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Research Article

The effect of STEM for gifted activities' mathematical problem-posing skills of gifted primary school students

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Abstract

STEM for gifted has become a rapidly developing field in gifted education. Many research findings on the use of STEM in the education of the gifted have increased the number of studies on how and in what way it will be applied. This study aimed to examine the effect of STEM for gifted activities on the problem-posing skills of gifted primary school students. The explanatory design of the mixed method was used in the study. The study included 16 gifted primary school students selected by convenient sampling. A problem-posing test and a semi-structured interview were used as data collection tools. The effect of STEM for gifted activities on problem-posing skills was determined by the Wilcoxon Signed Ranks test. Semi-structured interviews with gifted primary school students were analyzed with descriptive analysis. At the end of the study, it was concluded that STEM for gifted activities improved the problem-posing skills of gifted primary school students and their retention. Gifted primary school students expressed that they liked STEM for gifted activities; they liked the design phase the most, and it increased their interest in science, mathematics, and engineering. Gifted primary school students stated that problem-posing was moderately difficult because they did not do problem-posing activities at school, but their problem-posing skills improved thanks to STEM for gifted activities.

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Introduction

Educational activities are organized in schools for students who have cognitive developmental delays (learning, speaking, hearing, reading, writing, mathematics disorder), normally developing and gifted students. While students with this characteristic can receive education and training services in the same class, depending on their status, they can receive education and training services either in support education rooms in their schools or in special education institutions in accordance with their individual differences. Students with developmental delay; the hearing impaired participate in educational activities in institutions such as special education centers, and gifted students participate in education activities in SACs where ensures the development of their special capabilities Thanks to the differentiated and enriched education they experience, they acquire the skills of problem solving in daily life as well as acquiring high-level cognitive skills such as analysis, synthesis and evaluation as well. Apart from concrete thinking skills, studies about abstract thinking skills are also expected (Satmaz, Tortop & Deniz, 2018). Gifted students who come to SACs are individuals

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who perceive and learn complex concepts and ideas faster than their friends, and who are not content with learning more (Winebrenner, 2000). High-level thinking skills should be taken into account in order to discover the characteristics of gifted students and maximize their potential (Trna, 2014). Gifted students also show higher-order thinking skills such as problem solving and constructing (Yuan & Sriraman, 2011). In addition, the creativity characteristics of gifted students are associated with their mathematical problem-posing skills (Johnson, 2000; Sheffield, 2018).

Problem-posing is a learning model in which students set up the problem according to a certain situation and then solve the problem they have established. It is an inductive inquiry process that guides students' communication in the classroom and supports their critical thinking skills (Isik & Kar, 2012). In problem-posing, the student is expected to pose problems by combining metacognitive thinking skills with past life experiences, by giving instructions such as any table, figure, visual, operation, result and rule, real life problem, let's pose a problem (Ev-Cimen & Yildiz, 2017). Three different ways can be used for these problems expected from the student. The first of these is to pose a free problem that the student is asked to pose by using his/her creativity without limiting, the second is to pose a semi-structured problem that the student is asked to pose about the figure, table, story, picture or a problem appropriate to a given problem, and the third is to add to the problem given to the student, to change the given and conditions in the problem, to change the conditions in the problem. It is a structured problem-posing that is posed by fitting a subject or replacing the solution with the given ones (Kilic, 2011; Silver, 1994). In order for students to pose such problems, teachers are in the process of problem-posing; they should encourage their students to pose problems, do activities that will make mathematics fun and provide opportunities, give time to students to pose and solve problems, watch and listen to them during the problem-posing process, and only interfere with the mathematical operations of students who want help (Cheesemen, 2009). In this way, students; as their interest in mathematics increases, their fear of mathematics decreases. In addition, students' mathematics motivation increases, students can develop positive attitudes towards mathematics lessons, and even students' creativity characteristics improve (Altun, 2001; Lavy & Shriki, 2007; Silver, 1997; Yurtbakan & Aydogdu-Iskenderoglu, 2020).

In addition to the activities in the mathematics lesson, the activities in the sciences play an important role in the improvement of the creativity of gifted students. The practical implementation of science and mathematics sciences (Pang & Good, 2000), which are based on interconnected ways and share scientific processes such as problem solving and questioning, supports the improvement of students' science and mathematics skills (Tyler- Wood, 2000). STEM education, which is a differentiated and enriched education in which mathematics- science are applied together; It provides the opportunity for gifted students studying in SACs to express themselves and triggers the interests and abilities of students (Koshy, 2002; Omeroglu, 2004; Rinn, Plucker & Stocking, 2010; Tiryaki, Yaman & Cakiroglu, 2021).

STEM education which attracts the attention of countries both economically and politically; It aims to combine the fields of mathematics, engineering, science and technology to analyze education with a holistic approach by linking these disciplines (Broderick, 2018; Kuenzi, 2008; Smith & Karr-Kidwell, 2000). STEM education, which aims to support students' twenty first century skills, also enables students to realize how they transfer what they learn in the classroom environment to daily life, and to learn high-level thinking skills and meaningful learning. (Ministry of National Education of Turkey [MoNET], 2016; Yildirim & Altun, 2015). It also helps gifted students to better develop their skills such as looking at problems by using different disciplines together, thinking logically and critically, questioning, and being creative (Cepni, 2017; Roberts, 2012). In short, STEM education enables students to look at the problems they encounter in their lives with a critical perspective, to understand how tools and equipment work, to use technology effectively and to create original products by collaborating (Bybee, 2010; Hernandez, 2014).

In order for STEM education to be beneficial to students, some precautions must be taken. STEM practitioners, schools, administrators, and teachers should first start by considering their own needs and ideas (Savan-Gencer, Doğan, Bilen & Can, 2019). Practitioners should be educated and knowledgeable about STEM for gifted activities, willing and diligent (Aydeniz, 2017; Eroglu & Bektas, 2016; Toma & Greca, 2017). They should not be limited in material and time. In order for students to establish the connection between science, engineering, technology, mathematics disciplines, they need to explain the ideas of each of these disciplines (Honey et al., 2014). They need to make students more productive by using measurement and evaluation tools more in the process and giving immediate feedback to students about assessments (Zengin, Kaya, & Pektas, 2021). In this context, in order for STEM education to be successful, students need to give opportunities to learn by doing, so that they can embody what they have learned, make production, that is, be successful in practice (Pehlivan & Uluyol, 2019).

Implementation of STEM for Gifted Activities

STEM for gifted requires students to use their knowledge and skills in science, technology, engineering, and mathematics disciplines to solve a social problem. In STEM for gifted, rather than making gifted students memorize information, students are expected to try to find solutions for the solution of the problem situation, to do research, to ask questions, and to produce original products while producing a solution. Gifted students are expected to solve the 21st century skills they have and the problems they encounter on a project basis. It is important to follow the steps below in STEM education (MoNET, 2020).

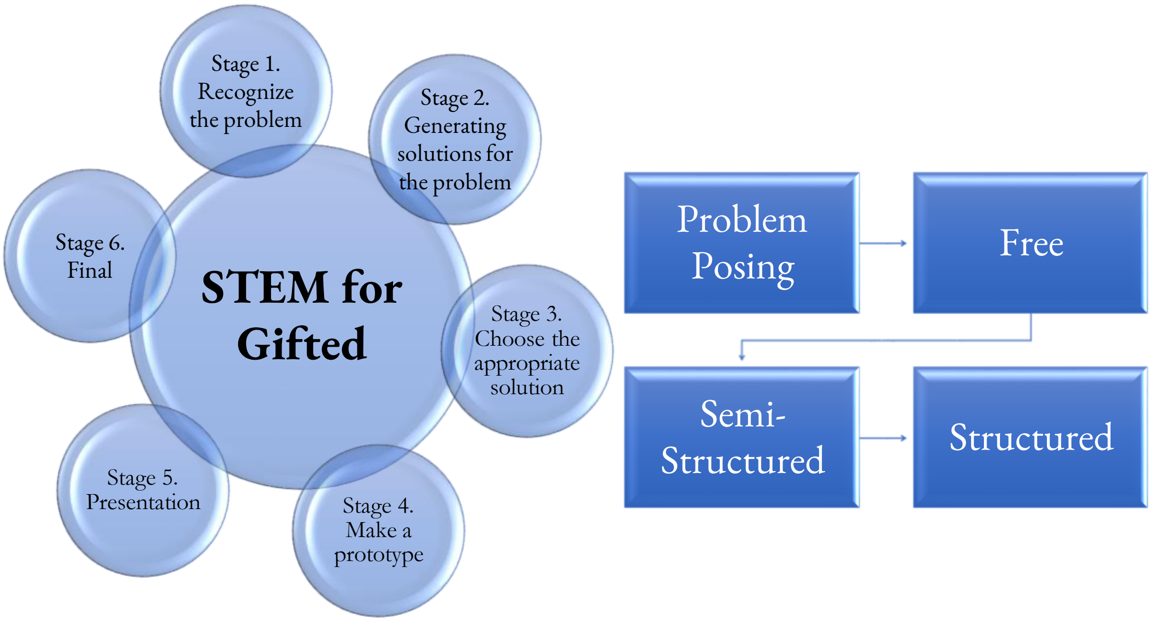

Figure 1. Problem-posing practice steps with STEM for gifted activities

Recognize the problem: The problem needs to be defined and analyzed in a cause-and-effect relationship (MoNET, 2020). It is tried to make gifted students feel the problem situations that we may encounter in daily life based on newspaper or television news and story books. For example, the students are reading the story of people who could not go to their fields on the other side because of the river in front of their house.

Generating solutions for the problem: Multiple possible solutions to the problem are suggested (MoNET, 2020). Gifted students are expected to come up with ideas on how to solve the problem by brainstorming after they are made to feel the problem situation in newspaper or television news or in story books. At this stage, the suitability of the solutions produced by the students is not discussed, and all the ideas are written on the board. For example, the ideas put forward by the students to solve the problem of crossing the river are written on the board.

Choose the appropriate solution: The appropriate idea is chosen among the ideas put forward by the students for the solution of the problem (MoNET, 2020). At this stage, solutions are discussed with the students in terms of criteria such as cost, safety, functionality, and not harming the environment, and a safe, functional, cost-effective, and environmentally friendly solution is chosen. For example, for the problem of crossing the river, cable cars, flying balloons, and bridge solutions are presented by the students. Bridge construction is chosen as a solution because it is safe, cost-effective, functional, environmentally friendly, and does not require any energy consumption.

Make a prototype: A product or prototype is developed and tested using the best solution (MoNET, 2020). At this stage, the necessary materials for the solution are given to the gifted students, and the students are expected to present the product concretely by using their science, mathematics, engineering, and technology skills. Gifted students are divided into groups to provide an environment for collaborative work. For bridge construction, which is the most suitable solution for crossing the river, students are given a rope, straw, mouth stick, silicone gun, and silicone, and they are expected to produce a product as a group.

Presentation: Shares the product or prototype with other people and receives their comments and criticisms (MoNET, 2020). At this stage, the students present their prototype to the friend or friends they have chosen from the group in front of the class. The purpose of the presentation is to ensure that the good aspects of the prototype made by the students are taken as examples by other groups and to draw attention to the shortcomings seen by the students in other groups. For example, the gifted students argue that the bridge they built to solve the problem of crossing the river should be put in place to break the speed of the water in order not to damage the bridge due to the increase in the intensity of the water as a result of the melting of the snow and increasing rains in the spring months. In addition, it draws attention to the construction of a bow-shaped arch underneath the bridge in order to carry the weight on it.

Final: The product or prototype is evaluated, and ideas for improvement are developed (MoNET, 2020). At this stage, gifted students give their final shape to the prototype by considering each other's criticisms. For example; gifted primary school students give the bridge its final shape by placing springs that will allow it to flex under the bridge and feet that increase resistance to water violence in order to increase the load bearing capacity of the bridge.

STEM for gifted, after the STEM construction phase is completed, the problem-posing phase is started. In the problem-posing phase, first of all, the subject of mathematics related to the prototype we produce for the solution of the problems that we may encounter or encounter in our daily lives is discussed with the students. For example, it is concluded that the bridge prototype is related to the measurement learning domain (weight and length) of mathematics. Then the students are asked to pose a free problem related to the appropriate learning area. Free problem-posing, students are not limited and they are expected to pose problems that include the operations and numbers they want. Students are asked to present their problems on the board. Problem feature, unnecessary data usage and solvability are checked. Then, the semi-structured problem-posing phase is started. The students are given the data necessary for the problem, but the last sentence of the problem is not given. The reason for this is that the student determines the operations themselves using the given numbers. After the semi-structured problem situation is transformed into a problem by the gifted students, they are asked to make a presentation. Problem feature, unnecessary data usage and solvability are checked. Finally, the structured problem-posing phase is started. In structured problem-posing, students are given numbers and operations. Gifted students are expected to pose problems that can be solved, in which the given things are not used or added to the given ones. Problems posed by gifted students are evaluated according to criteria.

Effect of STEM education on gifted high school students' mathematical problem solving skills, their university preferences (Suarsana, Lestari & Mertasari, 2019; Vu et al., 2019), the effect of secondary school students on creativity and science attitudes, their attitudes towards coding, critical thinking, metacognitive awareness and It is seen that there aare studies examining the effect on problem solving skills, and only one study in the field of mathematics was conducted to examine the effect on problem-posing (Akben, 2020; Avci, Okusluk & Yildirim, 2021; Boran & Karakus, 2022; Erdogan & Gul, 2020; Ozcelik & Akgunduz, 2017; Tiryaki, Yaman & Cakiroglu, 2021). Although it has a large effect size on primary school students, which are mostly carried out with secondary school students, it is seen that STEM education (Becker & Park, 2011; Ecevit, Yıldız, & Balci, 2022) is done on the experiences of gifted primary school students in material development and project design (Kalkan & Eroglu, 2017; Karahan & Unal, 2019). In this sense, it is thought that examining the effect of STEM education on the problem-posing skills of gifted primary school students will fill the gap in the literature. In addition, the use of STEM activities (Kocak & Icmenoglu, 2012; Tiryaki, Yaman & Cakiroglu, 2021), which has an important role in developing creativity, which is one of the most sensitive components of giftedness, to develop problem-posing skills that require creativity (Davis & Rimm , 2004) provide students with a different perspective. important in terms of gain.

Problem of Study

The effect of STEM for gifted activities on the problem-posing skills of gifted primary school students will be examined in the research.

- Is there a statistically significant difference between the problem posing pre-test scores and post-test scores of gifted primary school students who receive STEM for gifted activities?
- Is there a statistically significant difference between the problem posing post-test scores of gifted primary school students receiving STEM for gifted activities students and their retention problem-posing test scores?
- What are the thoughts of gifted primary school 4th grade students about problem-posing with STEM activities for gifted students?

Method

Research Model

The explanatory design, which is one of the patterns of the mixed method, was adopted in the study. In the explanatory design, before the qualitative data is used to support the results, quantitative data are collected (Cresswell, 2008). Quantitative data collected in the post-pre test experimental design without control group were supported by qualitative data collected through a case study. For this reason, after the open-ended problem-posing test was applied to the gifted primary school students as a permanence-post and pre-test, interviews were conducted with the students about STEM for gifted activities and problem-posing with STEM for gifted activities.

Study Group

A total of sixteen primary school 4th grade students studying at a SAC in the Eastern Black Sea region in Turkey participated in the study by way of convenient sampling. The demographic information of the gifted primary school students is shown in Table 1.

Table 1. Structures of students and coding

No	Age	Gender	Favorite lesson	Enrolled program	Codes
1	10	Female	Science	Supportive Program	S1-F-10
2	10	Male	Mathematics	Supportive Program	S2-M-10
3	10	Male	Mathematics	Supportive Program	S3-M-10
4	10	Female	Science	Supportive Program	S4-F-10
5	10	Female	Turkish lesson	Supportive Program	S5-F-10
6	10	Male	Mathematics	Supportive Program	S6-M-10
7	10	Male	Science	Supportive Program	S7-M-10
8	10	Male	Mathematics	Supportive Program	S8-M-10
9	10	Female	Mathematics	Supportive Program	S9-F-10
1o	10	Male	Social studies	Supportive Program	S10-M-10
11	10	Male	Social studies	Supportive Program	S11-M-10
12	10	Female	Mathematics	Supportive Program	S12-F-10
13	10	Male	Turkish lesson	Supportive Program	S13-M-10
14	10	Female	Mathematics	Supportive Program	S14-F-10
15	10	Male	Science	Supportive Program	S15-M-10
16	10	Male	Mathematics	Supportive Program	S16-M-10

All of the students are 10 years old and are studying in the supportive education program of the SAC. Ten of the students are boys and 6 of them are girls. Eight of the students like mathematics the most, 4 like science lessons, 2 of them like social studies and Turkish lessons. The students are coded in a way that shows the participant number, gender and age (S1-F-10, S2-M-10, ………, S16-M-10).

Data Collection Tools

In the study, open-ended problem-posing test and semi-structured interview form were used.

Problem-Posing Test

The test, which includes 4 open-ended questions, was prepared for 2 structured, 1 free problem-posing and 1 semi-structured. Permission was obtained from the authors for the study, and 3 questions in the test (1 structured, 1 semi-structured, 1 free problem-posing) were used by taking the opinions of 3 experts in the field of mathematics education. While preparing the open-ended test, first of all, problem-posing tests developed in the literature to reveal the problem-posing skills of primary school students were examined. Then, 4 questions (2 structured, 1 semi-structured, and 1 free) were prepared to reveal the problem-posing skills of gifted students. The questions were presented to the opinions of three experts in the fields of one gifted and two primary school mathematics. After the approval of the experts, the problem-posing test was administered as a pilot to four gifted students. Student answers were scored separately by the researchers, and the consistency between the researchers was checked using the Kendall's W test. It was determined that the agreement was 100%.

Semi-Structured Interview

Prepared by the researcher; "Did you like STEM for gifted activities, and if so, which part did you like the most? Did you find STEM for gifted activities useful, and if so, what are the benefits? Is problem-posing difficult, if so why, what are your views on STEM for gifted activities and problem-posing?" questions were asked to the students. For the interview tool, 3 experts (primary school mathematics teaching) were consulted and the tool was finalized in line with expert opinions (see Appendix 1).

Before starting the study, STEM for gifted activities were examined from the literature and ten weeks STEM for gifted activities was planned by the researchers. While planning the activities for STEM for gifted activities, help was received from two academicians in the field of science who have academic studies on STEM for gifted activities and a science teacher who has 20 years of experience and conducts STEM for gifted activities workshops with gifted students. After completing the STEM for gifted activities, the activities were explained to two experts in the field of primary school mathematics education and 1 primary school teacher with 15 years of teaching experience who worked on problem-posing, and opinions were received about which subject of mathematics would be asked to pose problems by connecting the students. STEM for gifted activities activities planned in line with expert opinions are shown in Table 2.

Table 2. STEM for gifted activities associated with mathematics subjects

No	Activity title	Science	Math subject
1	Bird's nest (MoNET, 2020)	Life in living things	Natural numbers
2	Wind binoculars	Motion and force	Fractions
3	Parachute	Motion and force	Measuring time
4	Air powered car (MoNET, 2020)	Motion and force	Measuring length
5	Rocket making	Motion and force	Measuring length
6	Bridge construction	Motion and force	Weighing
7	Catapult (MoNET, 2020)	Motion and force	Weight-length
8	Air powered vacuum cleaner	Motion and force	Measuring area
9	Underwater vehicle	Motion and force	Measuring liquid
10	Thermometer	Heat	Graphic

The air-powered car activity in the book "Achievement-Centered STEM Activities" published by the General Directorate of Private Education Institutions of the MoNET in 2019 was applied to the students. In the first step of STEM for gifted activities, which is define and analyze the problem; Students are made aware of what kind of power the air we breathe every second can create when compressed, and where this power can be used in our lives. Afterwards, they are asked whether the thrust of the air can be used in transportation, whether a transportation vehicle can be made using the power of the air, and their opinions are taken about how the air can be compressed. In the second step, find possible solutions and choose the best; The students are asked what can be used to trap the air first and then expel it. In the third step, make an example and test it; Students are divided into groups and each group is given 3 straws, 1 plastic bottle, 5 plastic bottle caps, skewers, balloons and tape, and the students are asked to design a car that works with balloons. In the fourth stage, share the product; each group chooses a spokesperson and explains their designs in detail to their friends. During the narration, he takes note of the criticisms of his friends, and the group who does not present their design takes note of the good idea in the group. In the last step, which is to evaluate the product and think better; After sharing, students are asked what they can do to improve their designs (MoNET, 2019). After completing the STEM for gifted activities steps, the students were asked which subject of mathematics we can associate the car with the air. Based on the length measurement answer received from the students, they were asked to pose and solve one free problem. Afterwards, the students were given the statement "The air powered car made by Zeynep goes 50 meters, the air powered car made by Egemen goes 40 meters..." and the students were asked to turn the statement into a problem and solve it. Finally People: Zeynep and Yaren, Numbers: 90, 30, 4; Operation: They were asked to pose and solve problems by giving addition and division data. After each problem-posing phase, the problems were evaluated by the students in terms of being logical, solvable, understandable, and designed in accordance with the STEM for gifted activity, and feedback was given to the students about their problems.

Figure 1. STEM for gifted activity example: Bird's nest, wind binoculars, parachute, rocket making, air powered car, bridge construction, catapult, air powered vacuum cleaner, underwater vehicle, thermometer

Before starting the application, the open-ended problem-posing test was administered to the students as a pre-test. Then, STEM for gifted activities were designed for 10 weeks (once a week) and problem-posing studies were carried out about the activity. The open-ended problem-posing test was applied as a post-test the week after the applications ended. The open-ended problem-posing test was applied for the last time as a permanence test 3 weeks after the post-test was administered. In the problem-posing test applied to the students, "3" points if the problems are set up correctly and completely solved (1+2), "2" points if the problem has been posed but the solving is half done (1+1), "1" point if only the problem has been posed, if the problem has not been posed or the numbers given Although it is used, if it is not a problem statement, a score of "0" is given (Yurtbakan & Aydogdu-Iskenderoglu, 2022). A total of 9 points can be obtained from the test; The variation between the data obtained from the permanence test- post test and pre test was analyzed with the Wilcoxon Signed Ranks test. The effect size of the statistically significant results was calculated.

Semi-structured interviews with the students were analyzed with descriptive analysis, the data obtained were shown in the table and after the interpretation of the table, the student views were conveyed as they were.

Results

In this section, descriptive analysis results obtained from gifted primary school students and Wilcoxon Signed Ranks Test results are included.

The Effect of STEM for Gifted Activities on Problem-Posing Skills

The open-ended problem-posing test, which was applied as a permanence and post-test after the implementation of STEM for gifted activities, was applied to gifted primary school students as a pre-test, The results of the applied tests are presented in tables together with the results of the interviews with the students.

Table 3. The scores of the students in the problem-posing pre-post-test, retention test

Students	Pretest			Posttest			Retention Test			PrS	PsS	RS
	1	2	3	1	2	3	1	2	3			
S1	3.00	3.00	,00	3.00	3.00	3.00	3.00	3.00	3.00	6.00	9.00	9.00
S2	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	9.00	9.00	9.00
S3	3.00	3.00	,00	3.00	3.00	3.00	3.00	3.00	3.00	6.00	9.00	9.00
S4	3.00	3.00	,00	3.00	3.00	3.00	3.00	3.00	3.00	6.00	9.00	9.00
S5	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	9.00	9.00	9.00
S6	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	,00	9.00	9.00	6.00
S7	3.00	3.00	,00	3.00	3.00	,00	3.00	3.00	,00	6.00	6.00	6.00
S8	1.00	3.00	,00	3.00	3.00	3.00	3.00	3.00	3.00	4.00	9.00	9.00
S9	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	9.00	9.00	9.00
S10	3.00	3.00	,00	3.00	3.00	3.00	3.00	3.00	3.00	6.00	9.00	9.00
S11	1.00	3.00	,00	1.00	3.00	,00	3.00	3.00	3.00	4.00	4.00	9.00
S12	3.00	3.00	,00	3.00	3.00	3.00	3.00	3.00	3.00	6.00	9.00	9.00
S13	1.00	3.00	,00	3.00	3.00	3.00	3.00	3.00	3.00	4.00	9.00	9.00
S14	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	9.00	9.00	9.00
S15	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	9.00	9.00	9.00
S16	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	9.00	9.00	9.00

PrS: Pre-test total scores **PsS**: Posttest total scores **RS**: Retention test total scores

In the question requiring semi-structured problem-posing, it was determined that 13 of the gifted students in the pre-test, 15 in the post-test, and all of them in the permanence test were able to both pose and solve the problem they posed. In the second question of the test (free problem-posing), it was observed that all of the gifted students were able to pose a problem successfully both in the retention, post-test and pre-test and were able to solve the problem correctly. In the third question of the test (structured problem-posing), it was revealed that 7 gifted primary school students were able to pose and solve problems in the pre-test and 14 students in the permanence and post-test. In this sense, it can be thought that more than half of the gifted students have difficulties in setting up structured problems, but they overcome this difficulty with the help of STEM for gifted activities .

Table 4. Problem-posing pre-post test Wilcoxon Signed Rank Test

	Post-pre	n	Mean r.	Sum of R.	z	partial η^2	p
Problem-posing	Neg.	0	,00	,00			
	Pos.	7	4.00	28.00	-2,460	0.62	.01
	Equ.	9					

It has been determined that STEM for gifted activities have a positive effect on the problem-posing skills of gifted students ($p<.05$).

Table 5. Problem-posing post-test-retention test Wilcoxon Signed Rank Test

	Post-pre	n	Mean r.	Sum of R.	z	p
Problem-posing	Neg.	1	1.00	1.00		
	Pos.	1	2.00	2.00	-.447	.66
	Equ.	14				

It has been determined that the positive effect of STEM for gifted activities on the problem-posing skills of gifted students is permanent ($p>.05$).

Views of Gifted Students on STEM for Gifted Activities and Problem-Posing

In this section, the views of gifted students about liking STEM for gifted activities and the part they like most, about the usefulness of STEM for gifted activities , about the difficulty and reason of problem-posing, and about posing problems with STEM for gifted activities are given

Table 6. The students' enjoying of STEM for gifted activities and their favorite stage

Enjoyment	Most enjoyable stage	Students	f
Yes I enjoyed(except for S5-F-10)	Finding suitable solution	S2, S8, S14	3
Yes a little enjoyed (S5-F-10)	Design	S5, S6, S7, S9, S16	5

A total of 7 gifted primary school students stated that they enjoyed STEM for gifted activities . More than half of the gifted primary school students stated that they enjoyed the design part of the activities the most. These are the students' opinions with the code S5-F-10 "*I enjoyed it a little bit. I had fun there. I enjoy the design stage. I enjoyed designing more events." expressed as.* In Table 7 below, students' views on whether STEM for gifted activities are beneficial or not are given.

Table 7. Gifted students' views about usefulness of STEM for gifted activities

Usefulness	Benefits	Students	f
Yes they are useful (all)	My math skills have improved.	S7, S8	2
	My interest in science has increased.	S2, S5, S6, S8, S16	5
	My interest in mathematics has increased.	S2, S5, S6, S8, S16	5
	My interest in technology has increased.	S8, S16	2
	My interest in engineering has increased.	S2, S7, S8, S9, S16	5
	My thinking skills have improved.	S2, S14	2

All gifted primary school students stated that they found STEM for gifted activities useful (see Table 7.). The students were asked, "*How did STEM for gifted activities benefit you*?" The students said that their interest in science, mathematics and engineering increased the most. S8-M-10 of the students expressed their thoughts on the subject as follows:

> "*I was more interested in science and mathematics. It says divide the top in half. We can calculate by eye, so it increased my math skills. Looking at the science, it increased my interest. I started to like science more. Technology and engineering increased my interest in them (S8-M-10).*
>
> *In addition to this, S14-F-10 expressed his thoughts on the benefit situation as "Yes, I can make up my mind because it improves our minds in the lessons."* stated in the format. Table 8 below shows the students' views on problem-posing with STEM for gifted activities.

Table 8. Opinions on problem-posing with STEM for gifted activities

	Students	f
Difficulty in problem-posing		
Easy	S6, S16	2
Middle	S5, S8, S9, S14,	4
Hard	S2,	1
Indecisive	S7	1
Cause of difficulty in problem solving		
We didn't do it at school.	Except for S8	7
Because I can install it easier than anyone.	S8	1
Problem-posing with STEM for gifted activities		
Improved my problem-posing skills.	All	8
Made math class easier.	S14	1
It improved my thinking skills.	S14	1
Increased my interest in math.	S14	1
My creativity has improved.	S2	1

Half of the gifted primary school students stated that they stated problem-posing as difficult, almost all of the students stated that there was no problem-posing practice at school, and that STEM for gifted activities improved their problem-posing skills. Opinions of the student coded S16-M-10 on the subject *"No, it was very nice to do with STEM for gifted activities. In this way, I can set up a better problem in the past, I couldn't at all because I didn't try. We weren't doing* *it at school, I came across it in only one homework, and that's just one"*, while the students with the coded S14-F-10 expressed their opinions as *"I think it is of medium difficulty. Thanks to STEM for gifted activities, it improved my brain on problem solving. It facilitated the mathematics lesson, my thinking skills improved, my interest in mathematics increased."* expressed as. The student with the code S6-M-10 said that it is not difficult, *"No, it is not difficult. At first, I couldn't pose a problem, but now I can make a problem with it"*, S2-M-10 coded student thought *"It is difficult for some to pose a problem. I could never have established it, I had no interest. We didn't do it at school. It just got easier with STEM for gifted activities. At school, I can sometimes do it faster than my friends when asked. I can pose various problems in a different way"* expressed as.

Conclusion and Discussion

In the study carried out to determine the effectiveness of STEM for gifted activities in the problem-posing skills of gifted primary school students; It has been determined that STEM for gifted activities not only improve the problem-posing skills of gifted students, but also ensure their permanence. Gifted primary school students stated that they enjoyed STEM for gifted activities, they enjoyed mostly at the design stage, and it increased their interest in science, mathematics and engineering. Gifted primary school students stated that problem-posing was moderately difficult because they did not do problem-posing activities at school, but their problem-posing skills improved thanks to STEM for gifted activities.

STEM education positively affects mathematics achievement and mathematics attitude (Yildirim & Altun, 2015). In the study, it was revealed that STEM for gifted activities improved the problem-posing skills of gifted primary school students and continued their permanence. The fact that STEM for gifted activities require calculations at the stage of testing the functionality of problem-solving-oriented products designed by students using science topics may have given students a different perspective. Because gifted students can think differently than their normally developing friends and their creative features are more developed. In Erdogan and Gul's (2020) study, gifted secondary school students were able to pose semi-structured problems of any difficulty; In the studies of Carkci, (2016) and Deringol (2019), it was concluded that the students with normal development could not solve the problems with the desired competence. In this sense, the fact that gifted students have the ability to think creatively, which is necessary for problem-posing (Daher & Anabousy, 2018; Mingus & Grassl, 1999), may be the reason why they are better at problem-posing skills than avarage student.

In the study, gifted primary school students stated that they liked STEM for gifted activities and that they enjoyed the design phase the most. In many studies, it has been concluded that students find STEM education fun and enjoy the practical activities rather than the theoretical part (Kalkan & Eroglu, 2017; Ozcelik & Akgunduz, 2018; Tiryaki, Yaman & Cakiroglu, 2021). In this study, gifted primary school students enjoyed STEM for gifted activities and they stated that they increased their interest in science, mathematics and engineering. The opinions of gifted students as enjoyed about STEM for gited activities may enable us to evaluate that it has high social validity. In another study, it was concluded that gifted students gain abilities such as cooperation, creativity, communication and critical thinking in addition to their mathematics and science achievements (Ozcelik & Akgunduz, 2017). In STEM for gifted activities, students are expected to notice the problem in a given situation, and to design after producing solutions for the problem they have noticed. In other words, the transformation of information into design rather than theory, and then into a product, increases the motivation of students (Ozcelik & Akgunduz, 2018). Students' motivation to do STEM for gifted activities by using different disciplines such as science, mathematics, engineering and technology may have increased their motivation. However, the reason why the students did not state that they increased their interest in the technology discipline may be that they did not use any software or coding via computer while designing the products. So students do not feel the importance of technology may be that they are not aware of the fact that tools such as pencils and paper are technological products.

Gifted primary school students stated that problem-posing was moderately difficult because they did not do problem-posing activities at school. Isik and Kar (2012) also concluded that students with normal development do not do enough problem-posing activities in their schools. However, gifted students in the study stated that their problem-posing abilities improved thanks to STEM for gifted activities. In this sense, the fact that the problem-posing skills of the gifted students who carry out their educational activities in the same class with the students with normal development do not develop may be due to the lack of sufficient problem-posing activities in schools. STEM for gifted activities are student-centered and that will trigger the student's different thinking skills are carried out and time is allocated for activities such as problem-posing, it can be ensured that gifted students reach the desired goal. Otherwise, as Cetinkaya and Soybas (2017) concluded, students may not be able to pose neither original nor creative problems..

Recommendations

In order to increase technology interests with gifted students, it may be necessary to implement software and coding applications while performing STEM for gifted activities .

- Different thinking skills of students can be improved by conducting studies in which different disciplines such as STEM for gifted activities take place together in schools where gifted students continue their education activities outside of SACs.
- In order not to leave the improvement of problem-posing skills of gifted students to SACs, students' problem-posing skills can be developed by making use of student-centered methods such as STEM for gifted activities in their own schools.
- The study can also be carried out with gifted secondary school students.
- The effect of STEM for gifted activities on the problem solving skills of gifted primary school students can be investigated.

Limitations of Study

Conducting this study with sixteen gifted students is a limitation and educational term. In addition, only 10 STEM for gifted activities were performed in the study.

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Appendix 1. Semi-structured Interview Questions

Semi-structured Interview Questions

Q1. Did you like STEM for gifted activities, and if so, which part did you like the most?
Q2. Did you find STEM for gifted activities useful, and if so, what are the benefits?
Q3. Is problem posing difficult, if so why, what are your views on STEM for gifted activities and problem posing?

Appendix 2. STEM for Gifted activity example

Activity title: Parachute
Theme: Motion and force- Measuring time
Materials: pet cup, rope, pompom, garbage bag, crayons
Implementation of Activity
Stage 1. Recognize the problem:
Students are asked the following questions: "How do birds reproduce, what are the endangered birds, what can be done to keep the birds extinct, how to protect the eggs of endangered birds, what kind of a safe place to store their eggs if the birds lay their eggs in their nest on a very high tree and do not return to their nests for a long time? How do you get it down from the tree?"
Stage 2. Generating solutions for the problem
Students are asked to come up with solutions for safely removing bird eggs from the tree.
Stage 3. Choose the appropriate solution
Students are guided to choose the appropriate solution from the solutions they produce.
Stage 4. Make a prototype
Students are divided into groups so that they can work collaboratively. A prototype of the parachute solution they propose is designed to remove bird eggs from waste materials from the tree.
Stage 5. Presentation
The groups take turns presenting their prototypes. They criticize the prototype (pointing out its shortcomings, reflecting its good aspects on their own projects).
Srage 6. Final
They put pom-poms on the prototypes they produce, drop them from high, and observe the descent situation safely.
Problem Posing

- Students are asked to pose a free problem about the parachute used to save bird eggs. The problems posed by the students are discussed (according to the status of having problem characteristics, being solvable, being logical).
- Eda wants to protect the eggs laid by the birds in the nests in the trees. Therefore, he decided to make a parachute to carry the eggs to safety. The parachute made by Eda can safely carry up to 6 eggs. Birds have laid 48 eggs in the bird's nest...
  Make the above statement a semi-structured problem and solve it.
  The problems posed by the students are discussed (according to the status of having problem characteristics, being solvable, being logical).

Objects	**Numbers**	**Math operations**
Parachute	240	X
Bird eggs	20	/
Tree	4	

Pose a problem with the above and solve it.
The problems posed by the students are discussed (according to the status of having problem characteristics, being solvable, being logical).