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Investigation of Seventh Grade Students' Creativity in the Problems They Posed by Using Story Cubes[1]

Sema Nur KAYA, Ministry of National Education, Türkiye,
ORCID ID: 0000-0003-4684-6362, semax055@gmail.com
Emre EV ÇİMEN*, Eskişehir Osmangazi University, Faculty of Education, Mathematics Education Department, Türkiye,
ORCID ID: 0000-0002-6835-6578, evcimen@ogu.edu.tr

Abstract: This research aimed to examine in terms of creativity the problems posed by the secondary school seventh grade students by using story cubes. In the research, qualitative research method was used in order to describe in depth the students' perspectives and their creativity in problem posing. The study group consisted of 12 students attending two public secondary schools - one in low and the other in high average achievement level- in Tepebaşı and Odunpazarı districts of Eskişehir province in 2018-2019 academic year. Mathematics course grades were taken as the basis for the selection of the students participating in the research, Considering the academic achievements of the students, two students -a girl and a boy- for each individual achievement level (high, medium and low), a total of 12 students from two schools were selected. Nine story cubes were used as the data collection tool in a semi-structured problem posing activity. The creativity of the students was evaluated in terms of fluency and flexibility criteria through the problems posed by them in the two activities. The level of fluency in the problems posed was determined by the "total number of mathematical problems posed", and the degree of flexibility was determined by the "number of different learning sub-domain of the problems posed" by looking at which learning sub-domain the problems belonged to. As a result, it was determined that the students could pose at most 12 and at least 6 problems in both activities. Based on this result, it can be stated that more than half of the students have an above-average fluency by posing problems above the average number. On the other hand, it was determined that the number of different learning sub-domain to which the posed problems belong is at most 4 and at least 2. From this result, it can be stated that the diversity of learning areas and thus the flexibility of the students is low.

Keywords: *Mathematics Education, 7th Grade, Problem Posing, Creativity, Fluency, Flexibility.*

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*** Corresponding Author**
Eskişehir Osmangazi University, Faculty of Education, Mathematics Education Department, Türkiye.

1. INTRODUCTION

Creativity emerges as a valuable quality that contributes to personal and social development for individuals (Sternberg & Lubart, 1995). Creativity, one of the four basic skills of the 21st century, has received increasing attention in psychology and education since the 1950s (Barbot, Besançon, & Lubart, 2015). However, creativity, which has been defined many times by researchers, is seen as a complex concept (Haylock, 1987; Sriraman, 2005; Mann, 2006). Although creativity was initially seen as an artistic and aesthetic phenomenon, recently researchers have broadened the approach by looking more closely at the concept of creativity in mathematics and natural sciences (Cropley, 2001, p. 5).

Different views have been put forward as to whether creativity is specific to a field or not (Sternberg, 2006). In addition, creativity, which includes creative thinking, is divided into two as "general and specific creativity". General creativity is expressed as the interaction between the ability, process and environment in which an individual or group produces a perceptible product that is both new and useful as defined in the social context (Plucker, Beghetto, & Dow, 2004, p. 90). Also, general creativity is associated with using problem-solving patterns in one domain to solve problems in another domain. On the other hand, special creativity refers to creativity in a specific field that takes into account the logical inference nature of the field (Leikin & Lev, 2012, p. 184). From this point of view, mathematical creativity is the prime example of field-specific creativity, which includes the joint work of the field of mathematics and the creativity process required for this, just like in science, medicine and literature (Sak, Ayvaz, Bal-Sezerel, & Özdemir, 2018, p. 277). In addition, researchers have considered mathematical creativity in a specific category of general creativity (Balka, 1974; Silver, 1997). Mathematical creativity is a subject that draws attention due to its ties with mathematical giftedness and advanced mathematical thinking (Singer, Pelczer, & Voica, 2014). Sriraman (2005, p. 23) stated that the definitions of mathematical creativity in the literature of mathematics and mathematics education are not clear and vague. For example, according to Sriraman (2005, p. 23), Hadamard (1945) and Poincare (1948) as the ability to distinguish or choose mathematical creativity, Brikhoff (1969) as the ability to distinguish between acceptable and unacceptable patterns, Ervynckle (1991) defined it as the ability to make non-algorithmic decision. To examine mathematical creativity, researchers have applied to teaching methods such as problem posing, multiple solution tasks, problem solving and open-ended problems (Nohda, 1995; Silver, 1995; Leikin, 2009, 2018; Guberman & Leikin, 2013). Addressing problem solving skills through non-routine problems contributes to students' metacognitive skills and creativity. (Hacisalihoğlu-Karadeniz, & Şehit, 2022; Yıldız, Baltacı, Kurak, & Güven, 2012). As non-routine problem solving is a way of demonstrating mathematical creativity, problem posing too, is one of the teaching methods that demonstrates mathematical creativity (Sriraman, 2005; Yuan & Sriraman, 2011; Albert & Kim, 2013). In addition, Silver (1994, 1997) introduced three criteria to examine mathematical creativity in problem posing, namely fluency, flexibility and originality. In the context of these criteria (fluency, flexibility and originality) established for problem posing, the cognitive consequences of mathematical creativity are focused.

Problem posing is considered as a creative process in itself (Dillon, 1998; Voss & Means, 1989 as cited in Leung, 1997, p. 81; Torrance, 1988, p. 47) Problem posing is the process of perceiving creativity, difficulties, problems, knowledge gaps, missing items, skewness of something, and then making predictions about these deficiencies, forming hypotheses and re-evaluating and testing these predictions and hypotheses as much as possible together with them by examining and testing, and finally conveying the results (Act. Saeki, Fan and Van Dusen, 2001, p. 24). Therefore, problem posing is an important skill in terms of creativity. Because it can be said that problem posing also serves the purpose of enriching creativity in individuals (Silver, Kilpatrick, & Schlesinger, 1990). On the other hand, Freire stated that problem posing is based on creativity and encourages correct reflections on reality (Act. Lewis, Petrina, & Hill, 1998, p. 5). Therefore, problem posing studies pave the way for the creativity of individuals to emerge. On the other hand, many researchers (Krutetskii, 1976; Haylock, 1997; Silver, 1997) agree that there are three basic features for creative thinking and products: fluency, flexibility and originality (Saeki, Fan & Van Dusen, 2001, p. 25). In addition, it can be said that the main features of creativity are indicators that aim to reveal the creative thinking of students in problem solving and posing studies (Silver, 1997).

Various studies on problem posing and creativity have been conducted by researchers in the literature (Amalina, Amirudin, & Budiarto, 2017; Daher & Anabousy, 2018; Dickman, 2014; Khutobah, Yuliati, Indriati, & Hussen, 2017; Kontorovich, Koichu, Leikin, & Berman, 2011; Leung, 1997; Leung & Silver, 1997; Singer, Pelczer & Voica, 2014; Shriki, 2013; Singer & Voica, 2015; Pelczer & Rodríguez, 2011; Van Harpen & Sriraman, 2012; Yuan & Sriraman, 2011; Zakaria & Salleh , 2012). Researchers in the related literature (Cai & Hwang, 2002; Kontorivich, Koichu, Leikin, & Berman, 2011; Silver, 1994, 1997; Silver & Cai, 2002; Yuan & Sriraman, 2010) have identified fluency, flexibility and originality in creativity studies with problem posing skills considered as categories. On the other hand, Siswono (2004) defined the theory of "Levels of Creative Thinking - [LCT]" when students pose problems. Siswono (2004, 2009) based the Level of Creative Thinking - (LCT) on the three basic components of creativity by Krulik and Rudnick (1995) and Silver (1997), which are fluency, flexibility and originality.

When the national and international literature on mathematics education is examined, in the majority of the researches; the relationship between students' problem posing and creativity was tried to be measured with standard tests, and most of the studies were put forward within the limits of quantitative measurement tools. From this point of view, it is seen that there are limited studies that examine the relationship between problem posing and creativity of students in a holistic way and examine in-depth. In this research, it is aimed to examine the problems created by seventh grade students using story cubes in terms of creativity.

2. METHODOLOGY

In this research, qualitative research method was used to describe the students' perspectives and their creativity in problem posing in depth. Qualitative research allows in-depth analysis of individuals' perceptions, experiences and attitudes (Güler, Halıcıoğlu, & Taşğın, 2015). Case study model, one of the qualitative research designs, was used in the research. The case study is defined as an empirical research type that seeks answers to the questions of "how and why"

specific to the current situation under investigation and allows the researcher to collect rich data in depth (Yin, 2014; cited in Saban & Ersoy, 2016, p. 113).

2.1. Research Participants

The study group of the research consisted of a total of 12 students attending two public secondary schools with low and high achievement levels in Tepebaşı and Odunpazarı Districts of Eskişehir province in the spring semester of 2018-2019 academic year. Mathematics course grades were taken as the basis for the selection of the students participating in the research, and two students (one girl and one boy) from each high, medium and low levels, 6 students from each school, total 12 students were selected (Table 1). Purposeful sampling technique, which is one of the non-probabilistic sampling techniques, was used in the research. Purposeful sampling means choosing situations that are rich in information so that the research can be done in depth; it provides the opportunity to understand these situations in depth (Patton, 2014, p. 230). There are many methods used within the scope of purposeful sampling, and the maximum variation method was used in the research. Maximum diversity aims to find and define the main themes with many differences (Patton, 2014, p. 235). However, maximum diversity is the determination of homogeneous or different situations within the problem being examined and the study is carried out on these situations (Büyüköztürk, Çakmak, Akgün, Karadeniz, & Demirel, 2013). In the selection of the students of the study group, attention was paid to the selection of students who could express themselves well. In the study, the names of the students were kept confidential considering the scientific research ethics, and the students coded as S1, S2, S3,… , S12. The distribution of the students selected from both low and high - achieving schools, is given below. The students coded with odd numbers represent male students, and those coded with even numbers represent female students. The study group students and their achievement levels from the selected schools as follows:

- Low Success School-1:
  Low Level (S1, S2), Medium Level (S3, S4), and High Level (S5, S6)
- High Success School-2:
  Low Level (S7, S8), Medium Level (S9, S10), and High Level (S11, S12)

The application of the research was carried out in the spring semester of the 2018-2019 academic year in two public secondary schools, respectively, in Tepebaşı and Odunpazarı districts in Eskişehir - Türkiye. The schools were determined as low and high achievement levels based on the LGS (High School Entrance Examination) exam results held in the 2017-2018 academic year. The low and high-achieving schools were coded as School-1 and School-2, respectively, by the researcher. The other reason for choosing these schools is that the students have similar socio-economic levels and there are suitable environments for conducting interviews at the school. In addition, School-1 socio-economic level is below normal and School-2 socio-economic level is above normal. During the research process, interviews were conducted with each of the students individually and face-to-face in the library of the school, which is a quiet environment where students feel comfortable.

2.2. Data Collection Tools

In the research, nine wooden small story cubes with different shapes carved on each side were used (Figure 1). In this activity, the students were asked to take all 9 story cubes in their palms and throw them randomly on a table at once. Afterwards, they were asked to choose at least two or more of the story cubes scattered on the table and pose problems using the images on the top of them. It was also stated that they could reuse an image to pose another problem. The same problem posing activity in both schools was prepared separately in the form of worksheets suitable for the story cube, to be performed once. The students were asked to pose as many problems as they could without time limit in accordance with the related problem posing activity.

Picture 1. *Story Cubes*

2.3. Data Analysis

The potential creativity of the students was evaluated with the criteria of "fluency" and "flexibility" through the problems established in the research. The opinions of one expert in the field of mathematics education and two experts in teaching mathematics to the gifted were consulted for the examination and the criteria determined. As a result of the expert opinion that it would not be appropriate to determine the originality criterion in the products of the secondary school students in determining their potential creativity, the originality criterion was not taken into account, and the fluency and flexibility criteria were taken as the basis for potential creativity. With the expert opinion, it was decided to determine the fluency of the students in the problems they posed by the "total number of mathematical problems posed", and their flexibility to be determined by the criterion of "number of different learning sub-domain" by examining the distribution of the problems posed by the students in different learning areas. For both potential creativity indicators, the students were divided into three different groups with the analyzes made. Statistical processes were performed to determine the groups in question and expert opinions were taken before and after the formation of the groups. These groups were determined as low, medium and high levels; in this grouping, firstly, intervals were created, and each student's fluency and flexibility levels were determined by determining and grouping the remaining number values in the relevant intervals. In the activity of problem posing with story cube, fluency was determined as low level (6, 7), medium level (8, 10) and high level (11, 12); flexibility was determined as low (2), medium (3) and high (4).

3. FINDINGS

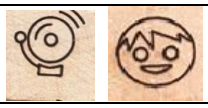
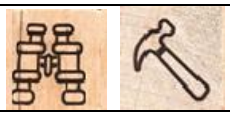
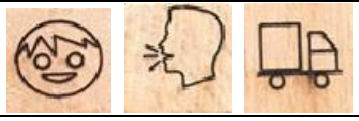
As a result of the analyzes, the students were examined in three groups as low potential creative, medium potential creative and high potential creative, considering the criteria of fluency (total number of problems posed by students) and flexibility (total number of problems posed in accordance with different learning sub-domain). The findings obtained from the problems posed by the students are presented below for each school type.

3.1. Findings Obtained from the Application in School-1

Findings obtained from the problems posed by the students coded as S1 and S2, who have ***low achievement levels***, are given as follows respectively.

***The Student S1*:** Potential creativity of the student coded S1 was determined as medium level in the evaluation of the story cubes. It was determined that the student S1 posed 8 correct/appropriate mathematical problems in the story cubes activity. It was observed that this student posed his problems by using cubes in sets of two, three, four and five. The use of cubes and their problem codes are given in Table 1 below.

Table 1. *Student S1's Problem Posing Performance by Using the Story Cubes*

Number of Images Used	Shapes on the Surfaces of the Cubes	The Code of the Problem Posed
Use of 2 Cubes		S1P3
		S1P4
		S1P7
Use of 3 Cubes		S1P1
		S1P8
Use of 4 Cubes		S1P2
Use of 5 Cubes		S1P5
		S1P6

As can be seen in Table 1, student S1 posed three problems (S1P3, S1P4, S1P7) by using 2 cubes, two problems by using 3 cubes (S1P1, S1P8), one problem (S1P2) by using 4 cubes, and two problems by using 5 cubes (S1P5, S1P6). It was observed that these problems are distributed in 3 different learning sub-domains (Operations with Natural Numbers, Operations with Fractions, Measuring Length and Time). It was determined that the problems S1P1, S1P4, S1P6 and S1P7 are related to Operations on Natural Numbers, S1P3 and S1P8 are related to Measuring Length and Time, and S1P2 is related to Operations with Fractions. In Figure 1 below, three sample problems posed by S1 are shown.

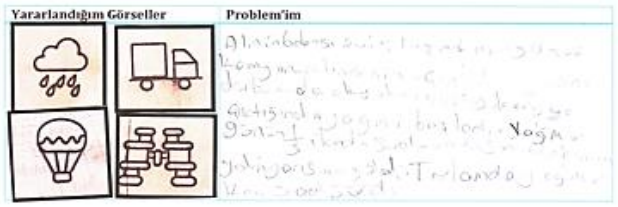
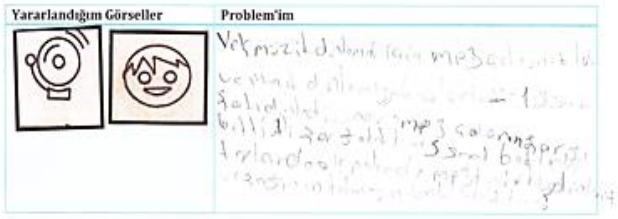
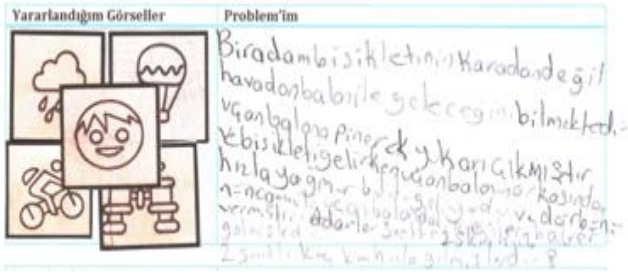
Sample Problem Posed by the Student S1 (Turkish)	English Translation of the Posed Problem
	Ali's father went upstairs, taking the flying balloon and binoculars with him to watch the truck coming to carry his house. When he got up, it started to rain, it lasted for 1/5 of the day, and the last truck came halfway down the road. How many hours did it rain in total? (S1P2 - Operations with Fractions)
	Veli found his mp3 player to listen to music and started to listen to music. Ali listened to the song for 1.5 hours. Then the mp3 player ran out of charge. Ali plugged it to the charger and waited for 3 hours. In total, how many mp3 songs did Ali listen to and wait for it to be charged? (S1P3 - Measuring Length and Time
	A man knows that his bike will come from air by balloon, not by land. He got on the flying balloon and rose up. And as his bike was coming, a rain cloud was coming from behind the flying balloon. And he informed the people in the flying balloon with the glass of the binoculars. How many kilometers did the men come in 2 hours at a speed of 25 kilometers per hour? (S1P6 - Operations with Natural Numbers)

Figure 1. *Problems: S1P2, S1P3 & S1P6*

In Figure 1, the problem S1P2 is in the sub-domain of Operations with Fractions since it includes fractions, S1P3 is in the sub-domain of Measuring Length and Time since it includes information about hour and minute, and S1P6 is in the sub-domain of Operations with Natural Numbers since it includes subtraction.

***The Student S2*:** The potential creativity of the student S2 was found to be low in the problems posed by the story cubes. It was seen that this student posed 7 correct/suitable mathematical problems in the story cubes activity. This student posed the problems by using the cubes in double and in triple, as shown in Table 2 below.

Table 2. *Student S2's Problem Posing Performance by Using the Story Cubes*

Number of Images Used	Shapes on the Surfaces of the Cubes	The Code of the Problem Posed
Use of 2 Cubes		S2P1
		S2P2
		S2P4
		S2P7
Use of 3 Cubes		S2P3
		S2P5
		S2P6

As seen in Table 2, the student S2 posed four problems (S2P1, S2P2, S2P4, S2P7) by using two cubes and three problems (S2P3, S2P5 and S2P6) by using three cubes. In Figure 2 below, two sample problems posed by S2 are shown.

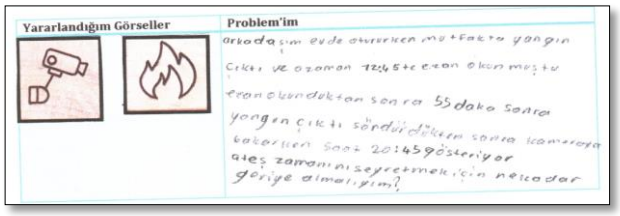
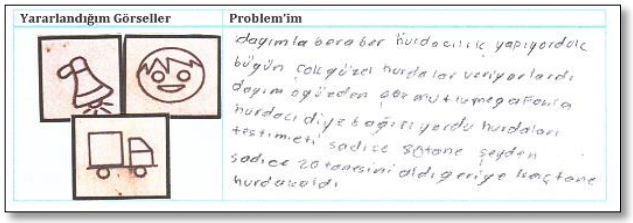
Sample Problem Posed by the Student S2 (Turkish)	English Translation of the Posed Problem
	While my friend was sitting at home, a fire broke out in the kitchen and at that time the call to prayer was read at 12:45. After the call to prayer, the fire broke out 55 minutes later, after extinguishing it, it shows 20:45 while looking at the camera. How far back should I go to watch the fire time? (S2P1 - Measuring Length and Time)
	we were doing scrap business with my uncle today they were giving away very nice scraps my uncle was so happy he was shouting on the megaphone "Scrap Dealer" delivery the scraps only took 20 out of 80 things how many scraps are left. (S2P6 - Operations with Natural Numbers)

Figure 2. *Problems: S2P1 & S2P6*

In Figure 2, the problem S2P1 is in for the sub-domain of Measuring Length and Time, since it includes information about hour and minute. The problem S2P6 is in the sub-domain of Operations with Natural Numbers since it includes subtraction.

Findings obtained from the problems posed by the students S3 and S4, who have ***medium achievement levels***, are given as follows respectively.

The Student S3: It was seen that the medium-achieving S3 student posed 6 correct/appropriate mathematical problems, and his potential creativity was determined as low. S3 posed the problems using the related cubes in pairs and triples as given in Table 3 below.

Table 3. *Student S3's Problem Posing Performance by Using the Story Cubes*

Number of Images Used	Shapes on the Surfaces of the Cubes	The Code of the Problem Posed
Use of 2 Cubes		S3P1
		S3P2
		S3P3
		S3P4
Use of 3 Cubes		S3P5
		S3P6

As seen in Table 3, S3 posed four problems (S3P1, S3P2, S3P3, S3P4) by using two cubes, and two problems (S3P5, S3P6) by using three cubes. It was observed that the problems he posed were distributed in 2 different sub-domains (Operations with Natural Numbers, Length and Time Measurement). In these problems, while the sub-domains were Operations on Natural Numbers for S3P2, S3P3 and S3P4, it was seen that they were related to Measuring Length and Time for S3P1, S3P5 and S3P6. Figure 3 below shows sample problems posed by the student S3.

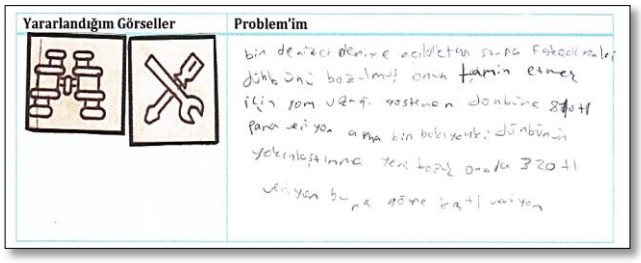
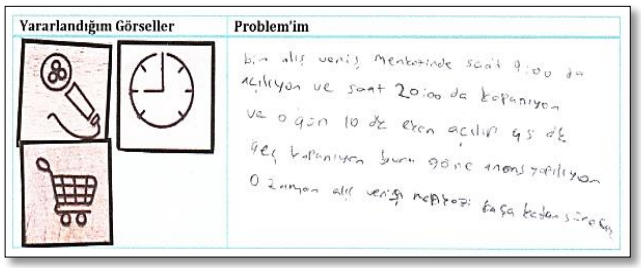
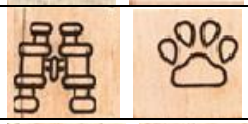
Sample Problem Posed by the Student S3 (Turkish)	English Translation of the Posed Problem
	After a thousand sailors go to sea, they realize that their binoculars are broken, they pay 810 TL for the binoculars that show 80 meters away to make sure of it, but they see that the zooming point of the binoculars is broken, and he gives 320 TL how much does he pay accordingly. (S3P4 - Operations with Natural Numbers)
	BİM opens at 9:00 in the shopping center and closes at 20:00, and if it opens in 10 minutes and closes 45 minutes late that day, the announcement is made accordingly, then until what time will the shopping center last. (S3P5 - Measuring Length and Time)

Figure 3. *Problems: S3P4 & S3P5*

As seen in Figure 3, the problem S3P4 is in the sub-domain of Operations with Natural Numbers since it requires addition. The problem S3P5 was evaluated to be in the sub-domain Measuring Length and Time since it includes operations with time.

The Student S4: It was determined that the student S4, who have medium achievement level, posed 6 correct/appropriate mathematical problems using the story cubes and his potential creativity was evaluated as low. S4 posed the problems using the related cubes in pairs and triples as given in Table 4 below.

Table 4. *Student S4's Problem Posing Performance by Using the Story Cubes*

Number of Images Used	Shapes on the Surfaces of the Cubes	The Code of the Problem Posed
Use of 2 Cubes		S4P1
		S4P2
		S4P3
		S4P4
		S4P6
Use of 3 Cubes		S4P5

As seen in Table 4, the student S4 posed five problems (S4P1, S4P2, S4P3, S4P4, S4P6) by using the cubes in pairs, and one problem (S4P5) by using three cubes. It was observed that the problems posed by this student are distributed in 2 different learning sub-domain (Operations with Natural Numbers, Operations with Fractions). It was determined that the learning sub-domain of the problems S4P1, S4P2 and S4P3 was Operations with Fractions, while the sub-domain of the problems S4P4, S4P5 and S4P6 was Operations with Natural Numbers. Figure 4 below shows sample the problems posed by S4 and their learning sub-domains.

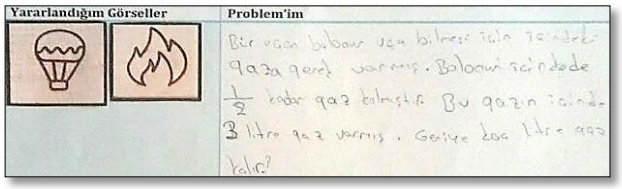
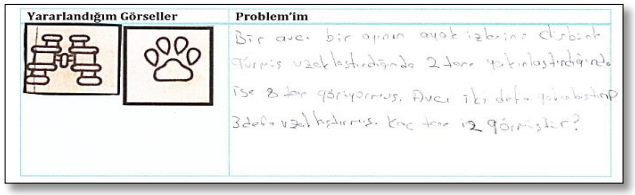
Sample Problem Posed by the Student S4 (Turkish)	English Translation of the Posed Problem
	A flying balloon needed gas in order to fly. There is about ½ gas left in the balloon. This gas contains 3 liters of gas. How many liters of gas are left? (S4P2 - Operations with Fractions)
	A hunter saw the footprints of a bear with binoculars, and when he zoomed in, he saw 2, and when he zoomed in, he saw 8. The hunter zoomed in twice and zoomed out 3 times. How many footprints has he seen? (S4P6 - Operations with Natural Numbers)

Figure 4. *Problems: S4P2 & S4P6*

As seen in Figure 4, since there are fractional numbers in S4P2, it was evaluated that the problem is in the "Operations with Fractions" sub-domain. It was evaluated that S4P6 is a problem that requires Operations with Natural Numbers.

Findings obtained from the problems posed by the students coded S5 and S6, who have ***high achievement levels***, are given as follows respectively.

The Student S5: The potential creativity of the student S5 was evaluated as moderate. It was determined that S5 posed 10 correct/appropriate mathematical problems in the story cubes activity. The student S5 posed his problems using cubes of three, four and five as shown in Table 5 below.

Table 5. *Student S5's Problem Posing Performance by Using the Story Cubes*

Number of Images Used	Shapes on the Surfaces of the Cubes	The Code of the Problem Posed
Use of 3 Cubes		S5P8
		S5P9
Use of 4 Cubes		S5P1
		S5P2
		S5P3
		S5P6
Use of 5 Cubes		S5P4
		S5P5

	S5P7
	S5P10

As seen in Table 5, student S5 posed two problems (S5P8, S5P9) using cubes in three, four problems (S5P1, S5P2, S5P3, S5P6) using cubes in four, and four problems and using cubes in five (S5P4, S5P5, S5P7, S5P10). Figure 5 below shows sample problems posed by S5 and the learning sub-domains.

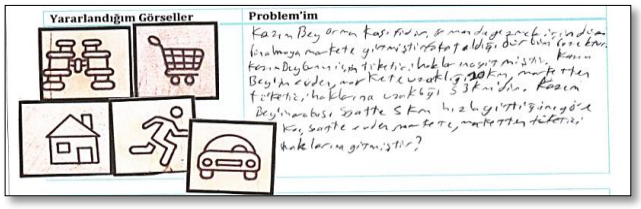
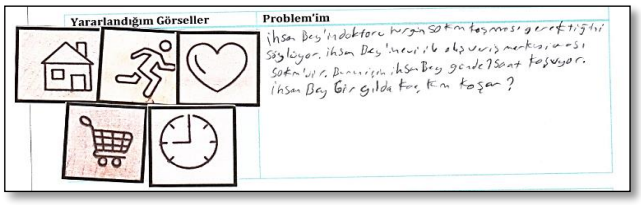
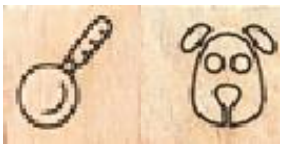
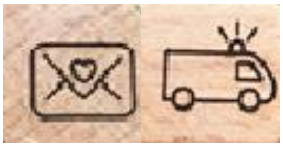
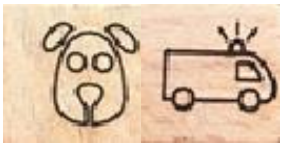
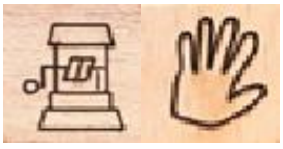
Sample Problem Posed by the Student S5 (Turkish)	English Translation of the Posed Problem
	Mr. Kazım is a forest explorer. He went to the market to buy binoculars for a walk in the forest, but the binoculars he bought were broken. Mr. Kazım went to consumer rights for this. Mr. Kazım's distance from the house to the market is 10 km, and the distance from the market to the consumer rights is 53 km. Since Mr. Kazım's car is traveling at a speed of 5 km per hour, how many hours did he go from home to the market, from the market to the consumer rights? (S5P5 - Operations with Natural Numbers)
	Mr. İhsan's doctor says he should run 50 km every day. The distance between Mr. İhsan's house and the shopping center is 50 km. For this, Mr. İhsan runs for 1 hour a day. How many kilometers does Mr. İhsan run in a year? (S5P10 - Ratio and Proportion)

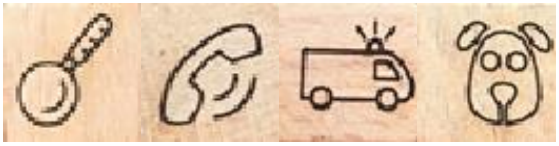
Figure 5. *Problems: S5P5 & S5P10*

In Figure 5, S5P5 belongs to the learning sub-domain of Operations with Natural Numbers since it requires four operations. Since the two quantities were compared in the problem S5P10, it was determined to be in the "Ratio and Proportion" learning sub-domain.

The Student S6: The potential creativity level of the student S6 was evaluated as high in the problems he/she posed. This student posed a total of 12 correct/appropriate mathematical problems as shown in Table 6 below.

Table 6. *Student S6's Problem Posing Performance by Using the Story Cubes*

Number of Images Used	Shapes on the Surfaces of the Cubes	The Code of the Problem Posed
Use of 2 Cubes		S6P1
		S6P3
		S6P5
		S6P6
		S6P7
		S6P9
		S6P11
		S6P12
Use of 3 Cubes		S6P2
		S6P4
		S6P10

Use of 4 Cubes		S6P8

As seen in Table 6, student S6 posed eight problems (S6P1, S6P3, S6P5, S6P6, S6P7, S6P9, S6P11, S6P12) using cubes in pairs, and three problems (S6P2, S6P4, S6P10) using cubes in groups of three, and one problem (S6P8) using 4 cubes. It was determined that these problems are distributed in four different learning sub-domains (Operations with Natural Numbers, Operations with Fractions, Ratio-Proportion, Measuring Length and Time). It was determined that S6P1, S6P2, S6P8 are in the domain of Operations with Natural Numbers; S6P9, S6P10, S6P11 are in the domain of Operations with Fractions; S6P3, S6P4, S6P5, S6P6, S6P12 in the domain of Measuring Length and Time and S6P7 is in the domain of Ratio and Proportion. In Figure 6 below, the student S6's three sample problems belonging to different learning sub-domains are given.

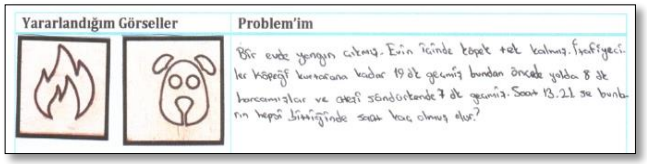
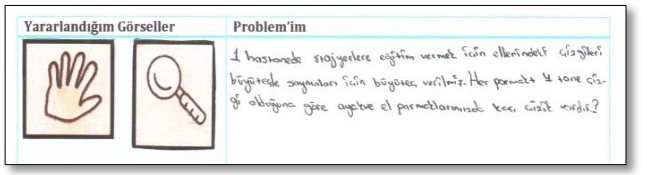
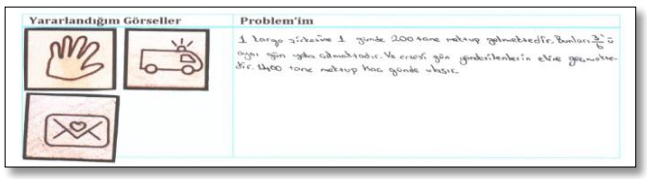
Sample Problem Posed by the Student S6 (Turkish)	English Translation of the Posed Problem
	There was a fire in a house. The dog was alone in the house. 19 minutes passed before the firemen rescued the dog, and before that, they spent 8 minutes on the road and 7 minutes passed while putting out the fire. If it's 13.21, what time will it be when all this is over? (S6P3 - Measuring Length and Time)
	In one hospital, a magnifying glass was given to trainees to count the lines in their hands with a magnifying glass to train them. If there are 7 lines on each finger, how many scratches are there on our toes and fingers? (S6P7 - Ratio and Proportion)
	1 cargo company receives 200 letters in a day. 3/6 of them depart on the same day. And the next day, they are is in the hands of the receivers. In how many days will 1400 letters arrive. (S6P10 - Operations with Fractions)

Figure 6. *Problems: S6P3, S6P7 & S6P10*

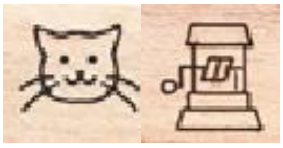
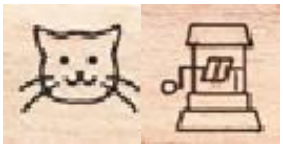
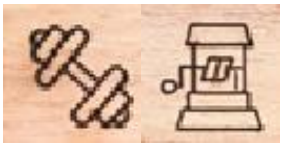
As seen in Figure 6, the problem S6P3 belongs to the "Operations with Fractions" learning sub-domain, since it includes fractional numbers. S6P7 belongs to the sub-domain of Measuring Length and Time since there is information about hour and minute. S6P10 belongs to the "Ratio and Proportion" sub-domain since there is a comparison of two quantities.

3.2. Findings Obtained from Application in School-2

Findings obtained from the students S7 and S8 who have **low achievement levels** are given below, respectively.

***The Student S7*:** The potential creativity of the student S7 was determined as high in the evaluation of the story cubes. It was determined that the student S7 posed 11 correct/appropriate mathematical problems in the story cubes activity as given in Table 7 below.

Table 7. *Student S7's Problem Posing Performance by Using the Story Cubes*

Number of Images Used	Shapes on the Surfaces of the Cubes	The Code of the Problem Posed
Use of 2 Cubes		S7P1
		S7P2
		S7P3 (Non-mathematical problem)
		S7P4
		S7P6
		S7P8
		S7P10
Use of 3 Cubes		S7P5
		S7P7

		S7P9
		S7P11
Use of 4 Cubes		S7P12

As can be seen in Table 8 the student S7 posed seven problems (S7P1, S7P2, S7P3, S7P4, S7P6, S7P8, S7P10) by using cubes in pairs, and four problems (S7P5, S7P7, S7P9, S7P11) by using cubes in threes, and posed one problem (S7P12) by using cubes in fours. It was found that these problems are distributed in 3 different learning sub-domains (Operations with Natural Numbers, Ratio-Proportion, Measuring Length and Time). The problems S7P1, S7P2, S7P4, S7P5, S7P7, S7P10 belong to the sub-domain of Operations with Natural Numbers; S7P6, S7P8, S7P9 belong to the sub-domain of Ratio and Proportion, and S7P11 belongs to the sub-domain of Measuring Length and Time. In Figure 7 below, sample problems posed by S7 and which belong to different sub-domains are given.

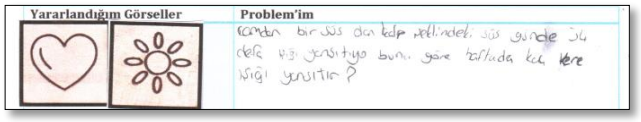
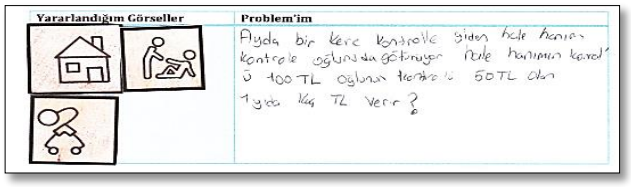
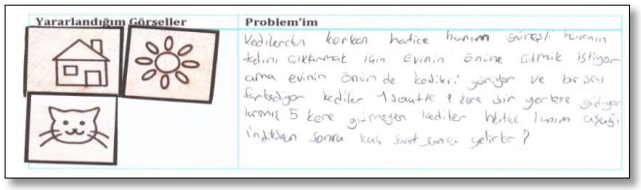
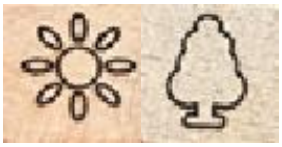
Sample Problem Posed by the Student S7 (Turkish)	English Translation of the Posed Problem
	The heart-shaped ornament, which is a glass ornament, reflects light three times a day, so how many times a week does it reflect light? (S7P6 - Ratio and Proportion)
	The lady who goes for the check-up once a month takes her son to the check-up, how much TL do they give in a year where the check of Mrs. Hale is 100 TL and the check of her son is 50 TL? (S7P7 - Operations with Natural Numbers)
	Mrs. Hatice, who is afraid of cats, wants to go out in front of her house to enjoy the sunny weather, but she sees the cats in front of her house and notices something. The cats go somewhere once in an hour. How many hours will the cats that do not go 5 times come after mrs. hatice goes down? (S7P11 - Measuring Length and Time)

Figure 7. *Problems: S7P6, S7P7 & S7P11*

As seen in Figure 7, the problem S7P6 belongs to the sub-domain of "Ratio and Proportion" since it includes comparison of two quantities. S7P7 belongs to the sub-domain of Operations with Natural Numbers, since it requires four operations to be solved. And S7P11 belongs to the sub-domain of Measuring Length and Time since it includes time calculations.

The Student S8: The potential creativity of the student S8 was determined as medium level in the evaluation of the story cubes. It was determined that Student S8 posed 8 correct/appropriate mathematical problems in the story cubes activity, as given in Table 8 below.

Table 8. *Student S8's Problem Posing Performance by Using the Story Cubes*

Number of Images Used	Shapes on the Surfaces of the Cubes	The Code of the Problem Posed
Use of 2 Cubes		S8P1
		S8P2
		S8P4
Use of 3 Cubes		S8P3
		S8P5
		S8P6
		S8P7
		S8P8

As seen in Table 8, the student S8 posed three problems (S8P1, S8P2, S8P4) by using the cubes in pairs, and five problems (S8P3, S8P5, S8P6, S8P7, S8P8) by using the cubes in groups of three. It was found that these problems are distributed in 2 different learning sub-domain (Operations with Natural Numbers, Operations with Fractions). The problem S8P7 is in the sub-domain of Operations with Natural Numbers, while the remaining problems are in the sub-

domain of Operations with Fractions. In Figure 8 below, two sample problems by S8, belonging to two learning sub-domains are given.

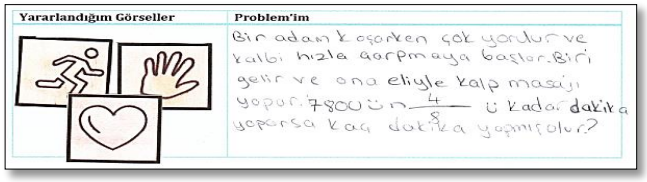
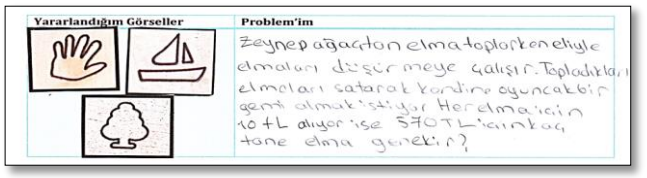
Sample Problem Posed by the Student S8 (Turkish)	English Translation of the Posed Problem
	A man gets very tired from running and his heart starts beating fast. Someone comes and gives him CPR with his hand. If he makes 4/8 of 7800 minutes, how many minutes will he have done? (S8P3 - Operations with Fractions)
	While Zeynep is picking apples from a tree, she tries to drop the apples with her hand. She wants to buy herself a toy ship by selling the apples she has collected. If she buys 10 TL for each apple, how many apples are needed for 570 TL? (S8P7 - Operations with Natural Numbers)

Figure 8. *Problems: S8P3 & S8P7*

As seen in Figure 8, since the problem S8P3 requires operations with fractions, it belongs to the sub-domain of "Operations with Fractions". The problem S8P7 belongs to Operations with Natural Numbers since it requires four operations.

The findings obtained from the problem posing works of the students S9 and S10 who have ***medium achievement levels*** are presented below, respectively.

The Student S9: It was determined that student S9 had a high level of potential creativity in the evaluation of the story cubes and posed a total of 11 correct/appropriate mathematical problems in the activity as given in Table 9 below.

Table 9. *Student S9's Problem Posing Performance by Using the Story Cubes*

Number of Images Used	Shapes on the Surfaces of the Cubes	The Code of the Problem Posed
Use of 2 Cubes		S9P1
		S9P3
		S9P4

		S9P6
		S9P7
		S9P10
		S9P12
Use of 3 Cubes		S9P2 (Non-mathematical problem)
		S9P5
		S9P11
Use of 5 Cubes		S9P8
Use of 9 Cubes		S9P9

As seen in Table 9, student S9 posed seven problems (S9P1, S9P3, S9P4, S9P6, S9P7, S9P10, S9P12) by using the cubes in pairs and three problems (S9P2, S9P5, S9P11) by using the cubes in threes, and one problem (S9P8) by using cubes in groups of five, and one problem (S9P9) by using nine cubes. It was found that these problems were distributed in 3 different learning sub-domains (Operations with Natural Numbers, Operations with Fractions, Percentages). It was evaluated that the problems S9P6, S9P7, S9P12 were in the domain of Operations with Natural Numbers; S9P1, S9P2, S9P3, S9P4, S9P5, S9P11 were the domain of Operations with

Fractions, and S9P10 was in the domain of Percentages. In Figures 9 below, student S9's sample problems regarding the two learning sub-domains are given.

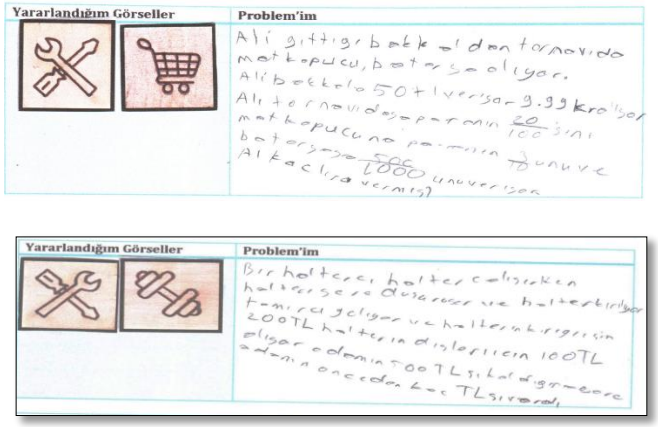
Sample Problem Posed by the Student S1 (Turkish)	English Translation of the Posed Problem
	Ali buys screwdriver, drill bit and battery from the grocery store. Ali gives 50 TL to the grocery store and receives 9.99 kr Ali gives 20/100 of the money for the screwdriver, 3/10 of the money for the drill bit and 500/1000 of it for the battery. How many liras did Ali give? (S9P1 - Operations with Fractions) While a weightlifter is working with a barbell, the barbell falls to the ground and the barbell breaks, the mechanic comes and receives 200 TL for the broken barbell, 100 TL for the outside of the barbell, if the man has 500 TL left, how many TL did he have before (S9P7 - Operations with Natural Numbers)

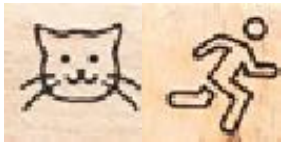
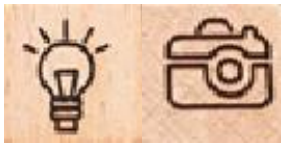
Figure 9. *Problems: S9P1 & S9P7*

As seen in Figure 9, since the problem S9P1 requires operations with fractional numbers, it is in the "Operations with Fractions" sub-domain. S9P7 is in Operations with Natural Numbers sub-domain since it requires four operations.

The Student S10: The potential creativity of student S10 was evaluated as high in the problems posed, and he posed 12 correct/appropriate mathematical problems in the story cubes activity as given in Table 10 below.

Table 10. *Student S10's Problem Posing Performance by Using the Story Cubes*

Number of Images Used	Shapes on the Surfaces of the Cubes	The Code of the Problem Posed
Use of 2 Cubes		S10P1
		S10P4
		S10P5
		S10P6

		S10P7
		S10P8
		S10P9
		S10P12
Use of 3 Cubes		S10P2
		S10P3
Use of 4 Cubes		S10P10
Use of 5 Cubes		S10P11

As seen in Table 10, the student S10 posed eight problems (S10P1, S10P4, S10P5, S10P6, S10P7, S10P8, S10P9, S10P12) by using cubes in pairs, two problems (S10P2, S10P3) by using cubes in groups of three, one problem (S10P10) by using four cubes, and one problem (S10P11) by using five cubes. It was found that these problems were distributed in 3 different learning sub-domains (Operations with Natural Numbers, Operations with Fractions, Ratio and Proportion, Measuring Length and Time). Two of the problems S10P1, S10P3 were in Operations with Fractions, three S10P2, S10P8, S10P10 were in Ratio and Proportion, six S10P4, S10P6, S10P7, S10P9, S10P11, S10P12 were found to be in the domain of Measuring Length and Time. S10's three sample problems belonging to different sub-domains are shown in Figure 10 below.

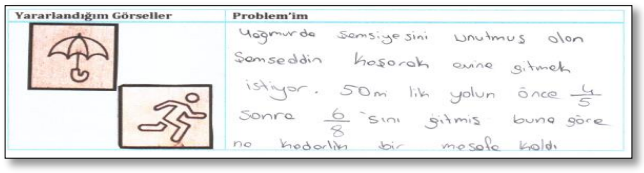
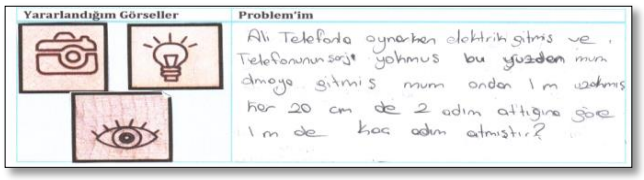
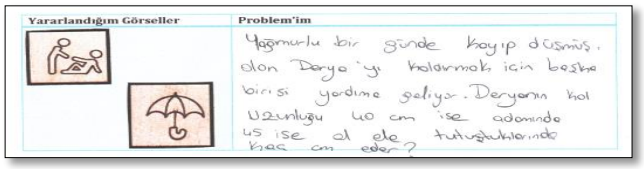
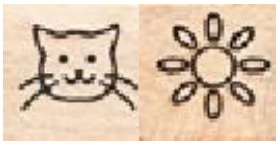
Sample Problem Posed by the Student S10 (Turkish)	English Translation of the Posed Problem
	Şemseddin, who forgot his umbrella in the rain, wants to run home. He went 4/5 and then 6/8 of the 50 m road, so how much distance is left (S10P1 - Operations with Fractions)
	While Ali was playing with the phone, the electricity went out and the phone had no charge, so he went to buy a candle. The candle was 1 m away from him. Since he took 2 steps in every 20 cm, how many steps did he take in 1 m? (S10P2 - Ratio and Proportion)
	Someone else comes to help lift Derya, who slipped and fell on a rainy day. If the arm length of Derya is 40 cm and the man's is 45, how many cm is it when they hold hands? (S10P6 - Measuring Length and Time)

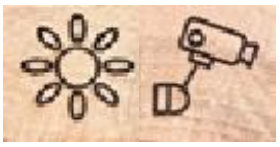
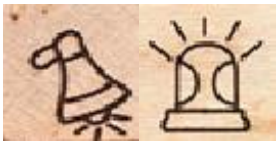
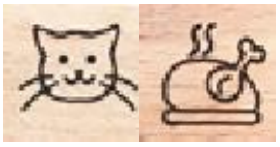
Figure 10. *Problems: S10P1, S10P2 & S10P6*

Since the problem S10P1 includes the comparison of two quantities, it belongs to the "Ratio-Proportion" sub-domain. The student S10P2 belongs to the "Operations with Fractions" sub-domain since it requires operations with fractional numbers. S10P6 belongs to "Measuring Length and Time" sub-domain since it includes length measurement.

The findings of the students S11 and S12 who have high **achievement level** are as follows:
The Student S11: It was determined that the student coded S11 had a high level of potential creativity in his problems and posed 12 correct/appropriate mathematical problems in the activity as given in Table 11 below.

Table 11. *Student S11's Problem Posing Performance by Using the Story Cubes*

Number of Images Used	Shapes on the Surfaces of the Cubes	The Code of the Problem Posed
Use of 2 Cubes		S11P1
		S11P2
		S11P4

		S11P5
		S11P6
		S11P8
		S11P9
		S11P10
		S11P11
		S11P12
Use of 3 Cubes		S11P3
		S11P7

As seen in Table 11, the student S11 posed 10 problems (S11P1, S11P2, S11P4, S11P5, S11P6, S11P8, S11P9, S11P10, S11P11, S11P129 using the cubes in pairs, and two problems (S11P3, S11P7) using the cubes in groups of three. It was found that these problems are distributed in 3 different learning sub-domains (Operations with Natural Numbers, Operations with Fractions, Ratio and Proportion). The problems S11P2, S11P3, S11P7, S11P9, S11P10, S11P11, S11P12 are in the sub-domain of Operations with Natural Numbers; S11P5, S11P6 are in Ratio and Proportion, and S11P1, S11P4, S11P8 are in Operations with Fractions. In Figure 11 below, S11's sample problem is given.

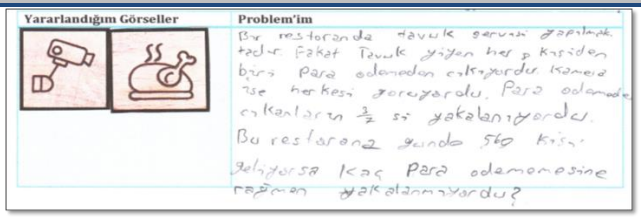
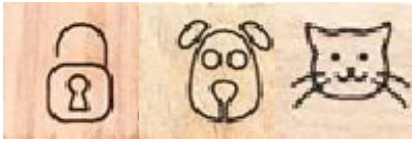
Sample Problem Posed by the Student S11 (Turkish)	English Translation of the Posed Problem
	Chicken is served in a restaurant. But one out of every 8 people who eat chicken leaves without paying. The camera was seeing everyone. 3/7 of those who left without paying were caught. If 560 people come to this restaurant a day, how much money was not caught despite not paying? (S11P8 - Operations with Fractions)

Figure 11. *Problem: S11P8*

Since the problem S11P8 requires operations with fractional numbers, it was considered to be in the "Operations with Fractions" learning sub-domain.

The Student S12: The student S12 has a low level of potential creativity in his problems; and in the story cubes activity, it was found that he posed 6 correct/appropriate mathematical problems, as given in Table 12 below.

Table 12. *Student S12's Problem Posing Performance by Using the Story Cubes*

Number of Images Used	Shapes on the Surfaces of the Cubes	The Code of the Problem Posed
Use of 3 cubes		S12P1
		S12P2
		S12P3
		S12P4
		S12P6
Use of 4 cubes		S12P5

As seen in Table 12, the student S12 posed five problems (S12P1, S12P2, S12P3, S12P4, S12P6) by using the cubes in threes and one problem (S12P5) by using four cubes. These

problems are distributed in 2 different learning sub-domains (Operations with Natural Numbers, Algebraic Expressions); it was determined that the problems S12P1, S12P2, S12P3, S12P4 are in Operations with Natural Numbers and S12P5, S12P6 are in the learning sub-domain of Algebraic Expressions. A sample problem posed by the student S12 is shown in Figure 12 below.

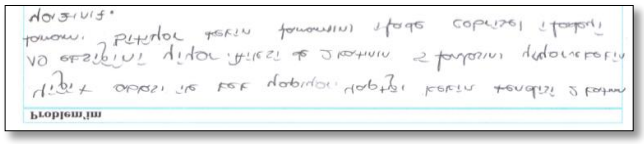
Sample Problem Posed by the Student S12 (Turkish)	English Translation of the Posed Problem
	Yigit is making cakes with his older sister. He eats 10 less than twice the cake he made. His family also eats 5 more than twice as much and the whole cake is finished. Write the algebraic expression to express the entire cake. (S12P6 - Algebraic Expression)

Figure 12. *Problem: S12P6*

It is seen that the problem S12P6 is in the sub-domain of Algebraic Expression since it clearly asks for an algebraic expression for the answer.

4. RESULTS AND DISCUSSION

In this research, the potential creativity of secondary school seventh grade students in the problems they pose about the story cube was examined, and at the end of the research, the results that were thought to contribute to mathematics education were reached.

In the problem posing activities related to the story cube, it was determined that the students posed a maximum of 12 problems and the least a total of 6 problems. From this point of view, since fluency is proportional to the number of problems posed, it can be said that fluency will increase as the number of problems posed by the students increase. On the other hand, it was determined that the number of different learning sub-domain in the problems posed by the students was at most 4 different learning sub-domain in the problem-posing activity with both story creation cards, and at least 2 different learning sub-domain. In addition, the learning sub-domain of the problems related to the story cubes were grouped under Measuring Length and Time, Operations with Natural Numbers, Operations with Fractions, Percentages, Algebraic Expressions and Ratio and Proportion, and it was seen that the students most often posed problems appropriate for the Operations with Natural Numbers learning field. In this context, since the different learning sub-domain in the problems are proportional to the flexibility, it can be said that the more the students turn to different learning sub-domains in the problems they pose, the flexibility will increase in parallel. In short, although the total number of problems that students posed is above the expected level, but the distribution of these problems in different learning areas remained low. In parallel with the study of Taşkın (2016), it was concluded that most of the students attach more importance to the number of problems than the nature and structure of the problem. In this case, it can be concluded that creativity in problem posing stands out the most with the dimension of fluency.

Both the fluency and flexibility criteria of the students in School-1 and School-2 are in three categories as low, medium and high level. The potential creativity of students with low

academic achievement level in School-1 was determined as medium level (S1) and low level (S2). Potential creativity was determined as low level in all of the students whose academic achievement level was medium. The potential creativity of the students with high academic achievement levels of the school in question took place in the middle level (S5) and high level (S6) categories. On the other hand, the potential creativity of students with low achievement level in School-2 was determined as medium (S8) and high (S7). It was observed that all of the students with medium achievement level had a high level of potential creativity. In addition, the potential creativity of students with a high achievement level is in the low level (S12) and high level (S11) categories. On the other hand, it can be said that the potential creativity of S12 in School-2 is low, which constitutes a remarkable dimension of the research. As a result, in the light of these findings, it does not present a direct relationship between academic achievement and students' problem posing activities and their potential creativity. On the other hand, Haylock (1987) also concluded in his study that students with the same level of academic achievement in mathematics can display different performances in their mathematical creativity.

When school types are evaluated in terms of socioeconomic status, it can be said that the potential creativity of students studying at a school with a socioeconomic level above normal is more successful in problem posing than students studying at a school with a socioeconomic level below the normal level. However, in parallel with this study, similar results were obtained to the study conducted by Arıkan and Ünal (2013). However, in the study of Turhan Türkkan (2018), no significant difference was found between the achievements of the students according to their school levels. From this point of view, it can be said that there are differences between the research results.

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It was determined that the students with medium academic level in School-2 have higher level of fluency criteria because they have more problems than students with medium academic level in School-1. On the other hand, considering the flexibility criteria of the students in question, it was seen that School-1 was at a low level and School-2 was at a medium level (S9) and high level (S10). On the other hand, it is seen that the flexibility criteria of students with high achievement level differ at school level. On the other hand, while it was determined as both low level (S5) and high level (S6) in School-1, it was stated as medium level (S11) and low level (S12) in School-2. As a result, regardless of the type of school, the fact that students pose problems related to a small number of learning sub-domain is an indication of their inflexibility. However, the students' lack of knowledge in different subject areas of mathematics affected flexibility negatively. Likewise, the study of Van Harpen and Sriraman (2013) is similar to the

result of this study in which students pose problems in at most two categories and therefore they can be accepted as having low flexibility.

Studies on different dimensions of creativity have concluded that girls are more successful than boys (De Moss, Milich, & DeMers, 1993; Cheung & Lau, 2010). In this study, it was determined that there were girls (S6 and S10) who had a high level of flexibility in the problems posed similarly. However, it was observed that the gender factor was not effective in the fluency criterion. This is another important result of the research.

As another result of the study, it was observed that the students had difficulties in posing problems. It can be said that this negatively affects the potential creativity of students in problem posing. Since there is a remarkable relationship between problem posing skills and mathematical knowledge (Van Harpen & Presmeg, 2013), the fact that students did not have enough mathematical knowledge may have affected their problem posing skills. Likewise, in the study of Işık and Kar (2012), it was determined that problem posing skills were negatively affected in line with their deficiencies in conceptual knowledge about mathematics. In addition, in the study of Şengül-Akdemir and Türnüklü (2017), it was seen that the mathematical information obtained from the students' conceptual images from their past lives affected the problem posing process. In addition, students may have negatively affected their creativity due to the fact that they do not know what a problem means. Similarly, Aydoğdu (2019) stated in his study that this reason may be an indicator of the challenge of students in posing problems. In this study, the fact that the students did not encounter the problem posing activity before may have affected their potential creativity in the problems they posed. Similarly, Cai, Jiang, Hwang, Nie, and Hu (2016) stated that the inadequacy of problem posing is related to students' problem posing experiences. On the other hand, in the study conducted by Amalina, Amirudin, and Budiarto (2018), it was determined that the creativity of students in problem posing depends on their experiences in mathematics learning.

As another result of the study, the students posed at least 6 problems. In the study of Bonotto and Dal Santo (2015), it was determined that students belonging to two school types with different success levels posed 2-3 problems on average. From this point of view, it can be said that there are differences between the results of the study. This difference in the two studies can be shown to the importance of the time devoted to problem posing for students.

5. RECOMMENDATIONS

For further research recommendations; similar to this research, which is carried out in a semi-structured form with story cubes, semi-structured or free problem posing activities can be carried out with various, original materials. Students' problem posing and creativity skills can be examined by designing and applying research in which different tools are included in the problem posing process. This research can be replicated with similar applications at different grade levels. Also, the relationship between problem posing and creativity can be examined with quantitative methods.

6. ABOUT THE AUTHORS

Sema Nur KAYA: She is a secondary school mathematics teacher and a postgraduate student in the field of mathematics education. Her areas of study include problem solving, problem posing and creativity.

Emre EV ÇİMEN: Assistant Professor at the Department of Mathematics Education. Her areas of interest include problem solving, problem posing, interdisciplinary approach, and open and distance education.

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