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Comparison of Problem-Posing Skills of Gifted and Non-Gifted Primary School Students

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Abstract

The purpose of this study was to compare the problem posing skills of gifted and non-gifted primary school students. In this study, the case study method was used. The participants who were selected by convenient sampling consisted of 24 gifted and 24 non-gifted students attending from the East of Black Sea region of Turkey. The data in the study were collected with an open-ended problem posing test that was developed by the researchers. This test consists of three situations requiring free, semi-structured and structured, problem posing. The data were evaluated according to the problem posing test evaluation form that was developed by the researchers. At the end of the study, while there was no statistical significance between gifted and non-gifted primary school students in free and semi-structured problem posing, it was found that non-gifted primary school students were statistically significantly better than gifted primary school students in structured problem posing.

Keywords: Gifted and non-gifted, Primary school students, Problem-posing

Introduction

Education of gifted students is one of the issues that is emphasized in developed countries. Because the proper and correct training of these students brings important contributions to both their countries and humanity, however, the desired level has not been reached in the field of education for gifted students in our country (Çitil, 2018). Students who are better than their age group in art, creativity, and academic fields (Worrell et al., 2019), have advanced metacognitive thinking skills, and need special education are called gifted students (Kurnaz, 2013). Gifted students pay attention to the fact that the learning environments are interesting and fun and organized in a motivating way (Yetim-Karaca & Türk, 2020). Otherwise, they exhibit behaviors such as reluctantly attending or not attending classes (Çetin & Doğan, 2018). For this reason, before starting the education of gifted students, differentiated education programs should be implemented by considering their readiness levels, learning speeds, interests, and learning styles (Heacox, 2002; Tomlinson & Alan, 2000). In this way, it is seen that gifted students' interest in mathematics increases and their mathematics learning skills improve (İnan, 2019).

Gifted students who can demonstrate mathematical skills at the level of older students are called gifted students in the field of mathematics (Sowell, Zeigler, Bergwell, & Cartwright, 1990). Students who are gifted in the field of mathematics have a high desire to study, a high level of creativity, and high motivation towards the mathematics lesson (Mingus & Grassl, 1999). In studies comparing gifted students with their peers; it is seen that gifted students have low mathematics anxiety, and their mathematics motivation, attitudes, self-efficacy, mathematics learning behaviors, and problem-solving performances are high (Bulut, Yıldız, & Baltacı, 2020; Gürel & Yetkin-Özdemir, 2019; Pajares, 1996; Wang, Huang & Hwang, 2016). Even gifted students, thanks to their ability to use induction, deduction, and analytical thinking skills, are seen to make fewer mistakes when solving non-routine problems and use different strategies to solve problems (Holton & Gaffney, 1994; Tertemiz, Doğan & Karakaş, 2017; Vaivre-Douret, 2011; Yıldız, Baltacı, Kurak & Güven, 2012). In this context, gifted students have more academic knowledge, memory, reasoning, and learning skills compared to non-gifted students, their creativity is developed; and their motivation is strong, i.e., their cognitive, emotional, and physical development is good (Koçak & İçmenoğlu, 2012; Maria, 2014; Maker & Nielson, 1996; Roznowski, Hong & Reith, 2000; Yıldırım, 2016) can be shown as a result of their being better in mathematics than non-gifted students.

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Gifted students are more successful in studies that require complex and difficult cognitive performance (Stuart & Beste, 2011); they see problem-posing as more difficult than solving (Manuel & Freiman, 2017). Problem-posing, which is a feature of special talent and creativity (Silver, 1994), is a skill that helps students to make sense of symbolic examples in a mathematical sentence, to develop a mathematical language suitable for this meaning, and to develop their ability to establish relationships between solutions (Rudnitsky et al., 1995). There are three different types of problem posing that contribute to the development of students' mathematical thinking skills. The first of these is structured problem posing. In posing a structured problem, students are asked to add additional information to the problem, change the conditions and data in the problem, adapt them to different themes, or pose a problem by reversing what is given with the solution. In free problem posing, which is the second type of problem posing, no obstacles are placed in front of students; they are left free and asked to write creative problems. In semi-structured problem posing, which is the third type of problem posing; the student is given a table, picture, situation, result, story, or is asked to pose a problem similar to the given problem (Kılıç, 2011; Yılmaz, 2019). There are different skills that problem posing brings to students.

Problem posing, which distracts students from the feeling of being the ones who solve only the questions asked by the textbooks or their teachers, enables students to actively participate in the process and take responsibility in the process (Nardone & Lee, 2011; Rizvi, 2004; Upu, 2003). Problem posing, which is a skill that requires more reflection than problem solving, increases students' interest and motivation, develops their reasoning and thinking skills, increases their learning success, and develops skills such as self-control and cooperation (Cai, Hwang, Jiang, & Silber; 2015; Christidamayani & Kristanto, 2020; English, 1997; Silver, 1994; Singer, Ellerton, & Cai, 2013; Toheri, Winarso, & Abdul Haqq, 2020). For this reason, it is one of the issues that teachers focus on.

In the primary school mathematics curriculum, it is seen that it concentrates on low-level cognitive steps such as application, understanding, and remembering, which include low-level cognitive steps, and the gains that include high-level cognitive steps such as analysis, creation, and evaluation are few (Aktan, 2020). In addition, it is seen that there are few mathematics lesson hours in primary schools, there is a shortage of materials, and students develop negative attitudes towards mathematics, but primary school teachers organize fun activities to overcome these problems and increase students' mathematics achievement (Yurtbakan, Aydoğdu-İskenderoğlu, & Sesli, 2016). In addition, it is also interested in problem posing in order to develop students' high-level thinking skills, such as creative and critical thinking and problem solving (Daher & Anabousy, 2018). Teachers, who take on the responsibility of supporting and increasing the academic development of students (Plunkett & Kronborg, 2011), need to provide students with problem-posing skills, especially in order for younger students to better internalize the concepts of mathematics (Chapman, 2006). For this, teachers can choose books that are prone to posing problems in their classrooms and ask students to pose problems based on a sentence or a picture in the book and then evaluate each other's problems (Yurtbakan & Aydoğdu-İskenderoğlu, 2020). By creating discussion environments in the classroom, they can support students in posing problems and encourage students to talk about their problem-solving processes (Gavin & Casa, 2012). While having students pose a problem, they can direct the problem to reflect their real-life situations (Abu-Elwan, 2002), and have computer-assisted problem posing exercises (Atalay & Güveli, 2017).

There seems to be a limited number of studies examining the problem posing skills of gifted secondary school students (Erdoğan & Gül, 2020; Manuel & Freiman, 2017) in the literature. It is seen that there are many studies examining the problem posing skills of non-gifted primary and secondary school students (Alzahrani, 2021; Bevan & Capraro, 2021; Bulut & Serin, 2020; Can & Yıldız, 2021; Dae-Hyun & Jinhee, 2010; Dölek & Caliskan, 2018; Kwon & Capraro, 2021; Özçakır-Sümen, 2021; Peng, Cao & Yu, 2021; Tertemiz, 2017; Yurtbakan & Aydoğdu-İskenderoğlu, 2020). The fact that there is only one study comparing the problem-posing skills of gifted and non-gifted secondary school students (Espinoza, Lupiáñez & Segovia, 2016) and that the study did not compare the problem-posing skills of gifted and non-talented primary school students makes the study necessary. In addition, the fact that gifted students with advanced thinking skills will be compared with their peers in problem posing skills that require creativity is also important in terms of revealing the creativity characteristics of gifted students. In this important study, the problem-posing skills of primary school 4th grade students with and without special abilities will be compared. For this purpose, answers to the following questions were sought in the study:
1- How do the problem-posing skills of gifted and non-gifted 4th grade students differ?
2- Is there a significant difference in the problem-posing skills of gifted and non-gifted 4th grade students?

Method

Research Design

In this study, the case study method was used in order to compare the mathematical problem-posing skills of gifted and non-gifted primary school students. This method persuades researchers to use different data collection tools together and study in depth in a short time (Çepni, 2010). In the study, the problem-posing and problem-solving abilities of gifted and non-gifted students were determined with an open-ended test and then analyzed according to the rubric.

Study Group

To compare the problem-posing skills of gifted and non-gifted students (24 gifted, 24 non-gifted), 48 primary school 4th grade students continuing their education in a public primary school, who were selected by convenient case sampling from purposive sampling methods, were included. Convenient case sampling is related to the fact that it is easier or more accessible for individuals or groups to be researched int the research process (Ekiz, 2009). In this study, the convenience sampling method was used in order to reach the 4th grade primary school students with or without special talents and to speed up the study. 14 of the gifted students were continuing their education at the Science and Art Center, and four of them were boys and ten of them were girls. 14 of the non-gifted students who are continuing their education in a primary school in Trabzon are four girls and ten boys. While these students were coded as G1, G2, …, G24 for gifted students, non-gifted students were coded as NG1, NG2, …, NG24.

Data Collection Tools

In order to compare the problem posing skills of gifted and non-gifted students, first of all, studies comparing the problem-posing skills of primary school students in the literature were examined (Tertemiz, 2017; Yurtbakan & Aydoğdu-İskenderoğlu, 2020). Then, an open-ended problem posing test consisting of 3 questions (1 structured, 1 semi-structured, and 1 free) was developed by the researchers. Opinions of two academicians and one primary school teacher in the field of primary school mathematics teaching were taken about the language and the suitability of the prepared questions for the level of primary school students. In line with expert opinions, necessary corrections were made in terms of language and expression in the questions. After expert opinions, the open-ended problem-posing test was administered to 15 primary school 4th grade students as a pilot study. As a result of the pilot study, the statements that were not clear to the students in the questions were rearranged, and the questions were finalized. In addition, with the pilot study, it was determined how long it would take for the students to complete the test. The following questions are included in the open-ended problem-posing test:

Free Problem Posing

Construct a difficult problem that requires using one or more of the natural numbers addition, subtraction, multiplication, or division operations and solve the problem which you pose.

Semi-Structured Problem Posing

"1 pen, 13 TL, 2 books, 55.50 TL" Pose a problem using the data on the side and solve the problem which you pose.

Structured Problem Posing

"Çınar has got 52 books. Zeynep's books are 14 less than Çınar's books. Mert's books are 7 more than $\frac{1}{4}$ of Çınar's books. How many books does Mert have?" Pose a problem for this situation and solve the problem which you pose.

Data Collection and Analysis

The open-ended problem-posing test was applied to gifted and non-gifted students at the end of the 2021-2022 academic year (2nd week of June). An open-ended problem-posing test was applied to gifted students on the day when they came to the Science and Art Center. It was applied to non-gifted students in the mathematics lesson at school. Students were given 40 minutes for three problem-posing questions in the open-ended problem-posing test. In addition, students were asked to solve their problems. The reason the students are asked to solve the problem they have posed is to make sure that they correct the missing part of the problem they have posed while solving the question.

In this study, qualitative data were analyzed with descriptive analysis, and quantitative data were analyzed with the Mann Whitney U test. While evaluating the problems posed by the students, the problem posing rubric was used by the researchers. Before the rubric was prepared, the rubrics in the literature prepared according to the situations requiring free, semi-structured, or structured problem-posing for both gifted and non-gifted students studying in primary and secondary schools were reviewed (Erdoğan & Gül, 2020; Manuel & Freiman, 2017; Özçakır-Sümen, 2021; Yurtbakan & Aydoğdu-İskenderoğlu, 2022). Besides the rubrics, student answers were reviewed, and the form was finalized by creating different codes. Form was created by using the codes in the literature that examined the problem posing skills of primary school students before (Yurtbakan & Aydoğdu-İskenderoğlu, 2020, Yurtbakan & Aydoğdu-İskenderoğlu 2022). Formally; it consists of 3 sections; characteristics of the problems posed (empty, unsolvable [there is a problem situation but no solution], incomplete [there is a problem but the data is missing or the data in the problem is missing but there is no question root], solvable [the problem can be solved with existing data]), the solution to the posed problem (empty), the correct solution, the wrong solution (missing operation, logical error, unused data, unit error, operation error)) and the status of having the characteristics of the problems described (1 step, 2 step, 3 step and more, adding new data, using all given, changing the given).

After the descriptive analysis, the answers given by the students were scored for the quantitative analysis. Scoring was done as follows: 1 point if it is a problem that contains a mathematical expression that can be understood and solved; 0 points if it is not a problem (problem expression is not understood, does not contain a problem statement) (see Table 1., Table 2. and Table 3.) Then, the statistically significant difference between the problems posed by the gifted and non-gifted students was examined with the Mann-Whitney U test.

Consistency among researchers in the open-ended problem posing test, which was analyzed separately by both researchers, was calculated using the Miles and Huberman (2004) formula. The 5% of the researchers, who did not show consistency among themselves, reached a common conclusion by discussing them. The sum of the scores obtained by the gifted and non-gifted students from the rubric was taken, and the differentiation status was examined with the Mann Whitney U test.

Results

Descriptive Features of the Problems Posed by Gifted and Non-Gifted Students

In this part of the study, descriptive features of free, semi-structured, and structured problems posed by gifted and non-gifted students are included. Table 1 shows the characteristics of the problems posed by both gifted and non-gifted students.

Table 1. Characteristics of posed problems

Prob-lems	Features		Students	
			Gifted	Non-gifted
1. Situation (Free problem posing)	Empty		G8	-
	Unsolvable		-	NG3, NG20
	Incomplete		-	-
	Solvable	1 step	G9, G11, G14	NG7, NG17
		2 step	G1, G6, G7, G12, G13, G17, G18, G21, G22	NG13, NG16, NG18, NG21, NG23
		3 step	G2, G4, G23, G24	NG5, NG8, NG15
		more than 3 step	G3, G5, G10, G15, G16, G19	NG1, NG4, NG6, NG9, NG10, NG11, NG12, NG14, NG19, NG22, NG24
		Numbers not appropriate for level	G2, G7, G10, G23	NG2
		Solution by drawing a figure	G20	NG19, NG20
2. Situation (semi-structured problem posing)	Empty		G18	-
	Unsolvable		-	NG2, NG3
	Incomplete		G5, G8, G9	NG5, NG7, NG9, NG10, NG11, NG20
	Solvable	Adding new data	G6, G7, G17, G21	NG1, NG4, NG6, NG8, NG12, NG13, NG14, NG15, NG16, NG17,

				NG18, NG20, NG22, NG23, NG24
		Using all given	G1, G2, G3, G4, G10, G12, G13, G23, G24	-
		Not using all of the given	G5, G8, G9, G11, G14, G15, G16, G19, G20, G22	NG19, NG21
		Changing the given	-	-
3. Situation (structured problem posing)	Empty		G7, G13, G14, G15, G18	-
	Unsolvable		-	NG2
	Incomplete		-	-
	Solvable	Adding new data	G17	NG11, NG22
		Using all given	G1, G2, G3, G4, G5, G6, G8, G10, G11, G21, G24	NG3, NG4, NG5, NG6, NG7, NG8, NG9, NG10, NG12, NG13, NG14, NG15, NG16, NG17, NG18, NG19, NG21, NG24
		Not using all of the given	G9, G23	-
		Changing the given	G12, G16, G19, G20, G22	NG1, NG20, NG23
		Context switching	-	NG20

In the first situation, which requires free problem posing, gifted students mostly set up 2-step solvable problems, while non-gifted students posed solvable problems that required more than 3 steps (See Table 1). In the second case, which requires semi-structured problem posing, it is seen that gifted students can pose problems either by using all of the given data or by not using all of the given data; it has been seen that non-gifted students set up problems by adding new data. In the third case, which requires structured problem-posing, it has been determined that both gifted and non-gifted students can pose problems by using all of the given information. Table 2 shows how students solved their problems.

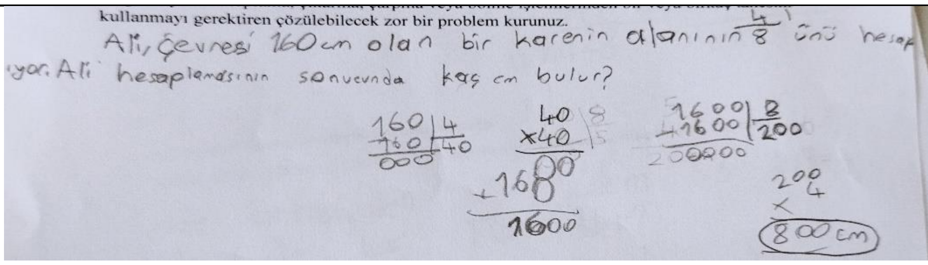
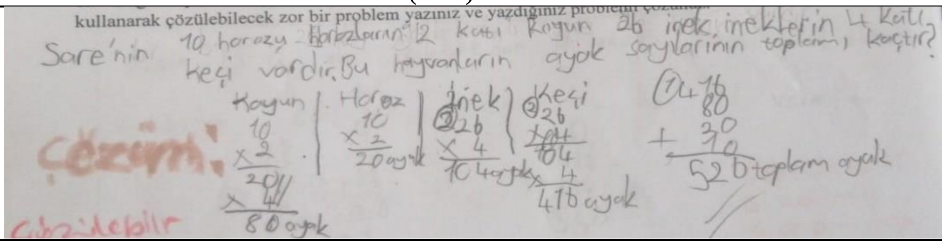
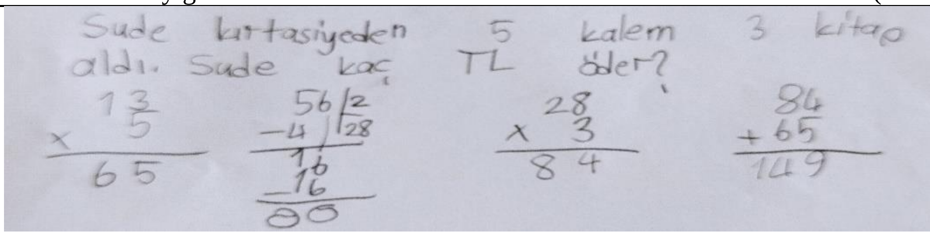
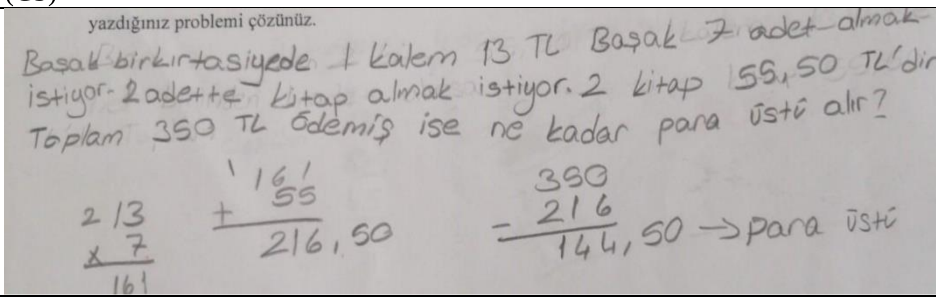
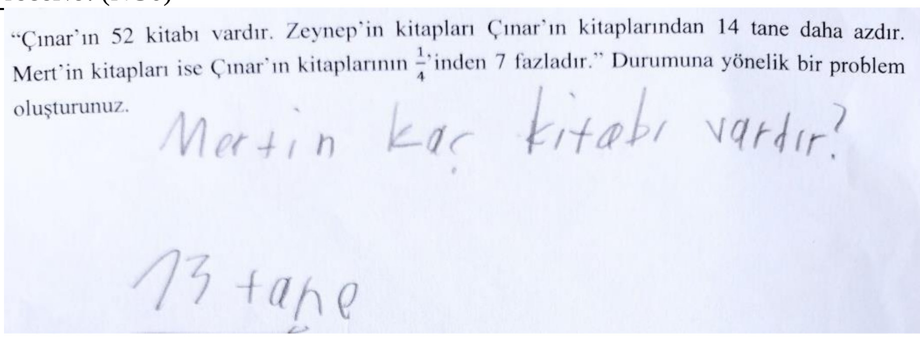
Table 2. Solving the posed problem

Solving		1. Situation		2. Situation		3. Situation	
		Gifted	Non-gifted	Gifted	Non-gifted	Gifted	Non-gifted
Empty		1	2	1	8	5	1
The right solving		22	16	13	7	16	18
The wrong solving	Missing transaction	-	2			-	2
	logic error	1	1	1	2	-	2
	unused data	-	1	-	-	-	-
	unit error	-	1	-	-	-	-
	Operation error	-	1	9	5	3	1
	Getting the number wrong	-	-	-	2	-	-

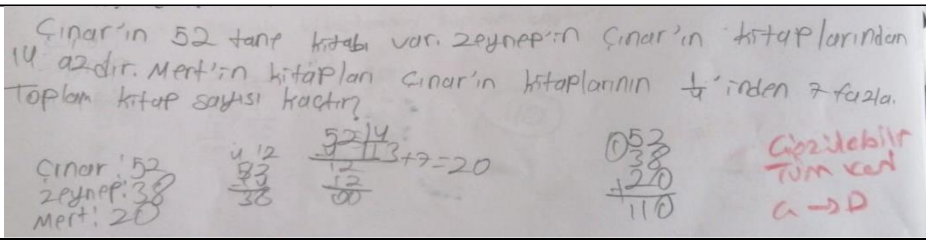
When the solutions to the problems posed by the gifted and non-gifted students are examined, in the first case, which requires free problem posing, and in the second situation, which requires semi-structured problem posing, it is seen that most of the gifted students can solve the problem posed better than the non-gifted students (see Table 2). In the 3rd case, which requires structured problem posing, it is seen that the number of non-gifted students who can solve the problem, albeit a little, is higher than the number of gifted students. In this sense, it can be thought that gifted students are more successful in solving free and semi-structured problems.

Table 3. Solving the posed problem

Prob-lems	Features	Examples

1. Situation	Solvable but wrong solution	 Ali calculates 4/8 of the area of a square whose perimeter is 160 cm. How many cm does Ali find at the end of his calculation? (G21)
	Solvable	 Sare has 10 roosters. There are twice as many sheep as roosters. There are 26 cows and 4 times as many goats as cows. What is the total number of feet of these animals? (NG4)
2. Situation	Unsolvable	 She bought 5 pens and 3 books from Sude stationery. How much did he pay in Sude? (G5)
	Solvable	 Başak wants to buy 7 pens, one of which is 13 TL, from stationery. In the stationery, both books are 55.50 TL. If he has paid 350 TL in total, how much change will he receive? (NG6)
3. Situation	Solvable but wrong solving	 Çınar has got 52 books. Zeynep's books are 14 less than Çınar's books. Mert's books are 7 more than $\frac{1}{4}$ of Çınar's books. How many books does Mert have? (G11)

Solvable



Çınar has 52 books. Zeynep's number of books is 14 less than Çınar's books. Mert's books are more than $\frac{1}{4}$ of Çınar's books. How many books do the children have altogether? (NG9)

2- Statistically Significant Difference of the Problems Posed by Gifted and Non-Gifted Students

In this part of the study, the results of the quantitative analysis regarding the statistical significance of the problems posed by gifted and non-gifted students are given (see Table 4).

Table 4. Problem posing

Students	1. Situation			2. Situation			3. Situation			Total		
	N	X	Sd	N	X	Sd	N	X	Sd	N	X	Sd
Gifted	24	,917	,28	24	,583	,50	24	,708	,46	24	2,21	,88
Non-gifted	24	,917	,28	24	,667	,48	24	,958	,20	24	2,54	,72

In Table 4, it is seen that the arithmetic mean and standard deviation scores of the gifted and non-gifted students in free problem posing (Situation 1) are equal; in semi-structured and structured problem posing (2nd and 3rd cases), non-gifted students have higher arithmetic averages and lower standard deviation scores than gifted students. The Mann Whitney U-Test results performed to see if these values are significant are given in Table 5.

Table 5. Problem posing skills of gifted and non-gifted students Mann Whitney U test results

Situations	Students	N	Mean of Ranks	Sum of Ranks	U	Z	p
1. situation	G	24	24,50	588,00	288,00	,00	1,00
	NG	24	24,50	588,00			
2. situation	G	24	23,50	612,00	264,00	-,590	,56
	NG	24	25,50	564,00			
3. situation	G	24	21,50	516,00	216,00	-2,299	,02
	NG	24	27,50	660,00			
Total	G	24	21,92	526,00	226,00	-1,430	,15
	NG	24	27,08	650,00			

While there is no statistically significant difference between gifted and non-gifted students' free problem posing (1st case), semi-structured problem posing (2nd case), and total problem posing scores ($p>.05$), it is seen that there is a statistical significance in favor of non-gifted students in structured problem posing scores ($p<.05$) (see Table 5).

Conclusion and Discussion

At the end of the study conducted to compare the problem-posing skills of gifted and non-gifted primary school students, it was revealed that gifted students mostly pose problems that can be solved in 2 steps, while non-gifted students pose problems that require more than 3 steps. In semi-structured problem-posing, it has been determined that gifted students either use all of the given data or do not use all of the given data, while non-gifted students pose problems by adding new data. Gifted students continue their education in the same class in science and art centers after completing their educational activities in different schools. All of the students who are not gifted continue their normal education activities in the same class in their own schools. The fact that the classroom teachers of non-gifted students were conscious of problem-posing and had them do problem-posing exercises in mathematics lessons may have supported the development of problem-posing skills in the students. On the other hand, gifted students from different schools may not allocate enough time to problem-posing studies by their classroom teachers in the schools where they receive education. For this reason, it may be that both gifted and non-gifted students experience differences in free and semi-structured problem-posing. In structured problem-posing, it has been observed that both gifted and non-gifted students can pose problems by using all of the given information. The reason why gifted and non-gifted students do not experience any difference in structured problem-posing may be that in structured problems, students adapt to the situation in the study by changing the numbers or changing the objects in the problem. In the literature, the problems posed by gifted students include more than one step (Manuel & Freiman, 2017); number types and quantities vary; question expressions differ semantically; at least four steps are required to solve problems, problems involve two or more computational processes (Espinoza et al., 2013); they can pose problems for four operations as well as practice writing; not being able to answer, logic. It is also seen that they experience problems such as making mistakes (Erdoğan & Erben, 2018). It is also seen that there are studies examining the characteristics of the problems posed by non-gifted students. In these studies, it is seen that students who are not gifted have difficulties in posing problems; there are deficiencies in the expressions of the problems they pose, they do not use the language well in the problems they pose; and therefore the problems are not understood to solve them, and the understood ones do not match the procedure used in the solution (Arıkan & Ünal 2013; Can & Yıldız, 2021; Çarkçı, 2016 Kartal, 2017). Contrary to these results, there are also results showing that non-gifted students are successful in posing problems; the problems they pose are logical and solvable, but the problems that the students pose are similar to the problems they pose in the classroom with their teachers (Dölek & Çalışkan, 2018; Kwon & Capraro, 2021; Özçakır-Sümen, 2021). When the situations of gifted students and non-gifted students posing arithmetic problems are compared, it is seen that the problems posed by mathematically gifted students are, require different steps, contain different computational processes to solve, and contain higher numbers with different semantic relationships. determined (Espinoza et al., 2016). In this context, the reason why both gifted and non-gifted students experience similarities and differences in problem posing may be due to their teachers' efforts to pose problems in mathematics lessons at schools. Because it is seen that enriched lesson activities in school to improve students' problem posing skills give positive results (Atalay & Güveli, 2017; Yurtbakan & Aydoğdu-İskenderoğlu, 2020; Kim & Hodges, 2012).

In the study, it was revealed that gifted students were more successful than non-gifted students in solving free and semi-structured problems. This may be due to the fact that gifted students use more strategies when solving problems than non-gifted students (Yıldız, Baltacı, Kurak, & Güven, 2012). Because gifted students think that problem posing is difficult and they state that they are more comfortable solving problems than problem posing (Manuel & Freiman, 2017). This situation is confirmed by the fact that the gifted students reached in the study are more successful in solving the problem they posed than the non-gifted students and more unsuccessful in solving the problem they posed, especially in the structured problem-posing, than the non-gifted students. The reason why gifted students who excel in creativity and motivation (Leana-Taşcılar & Cinan, 2012) fail to pose structured problems compared to non-gifted students may be that they are mentally tired when they come to the Science and Art Centers to receive education after their normal education. This mental fatigue may reduce their motivation, prevent them from concentrating on the subjects, and make them reluctant to attend classes. The inability of gifted students with creativity to focus their attention on the subject; they may find it simple to change only the numbers given in the problem situation or the appropriate expression for the situation, thus hindering their efforts to make the problem more creative by differentiating it.

Recommendations

1. Dialogic reading or computer-assisted problem-posing activities can be done to improve structured problem posing skills, which are more unsuccessful for gifted students than free and semi-structured problem-posing.
2. Since gifted students pose problems that require fewer steps in free and semi-structured problem-posing compared to non-gifted students, mind and intelligence games activities can be organized to improve the high-level thinking skills of gifted students.
3. Problem-posing activities can be increased in order to improve the problem posing skills of students in classes where gifted and non-gifted students study together.

Author (s) Contribution Rate

Authors contributed equally to the study.

Conflicts of Interest

There is no conflict of interest for individuals or institutions in this research.

Ethical Approval

Ethical permission (17.06.2022-E-81614018-000-2200023344) was obtained from Trabzon University institution for this research.

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