario." The teacher explained how social learning takes place in the classroom.

According to the teachers, one of the skills that the activity of writing the scenario of the mathematical operation has given the students is the comprehension skill. With this activity, students can make decisions about both problem solving in mathematics lessons and the subjects and activities of other lessons, and they can take action by thinking about what they can do. T4 said, "In my opinion, the most important skill this activity has given students is decision-making skills. I can say that they have gained such as making urgent and on-site decisions about what they will do and turning to produce solutions." He exemplified decision making. The ability to use information is also one of the skills that the activity contributes to the students. The student acquires new knowledge from the information by transferring what he/she has learned in one field to other fields. Using information in the living area and making it a part of one's life are also among the gains. T1 said, "We had dealt with a topic related to the data learning area in math class the other day. In the next lesson, we did an activity about reading comprehension. When I asked the students a question, he explained what he understood by drawing shapes with graphs." The teacher exemplified the development of comprehension skills.

The findings and comments regarding the sub-problem of "What are the students' opinions on the contribution of writing a mathematics scenario for solved problems to their higher-order thinking skills?" are presented in Table 4 below:

Table 4

Students' Views on the Contribution of Scenario Writing to Higher-Order Thinking Skills

Theme	Code	Sub-Code	f
Effect on Higher-Order Thinking Skills	Effect on Critical Thinking Skills	Establishing cause and effect relationships	12
		Questioning	14
		Generalization	14
		Making inferences	12
	Creative Thinking Skills	Originality	10
		Fluency	18
	Relating to Daily Life	Concretizing abstract concepts	18
		Relating mathematical language to everyday language	18
	Effect on Language and Expression Skills	Consistency	12
		Structuring	10

The opinions of the students about the contribution of the activity to their higher-order thinking skills are included in the table. As in the teachers' opinions, sub-codes were created based on the previously determined codes in the students' opinions. Student opinions on sub-codes are given below.

Depending on the cause-and-effect sub-code related to the critical thinking code, students can reveal the result of a cause by thinking about a subject together with its different aspects. In this regard, S1 said, "We used to immediately say the result when we were asked a question because we were used to the test. Now, while writing the scenario, we think about the operation, 'Why is this solved like this?' Sometimes I can even write more than one scenario for one solution. That's why I feel very happy," revealing the contribution of the scenario writing activity to the ability to establish cause and effect relationships.

One of the higher-order thinking skills that the activity contributes to is the questioning skill. S4, 5, 6,7, 12, 13, 18 said, "I no longer accept anything as right or wrong. I mix the information given to me with what I knew before, and after reading it well, I accept it as right or wrong. For example, I don't immediately accept the answer to a question given in mathematics as correct. I'm checking it" and exemplified the questioning skill. S9, 2, 3, 5, 11, 14, 15, 16 said, "I used to believe everything that was told to me and every solution was correct. Now I'm rolling it around in my head like 'Could this be?' I decide whether it is right or wrong after questioning the information and making sure." The student revealed the contribution of the activity to the questioning skill.

All of the students stated that they could not write sufficiently original scenarios in the scenario writing activity due to the inadequacy of their vocabulary. It was also stated that the inadequacy in reading books was also effective in that. The fact that the lessons in the schools are conducted with a focus on tests was shown as another obstacle to the development of originality. All of the students participating in the study emphasized the contribution of reading books to originality by saying, "We mostly solve tests in lessons. Therefore, our reading of books is limited or non-existent. That's why we have difficulty thinking differently." In addition, while examining the scenarios, it was also observed that the students wrote more original scenarios as the number of operations increased. It was determined that they wrote more original and fluent scenarios in cases requiring two or three operations compared to scenarios requiring one operation. In addition, it was concluded that the test-oriented course negatively affected the students' writing and thinking of original scenarios. Here, the opinions of teachers and students are consistent with each other. This reveals the consistency of the research. Fluency is one of the characteristics of creative thinking. It is the development that students are most happy with. In this regard, S1, 2, 3, 5, 7, 8, 9, 11, 12, 13, 14, 15, 16, 17, 18 said, "We didn't like to write before, so we didn't write the questions. We also had difficulty reading what we wrote. That's why we were thinking limitedly. With these activities, we started to write well and read what we wrote," revealing fluency. Quantitative results also support student opinions.

Relating to daily life is another higher-order thinking skills that students acquire. Concretizing abstract concepts is one of the gains that the activity provides to students. Concepts that are abstract in mathematics are concretized with examples from daily life. In this regard, all of the students who participated in the activity said, "In the previous math class, we used to ask or write questions like 'What is half of 78' as in the tests. Now we make it more meaningful by saying it is divided into two equal parts. Also, while writing the scenario, we go to the market, shop, spend money, get change, share with our friends," concretizing the event. Relating mathematical language to everyday language is one of the gains students had in terms of realistic mathematics education. S5 said, "Now, when I go to the market or shopping, I can calculate my shopping in my mind, and I think whether I would have shopped better if I bought this or that." Language and expression skills are among the higher-order thinking skills that students gain. Consistency has provided effectiveness for students in writing scenarios. Students' opinions also support quantitative data. In the quantitative data, a significant difference was found between the pre-test and post-test in terms of consistency. All of the students said, "We used to think with the logic of test questions. Sometimes we could ask meaningless questions. Now we write the question by relating the reasons by turning it into an event or a story." S12 said, "I feel like a writer, I tell the question as if I'm telling a story," revealing the consistency. Structuring is one of the skills that students acquire. The

cause and results of the problem were structured and turned into a scenario. In this regard, all of the students participating in the study said, "We used to conduct mathematics lessons with numbers and concepts. Now, we are trying to tell the mathematical scenario from all aspects, as if telling a story. As the number of operations in the question increased, we started to write better. Because as the number of transactions increases, our perspective expands, and we think about the event differently, so we love to write," the students exemplified the structuring. The researchers' observation and students' opinions support each other. Researchers and different evaluators stated that students structured scenarios with increasing number of operations better. When a focus group interview was conducted with five teachers who were not part of the study group to explore the reasons behind this, the teachers explained that creating short fantasies is easier. However, forming longer fantasies requires higher-order thinking, longer durations of thought, and a more comprehensive approach — which may have led to this outcome. That's why it's better structured. It makes a better description. As the number of transactions increases, the student enters into details, and as the details increase, the student reveals his existing capacity. In this context, student opinions and teacher opinions support each other.

Table 5

Students' Views on the Scenario Writing Activity

Theme	Code	Sub-Code	f
Views on the Activity	Most Liked	Story writing	18
		Teachers' approach	9
		Developing imagination	18
		Gamification	18
		Development of thought	9
	Most Challenging	Originality	18
		Structuring	18
		Written expression	8
		Test format	18
	Suggestions	Reaching other students	18
		Unconditional acceptance	2
		Repetition of the activity	18
		Relating to daily life	18

Table 5 presents the students' views on the activity of writing scenarios for mathematical operations. In the activity, codes of "most liked," "most challenging," and "suggestions" were formed. Sub-codes of story writing, teachers' approach, developing imagination, gamification, and development of thought were formed under the code of "most liked."

The story writing activity was the most liked scenario by all students. The students stated that they liked the activity very much because they perceived writing scenarios as a story writing activity. In this regard, the students expressed that they liked the activity by saying, "What I like the most is writing stories about the operations you give us." Another situation that students liked was the approach of the teachers who carried out the activities with students. All of the students emphasized unconditional acceptance by saying, "You approached us so well that I was looking forward to the day of this lesson. You treated everyone equally without discrimination, you didn't say anything bad or wrong to anyone, you made us find the right by saying 'how about we do it this way'." Another area that students like most about the activity is the development of imagination. In this regard, S15 said, "With the activity, I started to dream. As I dreamed, I realized that I was thinking better. For example, when I do an operation, I imagine myself as if I am living that operation and I am happy, so I loved this activity very much." He associated dreaming with loving math class.

Gamification is a popular feature of writing scenarios for mathematical operations. The students perceived the activity as a game. The development of students' thinking skills along with their imagination skills is one of the skills that students like.

According to the students' opinions in this activity, the most challenging skills were originality, structuring, written expression, and test format. The students stated that they had difficulty writing original scenarios. According to the students, the reasons for this are that; the lessons are conducted in a test format, the lack of vocabulary, and the reasons related to not reading enough books. In this regard, S14, who is studying at a school with a low socioeconomic status, said, "Our lessons are spent solving tests from the smart board in the class. My life consists of this environment. I have never been out of this environment. I've never been on vacation anywhere. I don't read much either. That's why I have to use the same words all the time when writing questions," revealing the reason for the originality problem and the limitations of the activity. Conducting test-oriented lessons and not giving enough space to expression activities also cause students to have difficulty in structuring due to the inadequacy of their vocabulary. Again, the lack of sufficient written expression activities is one of the challenging situations for the activity. Again, the test-oriented course leads to a limited number of written or oral expression activities. Conducting test-solution-oriented lessons makes it easier for teachers. Using ready-made, structured resources on websites in the digital environment does not require additional work for teachers, so it directs teachers to conduct test-oriented lessons. In this regard, all of the students summarized the issue by saying, "We had difficulty writing questions at first because our teacher always had us solve tests." Test-oriented teaching can limit students' higher-order thinking skills.

Students had suggestions for the activity as well. These are the application and reaching of this activity to other students, frequent repetition of the

activity, associating it with daily life and unconditional acceptance. All of the students stated that the activity provided them with significant gains, and since they liked the activity, they also suggested that the activity be applied to other students. They wanted this activity to be repeated in the lessons. The reason is that it also contributes to their skills such as language and expression and comprehension outside of mathematics lessons. Again, the students suggested that relating the activity to daily life develops their imagination, so they suggested that mathematics lessons be related to daily life. Another suggestion from the students was an affective suggestion. The students stated that they saw with this activity that the unconditional acceptance of their teachers would increase their success in the lessons, so they wanted unconditional acceptance from their teachers.

Discussion and Conclusion

An individual's ability to develop solutions to the problems they encounter in daily life indicates that they will be successful in expressing themselves and overcoming these problems. In this context, designing a scenario for a mathematically given numerical operation, coping with a problem, looking at the problem from a different perspective, and structuring the operation require higher-order skills. Therefore, it is a very important stage to instill higher-order thinking skills in students (Abosalem, 2016; Baş & Beyhan, 2012; Kosasih, Supriyadi, Firmansyah & Rahminawati, 2022; Muhibbuddin., Artika & Nurmaliah, 2023). In this context, it is seen that the scenario writing activities used in the study are effective in gaining higher-order thinking skills.

Badia & Becerril (2016) concluded in their study that thinking skills develop as the participants write scenarios in teacher education. Valdivia & Martinez (2019) concluded in their study that argumentative writing skills were acquired gradually by prospective teachers. Because when we look at the effect of scenario writing on higher-order thinking skills, it is seen that there was a significant difference at the $p<.001$ level and a difference of 26.72 points between the pre-test average (16.74) and the post-test average (43.46). This situation revealed that scenario writing has an effect on developing students' creative thinking, critical thinking, associating mathematical language with current language, and language and expression skills. This result is consistent with scenario-based studies (Vijayaratnam, 2012; Setyowati, 2020). In addition, it was revealed that scenario writing establishes a strong relationship between higher-order thinking skills and that developing critical thinking skills facilitates associating mathematical concepts with daily life.

According to the opinions of teachers and students, it was determined that, with the sub-codes of establishing cause and effect relationships, questioning, generalization, making inferences, originality, fluency, concretizing abstract concepts, associating mathematical language with current language, and consistency, scenario writing positively affects higher-order thinking skills. According to the opinions of teachers and students, it was revealed that scenario writing has an effect on many other areas such as reading and writing, affective characteristics, life and comprehension skills, besides mathematics. In addition, it was observed that mathematical operations with a large number of operations contributed to students' more creative thinking. This result is consistent with the study conducted by Damsir, Zubaidah, Kusnadi and Rian (2022).

When the opinions of the students about the activities of writing scenarios for a mathematical operation are evaluated, it is seen that their story writing skills have developed, their approaches to their teachers have changed, their imagination skills have improved while looking for a solution to a subject or problem, they can easily gamify a subject, their thinking skills have developed, they have developed more original ideas, their fiction writing skills in their written expressions have developed and they communicate more easily with other students. This result is consistent with the study conducted by Yaman & Süğümlü (2009) in terms of students' participation in the lesson. This situation reveals that students show development both cognitively and affectively. In addition, it was also observed that scenario writing skills enabled students to move away from rote learning and participate effectively in lessons by using their creative and critical thinking skills, as it was handled with a student-centered approach rather than test-oriented lessons. Accordingly, students' self-confidence and self-expression skills have developed through the activities, and students have stated that activity-based applications should be made in other lessons as well.

As a result, it was seen that the scenario writing activity generally developed higher-order thinking skills, and in particular, students' creative writing, critical thinking, structuring, consistency, imagination, problem solving, decision making and associating the subjects covered with daily life. When the current teaching theories related to mathematics lessons are examined in the literature, it is seen that realistic mathematics education (RME) contains the principles that include the above-mentioned skills of the students. In RME, the goals are medium and high level. In RME-based trainings, higher-order skills such as reasoning, communication, critical thinking, and problem solving-creation take place. In addition, it is known that in the theory, associations with daily life are made based on context scenarios (Çilingir-Altıner, 2021; Zulkardi, 2002). Wathne and Carlsen (2024), in

their study, concluded that multimodal mathematical reasoning in solving combinatorial problems enhances problem-solving, mathematical understanding, and reasoning skills. In addition, in this theory, students can reach higher-order thinking skills based on their own experiences and by combining mathematics with scenarios related to daily life, and they can include these skills in the learning process (Freudenthal, 1991; Gravemeijer 1994; Demirdöğen & Kaçar, 2010). Therefore, the student can write a scenario-based problem (Çilingir-Altıner, 2021). From this point on, it can be suggested that different theoretical-based studies should be carried out by adopting the RME approach in the development of mathematical scenarios and problems and their integration in the teaching process. Based on the results, the following suggestions can be made:

Suggestions

- Teachers can use scenario writing activities in different lessons to develop students' higher-order thinking skills.
- Teachers can use scenario writing activities in mathematics and different lessons to develop students' affective and social aspects.
- This study was conducted with primary school third grade students. It can also be carried out in other grade levels and lessons. Various studies can be conducted through scenario writing in different lessons.
- One of the limitations of this study is that the parents' opinions could not be taken. Parent opinions on the activity can also be investigated.
- Research can be conducted to reveal the effect of the activity on eliminating the problems caused by students' learning difficulties.

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